West Valley Feasibility Study

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

Burns and Roe Industrial Services Corporation

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

This report was prepared as a summary of work sponsored by the United States Government. The work was performed as part of the definition phase of a program to solidify liquid high-level radioactive waste stored at the Western New York Nuclear Service Center, West Valley, New York. Neither the United States nor the United States Department of Energy, nor any of their employees, make any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. The discussion and recommendations contained herein are neither approved or disapproved by the Government. References herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof.

This material and information does not purport to present an exhaustive treatment of the subject matter. For a title list or information on a specific subject, please write to the DOE, Technical Information Center, P.O. Box 62, Oak Ridge, Tennessee 37830.

WEST VALLEY
FEASIBILITY STUDY

BURNS AND ROE INDUSTRIAL SERVICES CORPORATION
PARAMUS, NEW JERSEY

JOHN PIRRO
PROJECT MANAGER

JANUARY 1981

PREPARED FOR
U. S. DEPARTMENT OF ENERGY
UNDER
CONTRACT No. DE-AC02-8ET44207

This report was prepared as a summary of work sponsored by the United States Government. The work was performed as part of the definition phase of a program to solidify liquid high-level radioactive waste stored at the Western New York Nuclear Service Center, West Valley, New York. Neither the United States nor the United States Department of Energy, nor any of their employees, make any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. The discussion and recommendations contained herein are neither approved or disapproved by the Government. References herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof.

This material and information does not purport to present an exhaustive treatment of the subject matter. For a title list or information on a specific subject, please write to the DOE, Technical Information Center, P.O. Box 62, Oak Ridge, Tennessee, 37830.

FOREWORD

This report was prepared by the Burns and Roe Industrial Services Corporation (BRISC) for the Department of Energy (DOE). It incorporates in one document the studies made by BRISC regarding the feasibility of using certain Western New York Nuclear Service Center (WNYNSC) Facilities to solidify and provide interim storage of High Level Liquid Wastes (HLLW).

The WNYNSC is located in West Valley, Town of Ashford, Cattaraugus County, New York and is the only commercially licensed nuclear fuel reprocessing plant. However, the Center has been shut down since 1972 and the HLLW resulting from reprocessing irradiated nuclear fuel is presently stored in large underground tanks at the Center. The Office of Nuclear Waste Management of DOE is responsible for performing studies to support a proposed project to solidify the HLLW.

BRISC and its subcontractor, Nuclear Energy Services, Inc. (NES), have supported this effort through eight (8) study tasks which are described in this report. The tasks are listed in Table 1 and their interrelationship is described below.

Task 1, Decontamination and Decommissioning of the Process Building, was performed by NES. The purpose of this task was to study means by which the radioactive areas in the fuel process building could be decontaminated to permit installation of solidification equipment and/or store solidified waste. As part of this study an assessment was made of radiation exposure, the cost required for decontaminating the desired areas, of desirable facility features that could be designed to reduce decontamination costs and of the cost required to decommission the facility when all the HLLW had been solidified.

In Task 2, studies were performed to identify the feasibility and cost of storing the canisters filled with solidified waste in the hot cells and/or fuel storage pool.

In Task 3, the seismic capability of the process building was studied. The feasibility and cost of including features which could be incorporated to increase the seismic resistance of the plant or to mitigate consequences of a seismic event were studied.

In Task 4, an assessment was made of the requirements for handling Low Level Wastes which would be generated during the initial decontamination, HLLW solidification, and decommissioning phases of the facility.

In Task 5, an assessment was made of the method and cost required to remotely remove fuel processing equipment, to remotely install solidification equipment and to remotely remove solidification equipment at the end of the project.

Task 6 was initiated to investigate possible management approaches that could be considered if the New York State Energy Research and Development Authority and DOE each had separate responsibilities at the WNYNSC at the same time during the HLLW solidification project.

The assessment in Task 2 showed that there was only marginal capacity to store all the canisters with solidified High Level Waste in the process building cells and the Chemical Process Cell was the only cell with reasonable capacity. However, this cell is also under consideration to be used as the area where solidification equipment will be installed. Therefore, the studies in Task 7 were undertaken to assess the cost of a separate facility to store canisters containing solidified High Level Waste. The studies in Task 8 were undertaken to assess the cost of a separate facility wherein the HLLW solidification equipment can be installed. These studies therefore addressed the costs of various options that can be selected to provide space for the installation of the HLLW solidification equipment and the storage of the canisters filled with solidified High Level Waste.

TABLE 1

TASKS FOR WEST VALLEY FEASIBILITY STUDY

<u>Task No.</u>	<u>Title</u>
1	Decontamination and Decommissioning of West Valley Process Building
2	Facility Utilization Studies
3	Seismic Study
4	Low Level Waste Management
5	Remote Removal and Installation of Solidification Equipment
6	Management Alternatives
7	Assessment of a Separate High Level Waste Storage Facility
8	Assessment of a Separate Facility for Housing the Solidification Equipment

TASK 1

DECONTAMINATION AND DECOMMISSIONING
STUDIES

TASK 1A

**DECONTAMINATION STUDY
FOR PREIMMOBILIZATION OPERATION**

An assessment of the method for decontamination of cell surfaces and decontamination and removal of fuel reprocessing cell equipment to permit manual entry into the cells for the installation of waste solidification.

TABLE OF CONTENTS

1.	SUMMARY	1a- 4
2.	INTRODUCTION	1a- 5
3.	DESCRIPTION OF ASSESSMENTS	1a- 8
3.1	Primary Cell Equipment Removal with Decontamination Assessment A	1a- 8
3.2	Primary Cell Equipment Removal with Hot Spot Decontamination Assessment B	1a- 9
3.3	Primary Cell Equipment Removal without Decontamination Assessment C	1a-10
3.4	Secondary Cell Equipment Decontamination and Removal Assessments D and E	1a-10
4.	STATUS OF FACILITY	1a-12
4.1	Configuration of Equipment and Structures	1a-12
4.2	Equipment and Structure Radiation Levels	1a-13
5.	END PRODUCT DESCRIPTION	1a-16
5.1	General Purpose Cell (GPC)	1a-16
5.2	Process Mechanical Cell (PMC)	1a-17
5.3	Chemical Process Cell (CPC)	1a-17
5.4	Extraction Cell (XC-1)	1a-18
5.5	Extraction Cell (XC-2)	1a-18
5.6	Extraction Cell (XC-3)	1a-19
5.7	Product Purification Cell (PPC)	1a-19
5.8	Liquid Waste Cell (LWC)	1a-20
5.9	Acid Recovery Cell (ARC)	1a-20
6.	TECHNICAL APPROACH	1a-21
6.1	Generic Activities	1a-21
6.2	Estimation of Costs	1a-28
6.3	Schedule	1a-30
6.4	Manpower Estimates	1a-31
6.5	Occupational Exposure	1a-32
6.6	Waste Volume Generated	1a-33
6.7	Final Radiation Levels	1a-34

TABLE OF CONTENTS

(Continued)

7.	ASSESSMENT SUMMARY	1a-37
7.1	Assessment Results	1a-37
7.2	Discussion of Results	1a-37
8.	RECOMMENDATION OF SELECTED DECONTAMINATION SEQUENCE	1a-45
8.1	Primary Cell Decontamination and Removal	1a-45
8.2	Secondary Cell Decontamination and Removal	1a-46
8.3	Combined Assessments	1a-47
9.	POTENTIAL ACCIDENT SCENARIOS	1a-49
10.	REFERENCES	1a-54

TABLES

4.1	Contamination Zone Definitions	1a-15
6.1	Summary of Decontamination Factors	1a-16
7.1	Assessment Summary	1a-38
9.1	Potential Accident Scenarios	1a-50

APPENDICES

A	Status of Facility
B	Decontamination Methods
C	Materials Handling
D	Cost Factors
E	Assessment A - Activities, Costs, Schedules, Manpower, and Exposure
F	Assessment B - Activities, Costs, Schedules, Manpower, and Exposure
G	Assessment C - Activities, Costs, Schedules, Manpower, and Exposure
H	Assessment D - Activities, Costs, Schedules, Manpower, and Exposure
I	Assessment E - Activities, Costs, Schedules, Manpower, and Exposure
J	Pert Charts

DECONTAMINATION STUDY

FOR PREIMMOBILIZATION OPERATION

1. SUMMARY

This report presents the results of a technical assessment of decontamination alternatives prepared for the Western New York Nuclear Service Center (WNYNSC). The purpose of the assessment is to determine the recommended method for decontamination of cell surfaces and decontamination and removal of fuel reprocessing cell equipment to permit manual entry into the cells for the installation of waste solidification equipment.

The primary cells of interest are the PMC, GPC, and CPC because they offer the largest usable volume for the solidification program. The secondary cells include XC-1, XC-2, XC-3 and the PPC which may be needed to support the solidification program. Five decontamination assessments were evaluated (A-E). The assessments included the estimated cost, occupational exposure, duration, manpower, waste volume generated, and final cell radiation levels achieved with the alternative decontamination methods. The methods varied from thorough destructive decontamination of cell wall and floor surfaces and decontamination and removal of equipment, to equipment removal without decontamination followed by cell wall and floor decontamination.

The recommended method for the primary cells is to utilize the remote manipulators and cranes to the maximum extent possible to decontaminate equipment and cell surfaces remotely, and to remove the equipment for temporary on-site storage (Assessment A). The recommended method for secondary cell decontamination is to remotely decontaminate the cells to the maximum extent possible prior to manned entry for contact-removal of the fuel reprocessing equipment (Assessment D). Assessment A is expected to cost \$8,713,500 in 1980 dollars (including a 25% contingency) and will result in an occupational exposure of 180.3 manRem. Assessment D is expected to cost \$11,039,800 and will result in an occupational exposure of 259 manRems. The overall calendar schedule for either assessment is approximately 2 years.

2. INTRODUCTION

From 1966 to 1972, Western New York Nuclear Service Center (WNYNSC) was the only commercial spent nuclear fuel processing plant in the United States. During that time, it processed approximately 640 metric tons of fuel and generated over 2.1 million liters of high level liquid waste. This waste is currently stored on-site in underground tanks. The Department of Energy (DOE) is currently considering the use of the WNYNSC facilities for the processing of the high level liquid wastes stored on site to a solidified form. Burns and Roe (B&R) and Nuclear Energy Services (NES) were selected to determine the necessary preparations to convert the WNYNSC for this waste solidification program and to subsequently decommission the facility.

The objective of the initial phase of this effort has been to perform a technical and economic assessment of the effort required to decontaminate and remove nonessential equipment from those WNYNSC hot cells which have potential for use in the solidification program. Decontamination is required to a level to permit manned entry into the cells for installation of the waste solidification equipment, and to permit interim storage of solidified waste.

The emphasis for this investigation was placed on the three primary WNYNSC cells. These cells have been identified as being essential for the waste solidification program. The three primary cells are: the General Purpose Cell (GPC), the Process Mechanical Cell (CPC) and the Chemical Process Cell (CPC). In addition, a study was made of several of the other cells within the WNYNSC facilities. The need for these cells to support the solidification operation is dependent upon the solidification process to be selected by DOE. The secondary cells considered are: three Solvent Extraction Cells (XC-1, XC-2, XC-3), Product Purification Cell (PPC), Liquid Waste Cell (LWC) and Acid Recovery Cell (ARC).

Various approaches to the decontamination of each cell were assessed. Each assessment included: the definition of the specific activities required to decontaminate the cells and remove nonessential equipment, an estimate of the cost to perform these activities, and a determination of the occupational exposure involved in cell decontamination and equipment removal. Three separate assessments were performed for each of the primary cells:

- A. Remote decontamination of existing equipment and structures and remote removal of equipment for on-site storage.
- B. Remote decontamination of hot spots on existing equipment and structures and manual removal of equipment for on-site storage.
- C. Remote removal of existing equipment without prior decontamination and remote decontamination of remaining structures. All removed equipment will be stored on-site.

The secondary cells are not equipped with cranes or remote manipulators. Accordingly, the feasible methods for decontamination and equipment removal were more restrictive for these cells. The assessments performed for these secondary cells were:

- D. Remote decontamination of piping and component internal surfaces, manual removal of piping and components and manual decontamination of cell walls and floors.
- E. Manual removal of piping and components followed by manual decontamination of cell walls and floors.

The scope of each assessment included: establishment of basic assumptions, development of a detailed list of activities required to achieve the end product, determination of existing radiation levels within each cell, estimates of the manpower required to perform the activities and waste volumes generated, preparation of a cost estimate, determination of occupational exposure resulting from the activities and establishment of final cell irradiation levels. The performance of the assessments was somewhat hindered by the lack of definitive radiation survey data for each of the cells. Where available information was inadequate, assumptions were made based upon the limited data available and experience from other similar facilities. Verification of these assumptions via a detailed facilities radiation survey and characterization will be necessary prior to initiation of decontamination work.

The following sections of this report describe in greater detail each assessment performed; the current status of the WNYNSC facility; the end product status for each cell; the assessment results for each cell, and conclusions and recommendations. Appendices present detailed information in support of the methods and assumptions used in the main text of the report.

3. DESCRIPTION OF ASSESSMENTS

This section describes each of the decontamination assessments addressed in this study. Three different assessments were performed for each of the three primary cells. Two assessments were performed for each secondary cell.

3.1 PRIMARY CELL EQUIPMENT REMOVAL WITH DECONTAMINATION (ASSESSMENT A)

1. Assumptions

This assessment is based on remote decontamination and removal of primary cell equipment followed by remote decontamination of primary cell internal walls and floors. The equipment removed will be remotely packaged in the Equipment Decontamination Room (EDR) or Mechanical Crane Room (MCR) and transported to a specially constructed storage vault for on-site storage.

2. Technique

The remote decontamination techniques considered in this assessment are dry vacuuming of equipment, floors and walls; high pressure aqueous chemical spraying (water lances) of equipment and structures with wet vacuuming of cell walls and floors (wet to pick up spray effluent); and chemical decontamination of component internals. Surface sprays will be performed in each primary cell with water lances mounted on the power manipulators. Vacuums will be adapted for use with cell power manipulators. Remote-operated rotating wet scrub brushes will be used on resistant surface contamination.

Decontaminated primary cell system equipment will be removed remotely using primary cell cranes and manipulators with air tools and plasma torches. The primary cells were designed to accommodate this type of operation (i.e., incorporating Hanford jumpers, manipulators, etc.). All primary cell cranes and manipulators were assumed to require overhauls

prior to removal operations and appropriate costs were factored into this assessment. A final spray decontamination of primary cell internal walls and floors was assumed to follow removal of piping and components. This spray decontamination will be accomplished with the high pressure water lance.

3.2 PRIMARY CELL EQUIPMENT REMOVAL WITH HOT SPOT DECONTAMINATION (ASSESSMENT B)

1. Assumptions

This assessment is based upon remote decontamination of equipment and cell internal walls and floors followed by manual removal of primary cell equipment. It was originally intended that only decontamination of equipment hot spots would be performed prior to removal. However, radiation levels in the primary cells appeared to be so extensive and uniformly distributed that all cell components are radiologically hot. Therefore, the assessment was performed on the basis of remote decontamination of all cell equipment prior to its manual removal. Removed equipment will be packaged in the EDR and MCR and transported to the specially constructed waste storage vault.

2. Technique

Under Assessment B, remote internal and external decontamination of cell equipment will be accomplished as in Assessment A. Primary cell walls and floors will be locally dry vacuumed, water lance sprayed and wet vacuumed to remove contaminants. The decontamination techniques used will be similar to those of Assessment A. Upon completion of equipment and cell decontamination, work crews will enter the primary cells to manually remove all components. These crews will wear anticontamination clothing

with supplied air hoods. A compressor and manifold will be located outside the cells and a network of air lines will provide breathing air to each worker's hood. A HEPA-filtered contamination control room will be established at a cell entry point (such as a crane room door, cell window, or hatch) to maintain controlled access and to provide a change room area.

3.3 PRIMARY CELL EQUIPMENT REMOVAL WITHOUT DECONTAMINATION (ASSESSMENT C)

1. Assumptions

This assessment is based on remote removal of primary cell equipment without decontamination followed by remote decontamination of primary cell internal walls and floors. Equipment removed will be remotely packaged and stored on-site for eventual decontamination and disposal as in the previous assessments.

2. Technique

Remote removal of primary cell equipment will be accomplished using the cell cranes and manipulators with air impact wrenches, tools and plasma torches as described in Assessment A (Section 3.1).

A final remotely controlled water lance spray decontamination of primary cell internal walls and floors will follow equipment removal operations. This decontamination, performed as outlined in Assessment A, will cleanup any contaminants dispersed within the cell during removal activities.

3.4 SECONDARY CELL EQUIPMENT DECONTAMINATION AND REMOVAL (ASSESSMENTS D AND E)

Two assessments were performed for the secondary cells. Alternatives for secondary cell decontamination were limited by the lack of installed cranes and

manipulators. Thus, remote disassembly and removal of cell equipment was not feasible. The assessments of the secondary cells were:

1. Assumptions

Assessment D

Remote decontamination of internal piping and components, manual removal of piping and components, and manual decontamination of cell walls and floors.

Assessment E

Manual removal of piping and components without decontamination, followed by manual decontamination of floors and walls.

2. Technique

The decontamination and removal techniques to be used in the secondary cells are the same as those identified for the primary cell assessments. Work crews entering the cells will wear anticontamination clothing with breathing air hoses attached. Personnel will enter the secondary cells through a contamination control area to be fabricated in the extraction chemical room (XCR). This area will be the only access to the cells for equipment removal and tool entry. A heavy-duty monorail will be installed in place of the existing monorail to facilitate the heavy lifting and maneuvering associated with removal operations. Equipment will be lifted out of the secondary cells through access ports in the top of the cells and in the roof of the XCR by a large crane located outside of the plant buildings. Removed components will be packaged and transported to the on-site storage vault.

4. STATUS OF FACILITY

The WNYNSC was shutdown in the spring of 1972 to pursue an expansion and modification program. The program included extensive flushing and decontamination of piping and vessels, and removal of surplus equipment. The program was abandoned before the planned decontamination was completed, but subsequent decontamination activities in the years following the shutdown have reduced radiation levels and simplified preparation for solidification of waste.

The activities required to prepare the primary and secondary cells for installation of waste solidification equipment are dependent on the configuration and radiological status of the cells. The configuration status includes identification of major components removed, degree of decontamination performed, and the drained or filled status of the major components. The radiological status includes the estimated radiation exposure rate on components, walls and floors, and estimated area radiation exposure rates and contamination levels.

4.1 CONFIGURATION OF EQUIPMENT AND STRUCTURES

The present configuration of the primary and secondary cell structures and equipment is summarized in Appendix A Table A-1.

The status of each cell is based on survey information provided by Nuclear Fuel Services (NFS) (Ref. 1), on drawing reviews of WNYNSC "As-Built" drawings, and on verbal discussions with the NFS staff during site visits. The As-Built drawings were often misleading because they included modifications planned for the expansion program that were never implemented. Verbal information from NFS was used in these cases. Table A-1 of Appendix A summarizes the best available information at this time.

4.1.1 General Purpose Cell

The General Purpose Cell and associated equipment was shutdown at the termination of reprocessing operations. Wall and floor areas are contaminated with fuel particulates and cladding hulls. No decontamination was performed on this cell. A small area of concrete floor surface was scarified with paving breakers. Work was terminated leaving concrete rubble in the cell.

4.1.2 Process Mechanical Cell

The Process Mechanical Cell surfaces were water flushed upon termination of operation. The original PM saw was removed along with miscellaneous small tools. A small cut-off saw remains in the cell. The walls and floors are contaminated with fuel particulates. The north end window seal must be replaced.

4.1.3 Chemical Process Cell

The Chemical Process Cell equipment was flushed internally. The existing in-place waste evaporators are disconnected from the acid recovery system to prepare for the installation of new evaporators. The new evaporators were never installed and are currently stored at the site. The two dissolver feed adjustment tanks contain approximately 3,700 lites of solution (mostly water) each, and the rework evaporator contains approximately 2,200 liters of solution (water). All other components are empty.

4.1.4 Secondary Cells

The equipment in the three Extraction Cells XC-1, XC-2, and XC-3, Product Purification Cell, Liquid Waste Cell and Acid Recovery Cell was rinsed internally and drained. Some external cell structure decontamination was performed. The floor of cell XC-1 and Tank 4D-1 were externally contaminated by spills from Tank 4D-2. The bottom line from Tank 4D-2 was removed to permit removal of a sludge buildup in Tank 4D-2. No other equipment was removed from these cells.

4.2 EQUIPMENT AND STRUCTURE RADIATION LEVELS

The present general area radiation levels in the primary and secondary cells, and the radiation levels from the major components in each cell are summarized in Appendix A Table A-2. The exposure rates shown in this table are estimates of the existing radiological conditions, prior to any proposed pre-solidification operations, decontamination or equipment removal.

Personnel radiation exposure for the activities in each cell results from two sources: general area dose rates and equipment dose rates. The cell area dose rate contributes to the occupational exposure for the duration the worker is in a particular cell. The equipment dose rate, at an assumed working distance of 3 feet, contributes to the occupational exposure for the duration of the activity.

Radiation levels for equipment and structures in each cell are based on survey data provided by NFS (Ref 1), Argonne National Laboratory Report UNI-1050 (Ref 2), verbal discussions with the NFS staff during site visits, and on measured exposure rate data presented in technical papers on the decontamination of similar facilities. These similar facilities include the Eurochemic Company reprocessing plant at Mol, Belgium (Ref 3) and the UK Atomic Energy Authority Dounreay fuel reprocessing plant (Ref 4). The US Nuclear Regulatory Commission Report, NUREG-0278 (Ref 5) provided useful guidance in estimating equipment exposure rates.

4.2.1 Area Radiation Levels

The cell average area radiation levels shown in Appendix A are the arithmetic average of the range of values reported in Ref. 1 and 2. Conservatively, no allowance was assumed for decay of the radionuclide inventory from the date of the last survey.

4.2.2 Equipment Radiation Levels

The exposure rates for each component listed in Appendix A is an estimate of the exposure rate at a 3 foot working distance. The exposure rate from large components (not a point source) decreases approximately linearly with distance from the component. Where exposure rate data was available at a specified distance the rate was adjusted linearly for a 3 foot working distance. Conservatively, no allowance was assumed for radioactive decay from the date of the last survey.

NFS prepared estimates of cell surface contamination levels as reported in Ref. 1. They established zone classifications based on the amount of alpha and beta smearable contamination levels. The contamination zone definitions are shown in Table 4.1. According to the surveys performed by NFS, all primary and secondary cells contain Zone 4 levels of contamination.

TABLE 4.1
CONTAMINATION ZONE DEFINITIONS

Zone Category	Smearable Contamination (dpm/100 cm ²)		Posting and Barriers
	Alpha	Beta	
Zone 1	<10	<100	Clean area outside security fence; not posted.
Zone 2	10 to 50	100 to 500	Clean area inside security fence; not posted.
Zone 3	50 to 500	500 to 50,000	Posted, rope barrier.
Zone 4	>500	>50,000	Posted, barrier, and airlock.

5. END PRODUCT DESCRIPTION

The end product for each of the cells considered feasible for use in the solidification campaign, will be a clean, decontaminated room with virtually no equipment remaining from the fuel reprocessing systems. Each cell will be decontaminated to permit manned entry without respiratory protection. Equipment retained for use during solidification will be decontaminated and repaired or restored to its original functional capabilities. All unused piping and electrical penetrations into each cell will be capped. All concrete wall and ceiling surfaces will be painted with strippable latex coatings (Ref. 6) after decontamination. Stainless steel cells liners will remain unpainted after decontamination. The Liquid Waste Cell (LWC) and Acid Recovery Cell (ARC) will remain in place for use in the waste solidification campaign. The general description of the equipment to be removed and equipment remaining for reuse is described herein for each cell.

5.1 GENERAL PURPOSE CELL (GPC)

Fuel Reprocessing Equipment To Be Removed

All components used to contain, store, transfer (except cranes and manipulators), and package chopped fuel hulls and associated fuel hardware will be removed. These include dissolver baskets, and timers, storage racks, dumping and packaging equipment, leached hull reload equipment, and special tools. The chopped fuel storage and criticality concrete wall will remain in place, except where required for storage of solidified waste canisters.

Equipment Retained For Immobilization

The 1.8-MT capacity crane power manipulator and tool holder, two master-slave manipulators and tool holder, and window radiation shields remain in place after decontamination and repair (if necessary).

5.2 PROCESS MECHANICAL CELL (PMC)

Fuel Reprocessing Equipment To Be Removed

All components used to position, saw and shear fuel assemblies will be removed (except cranes and manipulators). These components include the shear, disassembly, inspection and push out table, tilting fixtures, mechanical processing fixtures, mirrors and periscope. The stainless steel lined concrete pedestal for the disassembly saw and push out table will remain in place unless they are required for storage of solidified waste canisters. The push out ram will be withdrawn into the ram maintenance room.

Equipment Retained For Immobilization

The two 1.8-MT capacity cranes, power manipulator, four master-slave manipulators, and hatch covers remain in place after decontamination and repair (if necessary).

5.3 CHEMICAL PROCESS CELL (CPC)

Fuel Reprocessing Equipment To Be Removed

All piping and equipment used to dissolve fuel from the hulls, adjust feed, evaporate and condense liquid waste, transfer baskets (except cranes and manipulators), storage baskets, and jumpers will be removed from the cell. These components include the dissolver tanks, accountability and feed adjustment tank, evaporators, neutralizers, condensers, jumper storage rack, basket rack, dissolver pickup device, spare pickup and storage devices, and the jumper storage rack.

Equipment Retained For Immobilization

The 14.5-MT capacity crane, 1.8-MT capacity crane, power manipulator, equipment transfer car, vessel lifting strongbacks, and window radiation shields remain in place after decontamination and repair (if necessary).

5.4 EXTRACTION CELL (XC-1)

Fuel Reprocessing Equipment To Be Removed

All piping and components in this cell will be removed. These include the partition cycle extraction column, plutonium strip column, feed tank, waste catch tank, high level waste evaporator feed tank, preheater, decanters, surge tanks, phase separators and associated sample and control equipment.

Equipment Retained For Immobilization

This cell will be stripped bare of all equipment, piping and components. Walls and floors will be decontaminated.

5.5 EXTRACTION CELL (XC-2)

Fuel Reprocessing Equipment To Be Removed

All piping and components in this cell will be removed. These include the partition cycle and plutonium cycle strip columns, plutonium extraction column, uranium extraction columns, carbonate wash columns, acid wash columns, plutonium and uranium feed conditioners, solvent washers, storage tanks, strip feed heaters and coolers, decanters, surge tank, phase separators and associated sample and control equipment.

Equipment Retained For Immobilization

This cell will be stripped bare of all equipment, piping and components. Walls and floors will be decontaminated.

5.6 EXTRACTION CELL (XC-3)

Fuel Reprocessing Equipment To Be Removed

All piping and components in this cell will be removed. These include the uranium cycle strip and extraction columns, carbonate and acid wash columns, feed conditioners, solvent waste and storage tank, strip feed heater and cooler, decanters, surge tank, phase separators, ion exchanger waste cooler and associated sample and control equipment.

Equipment Retained For Immobilization

This cell will be stripped bare of all equipment, piping and components. Walls and floors will be decontaminated.

5.7 PRODUCT PURIFICATION CELL (PPC)

Fuel Reprocessing Equipment To Be Removed

All piping and components in this cell will be removed. These include the plutonium ion exchangers, product evaporators, silica gel beds, product storage tanks, evaporator condensate and feed tanks, surge tanks, regeneration waste tank, sample tanks, off-spec tank, reboilers, evaporator condensers, ion exchanger waste cooler, evaporator product coolers, and associated sample and control equipment.

Equipment Retained For Immobilization

This cell will be stripped bare of all equipment, piping and components. Walls and floors will be decontaminated.

5.8 LIQUID WASTE CELL (LWC)

Fuel Reprocessing Equipment To Be Removed

The liquid waste cell equipment and storage tanks will remain in place. The cell is virtually inaccessible for installation of solidification equipment because of the 3 ft wide access door and 3 ft thick concrete walls.

Equipment Retained For Immobilization

The existing liquid waste storage tanks will be utilized for temporary storage of decontamination liquid wastes.

5.9 ACID RECOVERY CELL (ARC)

Fuel Reprocessing Equipment To Be Removed

The acid recovery cell equipment will remain in place. A new off-gas and acid recovery building was added to the main process building. Recovery of decontamination acids will be performed in this new facility during decontamination, waste solidification and final decontamination and decommissioning.

6. TECHNICAL APPROACH

The technical approach used in preparation of this study is based on the techniques developed for use by NES for the AIF/NESP-009 study (Ref. 7). The techniques are directly applicable to the WYNSC facility and the same approach was used to identify the individual elements of an activity, and estimate the costs, schedule, manpower, occupational exposure, waste volume generated and final radiation levels achieved. In areas where additional information was required specific to decontamination of reprocessing plants, NES relied on reports of actual results from decontamination of the Separations Canyon Decontamination Facility (Ref. 8), the Chemical Processing Facility at Savannah River (Ref. 9), the Argonne National Laboratory HFEF/S cell (Ref. 10), decontamination of the Eurochemic reprocessing plant in Mol, Belgium (Ref. 3), and decommissioning of the Dounreay Fast Reactor Fuel Reprocessing Plants (Ref. 4). This section presents the generic techniques used by NES for identifying activities, estimating costs, schedules, manpower, occupational exposure, waste volumes and final radiation levels.

6.1 GENERIC ACTIVITIES

A list of activities was prepared for each assessment of the study to identify the major work elements. Each assessment contains a Pre-solidification Preparation Phase for data collection, equipment maintenance and repair, licensing, engineering and planning, and a Decontamination Phase for cell equipment and structure decontamination and removal. The Preparation Phase activities are essentially identical for all assessments with only minor differences identified for manual removal activities. The Decontamination Phase activities are identified for each primary and secondary cell, and include the cell-specific preparations, decontamination, equipment removal and cell closure activities. The generic decontamination and removal methods assumed for this study are identified in this section.

6.1.1. Internal System Decontamination

The general process for internal system decontamination assumed for this study consisted of the major activities identified below. This process is similar to that used for the successful decontamination of the Eurochemic fuel reprocessing plant at Mol, Belgium (Ref. 3), and incorporates some of the procedural guidance provided in NUREG-0278 (Ref. 5). The specific step-by-step process is described in Appendix B.

Internal Decontamination

1. Install decontamination flushing system in set-up area and connect plumbing and electrical utilities. Test the system.
2. Install temporary directional gamma detectors at strategic locations on equipment in each process area.
3. Mix the required chemical solutions in the flushing system mixing tanks.
4. Chemically flush and water rinse the contaminated systems with the following chemicals:
 - A. Hot potassium permanganate/nitric acid mixture
 - B. Hot sodium hydroxide/tartaric acid mixture
 - C. Hot hydrofluoric acid/nitric acid mixture
5. Perform a final radiation survey of the decontaminated equipment.

The potassium permanganate conditions the contaminated surface to improve the effectiveness of nitric acid to remove residual uranium and plutonium oxides as well as the ^{137}Cs and ^{90}Sr . The sodium

hydroxide/tartaric acid removes selected elements such as zirconium and niobium that resist acid flushes. The hydrofluoric acid/nitric acid removes residual ruthenium, if present.

Decontamination factors (DF's) assumed achievable were based on actual results reported at HFEF/S (Ref. 10) and Eurochemic (Ref. 3). These latter results indicated that decontamination factors of approximately 100 were obtainable during first-flush campaigns. NES assumed a DF of only 50 to allow for inaccessibility and contamination aging. Aging is known to reduce decontamination effectiveness. For systems which had been previously decontaminated, experience shows a DF of approximately 2 is possible in subsequent decontamination campaigns. For the WNYNSC facility, a conservative DF of 2 was assumed for internal decontamination of systems previously decontaminated by Nuclear Fuel Services (NFS) during the expansion program. For system internals not previously decontaminated a DF of 50 was used.

6.1.2 External Decontamination of Components and Structures

External decontamination of surfaces can be achieved with the high pressure (up to 10,000 psi) water or chemical lance technique, similar to that used at HFEF/S (Ref. 10) and Eurochemic (Ref. 3). The lance can be mechanically held with a 2-ton power manipulator for remote decontamination, or hand-held in manual decontamination. The PMC, GPC and CPC all contain significant quantities of "fines" deposited on walls, floors and equipment surfaces from the fuel chopping processes. Decontamination experience at HFEF/S (Ref. 10) indicate that dry vacuuming of surfaces is very effective in removing this loose contamination. Accordingly, dry vacuuming was assumed to precede high-pressure wet lancing decontamination for all cells. For the PMC and GPC on components with many interstices, scrubbing with a rotating remote-operated power brush was assumed. The general procedure for external surface decontamination is similar to that described in Reference (10) and described below. The step-by-step process is provided in Appendix B.

External Surface Decontamination

1. Dry vacuum all accessible surfaces with a HEPA filtered vacuum system. (The vacuum nozzle is positioned with a master/slave or power manipulator in remote decontamination.)
2. Prepare the cell for high-pressure lancing by covering leaded-glass windows (not being used), plugging floor drains, piping up water supply, and fabricating a power manipulator lance holding fixture.
3. Connect a wet vacuum system to the liquid waste system to collect spent decontamination liquids.
4. High pressure lance all surfaces using the following dilute solutions:
 - (a) Nitric acid
 - (b) Sodium hydroxide
 - (c) Nitric acid with hydroxylamine acid sulfate
 - (d) Hot water rinse.
5. Wet scrub surfaces as necessary with power brush.
6. Perform a final radiation survey of the decontaminated surfaces.

External surface decontamination factors assumed in this study were based on actual results for steel surfaces reported by Moore (Ref. 9) (overall DF's = 136 to 177). NES conservatively estimated a DF = 100 for stainless and carbon steel surfaces. Bacca (Ref. 10) reported DF = 2 for high pressure lancing of concrete surfaces, and NES used this same value in this study.

6.1.3 Equipment Removal

Two equipment removal techniques were assumed for this study: remote and manual contact. Remote removal makes use of the master/slave and power manipulators to disconnect Hanford type pipe jumpers, unbolt tie-down bolts, and disconnect electrical connectors. The cell cranes may then lift each component out for packaging and on-site storage. The GPC, PMC, and CPC were designed for this type of completely remote equipment maintenance and removal.

Manual contact removal requires the removal crews to work inside the cells to manually disconnect and unbolt each component. The relatively high levels of airborne alpha contamination necessitates cell wall and floor decontamination before cell entry augmented by extensive personnel protection and contamination control techniques. The controls assumed applicable for this study are described below.

Personnel Protection

For cell entries, personnel are assumed to wear protective clothing similar to that used at HFEF/S (Ref. 10) consisting of three layers of clothing, the outer layer being a plastic wet-suit. Air-supplied breathing hoods are assumed, although HEPA filtered respirators are also effective. Workers are assumed to wear lead-loaded aprons (0.5 mmPb) and lead-loaded gloves (0.35 mmPb) for additional protection.

Contamination Control

Personnel access to each cell was assumed to be through a personnel hatch. A contamination control envelope (room) was assumed to be constructed outside the cell for personnel access and small tool transfer. The envelope would be maintained at negative pressure to ensure leakage would be inward. The exhaust from the envelope would be HEPA filtered.

Equipment removal hatches would be fitted with a similar contamination control envelope with doors large enough to transfer equipment through them. One such equipment removal envelope is envisioned at the extraction chemical room. The envelope would be used to poly-bag all equipment prior to final packaging.

6.1.4 Materials Handling

On-site materials handling consists of removing components from their cells, packaging for storage, transferring to on-site storage and unloading. A brief description of each activity is included in this section.

Equipment Removal From Cells

Components removed from the CPC or GPC are transferred by crane to the Equipment Decontamination Room (EDR). Components are remotely placed in containers and loaded onto a flatbed tractor trailer. When fully loaded the tractor-trailer delivers the packages to the on-site temporary storage facility.

Two removal schemes exist for PMC equipment. Large components are remotely packaged in the MCR. Roof hatches are removed and the closed packages are extracted and placed on a waiting truck by a mobile crane. Smaller components are transferred to the GPC via the PMC/GPC hatch. Handling from that point is identical to the GPC removal scheme.

Components removed from the Extraction Cells and the PPC are handled by either of two methods. Large vessels and heavy components are removed by a 150-foot boom mobile crane through the contamination control envelope after poly-bagging. These large components are manually boxed, and loaded onto flatbed trailers or rubber-tired gantry cranes for

transport to temporary storage. Smaller components and bundles of piping are bagged and transported by the Extraction Chemical Room monorail (modified for heavier load carrying capacity) to the existing outdoor jib crane. The jib crane lowers the small components to packaging below for transport to temporary storage.

On-Site Storage Containers

Components that have no future use such as piping, and secondary cell steel framework, are stored in steel liners sized to fit the Super-Tiger or Poly-Panther Type B shipping containers. It is anticipated that these components may ultimately be shipped for off-site burial and the container cost is estimated on this basis.

The remaining components (tanks, extraction columns, condensers, etc.) are placed in Low Specific Activity (LSA) metal containers. Standard sizes of containers were used wherever possible. These packages are made with 1/4-inch thick steel plate and structural steel reinforcing. No additional shielding is provided. Packaging containing highly radioactive components may be selectively stored and shielded by packages to lower radiation levels.

Containers for very long or wide components are specially built to totally enclose the components using the same LSA package construction methods. For these components, special reinforcing will provide rigidity for lifting and storage.

A summary of the number and size of containers expected to be generated by removal of equipment is shown in Appendix C.

Storage Vault

A temporary storage vault was assumed necessary to contain the removed equipment pending ultimate disposition. The building is a reinforced concrete structure with a 4-inch thick concrete roof and 18-inch thick

concrete walls. The concrete slab floor is poured over a crushed rock foundation. The building dimensions are assumed to be 120 ft long x 100 ft wide x 27 ft tall. Additional building information (for cost estimating purposes) is described in Appendix C.

Packaged components for storage are lifted off the flatbed by a rubber-tired mobile gantry crane which straddles the flatbed. The gantry cab is shielded to protect the driver from the package contents. Each package is transported into the temporary storage vault and selectively placed. Adequate space is allowed to permit ready access for loading and unloading.

6.2 ESTIMATION OF COSTS

Assessment costs were calculated by the same method used in developing the AIF/NESP-009 (Ref. 7) cost estimate, where cost factors were developed for activity-dependent and period-dependent costs. Activity-dependent costs are those directly related to a specific activity such as removal of a component from a cell. Period-dependent costs are those related to the duration of an activity or series of activities such as crane rental per month, which might be used for several unrelated activities. Both types of factors include the cost elements of labor, materials, equipment, energy and services, where applicable.

All cost factors developed for this study are 1980 costs in the West Valley, New York region. These costs were obtained from national average cost information and regional correction factors as published by the Bureau of Labor Statistics (Ref. 11). The decontamination and removal activities are labor intensive, and accurate representative craft labor rates for Buffalo, New York (approximately 35 miles north of the site and a logical source of craft labor) were used as the basis for labor costs. Craft labor rates (\$/hr) used in cost calculations include base wages, fringe benefits, per diem (to account for travel by workers between Buffalo and the site), and 60% contractor overhead and profit. The following sections summarize the basis for development of the cost factors used in the study. Specific cost factors are listed in Appendix D.

6.2.1 Activity-Dependent Costs

Two methods were used to estimate activity dependent costs, namely unit cost factors (\$/ft², \$/inch of cut), and hourly craft cost (\$/hour). Unit cost factors are applied to pipe cutting, penetration capping, decontamination of floors and walls, etc. Hourly costs were used for activities where activity durations, crew size and composition were known from prior experience. Supporting material and equipment costs were developed from industry guides such as R.S. Means (Ref. 12) and Dodge (Ref. 13).

Actual in-cell nuclear experience was utilized to account for workers' time spent suiting up in anti-contamination clothing, inefficiencies in working while encumbered by protective clothing and breathing apparatus, and time spent for personnel and material radiation survey and control at radiation control checkpoints. This experience indicates an in-cell radiation zone worker is capable of only 3 effective work hours per 8 hour work day. To account for these factors, the costs for in-cell manual activities in radiation zones were estimated by determining the task durations in a non-radiation zone and applying an 8/3 factor to the duration estimate.

Out-of-cell activities were based on an average 6 hour effective work day per 8 hour shift which is typical for work in a low-level radiation environment.

6.2.2 Period-Dependent Costs

Period dependent costs include engineering, staff administrative costs, insurance, site security, health physics coverage, quality assurance and associated equipment rental for the term of the waste pre-solidification operation program. The estimated costs for these factors were based on experience at similar facilities, and from such sources as American Nuclear Insurers (Ref. 14) for insurance costs, and security service companies.

Period-dependent costs are determined on a monthly basis so the costs can be estimated as a function of the pre-immobilization campaign duration.

6.3 SCHEDULE

The schedule to perform each assessment was developed from the individual durations of each activity in the assessment. The durations were estimated from actual experience reported by Moore (Ref. 9) and Bacca (Ref. 10), Broothaerts (Ref. 3) and Hershey (Ref. 8). As discussed in Section 6.2, the in-cell manual decontamination activities were assumed to require considerably more time than out-of-cell activities because of the restrictive contamination control measures necessary. Only three productive work hours were assumed per eight hour shift.

Each assessment consisted of two parts: "Preparations" and "Decontamination Activities," as described in Section 6.1.

The preparations activities were common to all assessments except for minor differences where manual versus remote decontamination and removal activities were required.

A common PERT network was developed for the Preparation Phase, and individual Decontamination Activities PERT networks were developed for each Assessment A through E. Activity durations (in workdays) were summed along each path (including the Preparation Phase) to determine the critical path for each assessment. The total duration of the longest critical path was taken as the program duration.

The PERT networks for Assessments A through E are shown in Appendix J. One network is shown for the Preparations Phase because it is common to all assessments. Assessment A for the primary cells, and Assessment D for the secondary cells are shown on the same PERT network because of their similarity in work activities, i.e., internal system decontamination prior to equipment removal. Assessment A provided for remote removal of primary cell equipment and D requires manual removal of secondary cell equipment. The two assessments are shown in combination to illustrate the effect of preparing both primary cells and secondary cells for waste solidification concurrently. Each assessment however is totally independent of the other, and are connected only through the on-going activities of "Liquid Waste Disposal" and "Transfer Packaged Equipment to Temporary Storage Vault".

Similarity Assessments B and D are shown on the same network because of their similarity in activities for internal system decontamination and manual removal of equipment from both primary and secondary cells. Assessments C and E are shown on the same network because neither assessment includes internal system decontamination. In all cases the primary and secondary assessment networks can be totally isolated as noted above.

6.4 MANPOWER ESTIMATES

The manpower estimates for each assessment were developed using standard crews to accomplish specific decontamination and removal activities. For example, the crews required to prepare the primary cells for immobilization consist of the following crafts:

Crew A

Used for remote CPC equipment decontamination and removal:

- 1 crane operator
- 1 power manipulator operator
- 1 supervisor (utilized 1/2 time)
- 1 technician (utilized 1/2 time)

Crew B

Used for remote PMC and GPC equipment decontamination and removal:

- 1 crane operator
- 1 power manipulator operator
- 1 master slave manipulator operator
- 1 supervisor (utilized 1/2 time)
- 1 technician (utilized 1/2 time)

Crew C

Used for remote packaging in the EDR:

- 2 crane operators
- 1 supervisor

Crew D

Used for CPC manual removal and manual hot spot decontamination:

- 4 laborers
- 1 crane operator
- 1 supervisor (utilized 1/2 time)
- 1 technician

Crew E

Used for PMC and GPC manual removal and manual hot spot decontamination:

- 2 laborers
- 1 crane operator
- 1 supervisor (utilized 1/2 time)
- 1 technician

Crew F

Used for removal of components from MCR:

- 1 crane operator
- 1 hoisting engineer
- 1 truck driver
- 2 laborers
- 1 supervisor
- 1 oiler

The activity duration and standard crew composition were used to estimate the manhours required to perform the activity. Specific activities such as engineering, health physics monitoring and security were estimated directly.

6.5 OCCUPATIONAL EXPOSURE

The occupational exposure for each assessment was calculated from two major sources of radiation exposure: general area exposure rate, and individual component exposure rate. The estimated radiation levels for these two sources are described in Section 4, and are shown in Appendix A. As discussed in Section 4, there was insufficient radiation data available from WNYNSC on component and structure exposure levels to provide an accurate estimate of occupational exposure.

The occupational exposures calculated for each assessment are based on the average area exposure rates reported in Ref. 1, and from estimated component exposure rates taken from measurements on similar equipment at other facilities. All component exposure rates were based on a 3 ft working distance from the component. For these calculations a reported exposure rate in Roentgens per hour (R/hr) was taken to be equal to a dose rate of the same number of Roentgen Equivalent Man (Rems) per hour, without attempting to quantify the relative biological effectiveness of the radiation sources. Thus, 1 R/hr is assumed equal to 1 Rem/hr. Detailed radiation surveys of each cell must be performed prior to any further occupational exposure estimates.

The manRem dose estimates calculated in this study are based on the conservative assumptions that all crew members will be present for the entire duration required for the activity. Each worker will receive a dose contribution from the general area radiation level, and from the components being decontaminated or removed. For out-of-cell activities only the general area dose contribution is included.

6.6 WASTE VOLUME GENERATED

The wastes generated in the decontamination activities for each assessment will be high level and low specific activity liquids and solids. They will consist of neutralized internal system decontamination solvents, high-pressure lance chemical and water spray run-off, contaminated tools, spent filters and used personnel protective clothing. The fuel reprocessing equipment removed from each cell (the packaged volumes are shown in Appendix C) is stored on-site for later disposition and is not included in the liquid waste volume inventory reported in this study. Also, the waste volumes presented in this report do not consider any possible reductions that could be achieved by means such as evaporation, compaction, etc.

Liquid waste volumes generated from internal system decontamination were estimated from the decontamination sequence described in Section 6.1.1, for the number of system internal volumes of solvents and rinses required for decontamination and solvent neutralization. Liquid wastes generated from external surface decontamination were based on the reported quantities of waste per-square-foot of surface experienced during the decontamination at the Savannah River Plant (Ref. 8). This data indicated a total rate of 5 gals/ft² (solvent plus neutralizer) was used to decontaminate external surfaces, and accordingly 5gal/ft² was assumed for this study.

The neutralized liquids will be solidified on-site in the modified liquid waste treatment system (WNYNSC Task 4) and packaged for shipment for off-site disposal. These wastes produced by decontamination of systems and structures will contain large quantities of transuranics and fission products. The waste concentration and packaging methods used must assure subcritical concentration of radionuclides in each phase of disposal. Development of details where these wastes can be buried, equipment required for volume reduction and packaging, transportation, costs, etc., was not within the workscope for this study.

6.7 FINAL RADIATION LEVELS

The estimated post-decontamination radiation levels in each cell were developed using an overall decontamination factor (DF) approach. A decontamination factor is the ratio of initial radiation level divided by final radiation level. DF's depend on such factors as the contaminated component or structure surface finish, corrosion-film element or compound constituents, nuclide constituents, adherence of the corrosion film layer, aging of the corrosion layer and degree of prior decontamination performed.

The selection of suitable solvent DF's to use in any study without benefit of actual laboratory test data for samples from the contaminated systems is a difficult task. However, for study purposes, conservative DF's may be selected from decontamination campaigns at similar facilities to provide a rapid, consistent basis for comparative decontamination scenarios.

This approach was used in this study based on data reported in the Eurochemic (Ref. 3) and Savannah River (Ref. 9) decontamination programs. This decontamination data indicates overall DF's of 10 to 100 for the first concentrated solvent flush of systems, but much lower DF's for subsequent applications of the same or similar solvents (DF = 2 or less). This phenomenon is substantiated by similar experience at HFEF/S (Ref. 10). Accordingly, for the first solvent flush of a system a DF of approximately 50 is achievable, and for systems that have been decontaminated with concentrated solvents, subsequent decontamination can conservatively be expected to achieve a DF of approximately 2.

Only portions of the WNYNSC facility systems were decontaminated by the Nuclear Fuel Services staff using concentrated solvents as part of its modification program. Any subsequent decontamination performed in preparation for immobilization operation might achieve an additional factor of 2 reduction. This assumption was used by NES in this study for internal decontamination of systems. Systems not previously flushed were assumed to be decontaminated by a factor of 50 for internal solvent flushes.

Data from the Savannah River Plant (Ref. 9) suggest that removal of contaminated equipment from the cells can achieve an overall DF of approximately 50. This value was used for removal of reprocessing equipment⁵ from the CPC, and extraction cells.

Decontamination of walls and floors using high-pressure lances has been successfully demonstrated at numerous facilities. Eurochemic data (Ref. 3) shows concrete painted surfaces to be decontaminated by a factor of only 2, and stainless steel lined surfaces by a factor of about 50-60. Other facilities report stainless steel surfaces can be decontaminated by factors of 100-200. For this study, a DF of 2 was assumed for concrete surfaces and a DF of 100 for stainless steel lined surfaces.

These results are summarized in the following table:

TABLE 6.1

SUMMARY OF DECONTAMINATION FACTORS

	Overall <u>DF</u>
Wall and floor decontamination (stainless steel)	100
Wall and floor decontamination (concrete walls)	2
Equipment removal	50
Internal chemical flush	
- (previously decontaminated by NFS)	2
Internal chemical flush	
- (not previously decontaminated by NFS)	50

7. ASSESSMENT SUMMARY

This section presents a summary of the results of the detailed calculations performed for each alternative assessment (A through E). The important findings of each assessment of primary and secondary cell decontamination are identified and discussed in detail. Comparisons of these results to operating or decontamination experience at other facilities are made where possible.

7.1 ASSESSMENT RESULTS

The results for each assessment are summarized in Table 7.1 which provides the total costs, occupational exposure, manpower and working days duration. The detailed listing of activities performed for each assessment, and the costs, exposure, manpower and duration are shown in Appendices E through I.

7.2 DISCUSSION OF RESULTS

The key findings of each assessment are discussed herein, and the results are compared to experience known from other facilities.

7.2.1 Assessment A

The primary cells (PMC, GPC, and CPC) were all designed for fully remote maintenance, with all equipment designed for complete removal using the remote power manipulators, master-slave manipulators, and remotely operated cranes. There is an obvious advantage in utilizing remote handling methods with respect to keeping the occupational exposure "as low as reasonably achievable" (ALARA). This advantage must be weighed against the cost relative to other approaches.

The activities to decontaminate the primary cells remotely result in the lowest overall dose to the workers (180.3 ManRem). The major contribution to this dose is from the preparatory activities of decontaminating and repairing cranes, manipulators, and equipment removal rooms (EDR, MCR, CCR, etc.). These rooms are not fitted with

TABLE 7.1

ASSESSMENT SUMMARY
Primary Cells - Pre-Decontamination PMC, GPC, CPC, SRR

<u>Assessment</u>	<u>Cell</u>	<u>Final Radiation Levels mR/hr</u>	<u>Cost \$ *</u>	<u>Duration, days</u>	<u>Exposure ** Manpower, Manhours</u>	<u>Exposure, Man/Rem</u>	<u>Waste Volume, Gal.</u>
Internal Decon.	PMC	5					
Remote Removal	GPC	6					
A	CPC	12					
	SRR	0.1					
Totals			8,713,500	428	41,514	180.3	659,100
Internal Decon.	PMC	5					
Manual Removal	GPC	6					
B	CPC	12					
	SRR	0.1					
Totals			8,908,500	383	68,385	374.3	659,100
No Internal Decon.	PMC	5					
Remote Removal	GPC	6					
C	CPC	12					
	SRR	0.1					
Totals			9,678,900	404	76,232	389.6	406,900
Secondary Cells - XC-1, XC-2, XC-3, PPC							
Internal Decon.	XC-1	7.4					
Manual Removal	XC-2	0.85					
D	XC-3	<0.1					
	PPC	<0.1					
Totals			11,039,800	545	71,981	259	323,800
No Internal Decon	XC-1	7.4					
Manual Removal	XC-2	0.85					
E	XC-3	<0.1					
	PPC	<0.1					
Totals			26,984,300	416	776,548	4,554	133,200

* Cost in 1980 dollars with 25% contingency

** In-cell exposure is based on 3 hours per 8-hour workday
 Out-of-cell exposure is based on 6 hours per 8-hour workday

remote handling methods, so that all maintenance and decontamination must be performed by manual contact. The remainder of the occupational exposure is from the manipulator aisle dose during the intensive remote chemical decontamination of cell components and wall surfaces.

A decontamination subcontractor would be required to augment the standard crews to prepare the crane rooms, cranes, and manipulators for removal of equipment. The decontamination subcontractor crews will provide the necessary additional manpower to ensure the individual worker dose does not exceed 5 Rem per year or 3 Rem per quarter. For Assessment A, the decontamination subcontractor will have to provide a crew of 29 men during the pre-decontamination period and 7 men during the cell decontamination activities period. The additional 18,000 manhours, costs, and exposure to these workers is included in Table 7.1.

The 180.3 ManRem dose is lower than the annual dose received for refueling and maintenance at nuclear power plants, e.g. 748 ManRem for a BWR and 493 ManRem for a PWR (Ref. 15). The expected exposure for Assessment A primary cell decontamination at WNYNSC is approximately 30% of the average annual power plant dose.

The estimated average exposure per year at the WNYNSC during the 1970-1971 fuel reprocessing operation was 985 ManRem per year for operations and 1,002 ManRem per year for maintenance. (Ref. 16).

The decontamination of the WNYNSC in preparation for waste solidification is a one-time activity, not an annual occurrence as in an operating facility. The final radiation levels, expected to be achieved after cell decontamination, will permit worker in-cell residency as follows, without exceeding the 10CFR 20 exposure limits of 5 Rem per year per worker.

<u>Cell</u>	<u>Annual In-Cell Time Hours/Year/Worker</u>
PMC	1000
GPC	833
CPC	417
SRR	unlimited

An exposure limit objective of 1 Rem per year would reduce the in-cell residency to one-fifth the above values.

The 659,100 gal. of decontamination waste volume compares favorably with the volume of liquid decontamination waste estimated to be used to decontaminate a large nuclear power plant. NUREG/CR-0130 (Ref. 17) estimates 1,000,000 gal. will be required for decontamination of an 1100 MWe plant in preparation for decommissioning. The amount of decontamination waste estimated for decommissioning a large fuel reprocessing plant is approximately 300,000 gallons (Ref. 5). These two references serve to envelope the estimated volumes of decontamination wastes.

7.2.2 Assessment B

Assessment B results in a higher occupational exposure (374.3 ManRem) than Assessment A because of the manual equipment removal activities following decontamination. The cost for Assessment B is slightly greater than Assessment A although the decontamination activity duration is shorter (383 days vs. 428 days).

As in Assessment A, a decontamination subcontractor would be required to provide additional crews to augment the standard crews and to prevent personnel exposures exceeding the 5 Rem per year or 3 Rem per quarter limits. Twenty-nine workers would be required during the pre-decontamination period and 62 workers for the cell decontamination period. The additional 45,500 manhours, costs, and exposure to these workers is included in Table 7.1.

The decontamination waste volume generated is estimated to be the same as Assessment A, because the same decontamination flushing and wall cleaning activities are necessary as in Assessment A.

The final radiation levels in each primary cell are estimated to be the same as in Assessment A because the same decontamination scenario is assumed in each case. Accordingly, the allowable worker in-cell residency time for installation of the solidification equipment will be the same as in Assessment A.

7.2.3 Assessment C

Assessment C results in the highest dose to the workers of any of the primary cell assessments. The major contributors to this dose are the preparatory activities of repairing cranes and manipulators, the decontamination of equipment removal rooms as in Assessment A, the dose during transfer of packages to the temporary storage vault, and the manipulator aisle dose during remote decontamination of cell walls and floors. Packages transferred for storage would be transported by a lead shielded truck (3 in. of lead), and a shielded mobile gantry crane. However, it is anticipated that there would be some manual rigging required to ready the package for transport to on-site storage, which would contribute significantly to the dose.

The costs are considerably greater than Assessments A or B because of the additional decontamination subcontractor labor required to maintain exposures below the 5 Rem per year, 3 Rem per quarter limits. Pre-decontamination would require 29 additional workers as in Assessment A and B, and cell decontamination would require 84 workers to assist in manual rigging for packaging as well as cell decontamination. The additional 56,500 manhours for the decontamination subcontractor crew, costs, and exposure are included in Table 7.1.

The temporary storage vault for Assessment C will require additional concrete shielding to accommodate the non-decontaminated stored components. This additional concrete shielding will add about 1.2 ft around the outer walls of the building for a total thickness of about 3 ft. The increased shielding will add approximately \$1,485,000 to the building cost estimated for Assessments A and B. The increased cost of the vault offsets any potential savings from not decontaminating the equipment.

The volume of decontamination wastes is lower than either Assessments A or B (406,900 gal. vs. 659,100 gal.) because none of the cell equipment would be decontaminated. The only decontamination waste is from remote decontamination of cell interior walls and floors.

7.2.4 Assessment D

The secondary cells (XC-1, XC-2, XC-3, and PPC) were not designed for remote maintenance or removal of components. The components consist of piping and extraction columns that have no moving parts and therefore require little maintenance.

Decontamination of the piping and component internal surfaces was assumed to require pipe jumpers to isolate cell components, and flushing solutions pumped from the extraction chemical room. Cell wall and floor surfaces would be decontaminated manually.

Cell XC-1 would require the most extensive decontamination to remove the contamination of the spills from Tank 4D-2. The resultant occupational exposure in XC-1 is approximately a factor of 50 higher than any of the remaining cells. The total exposure of 259 ManRem for all secondary cells in Assessment D is considerably below the typical annual operational exposure received at nuclear power plants.

The secondary cells contain many more components than the primary cells, and were not designed for remote removal. Accordingly, cell XC-1 would require the most time to manually remove the cell components and manually decontaminate the cell walls and floors. The remaining cells (XC-2, XC-3, and the PPC) have already been decontaminated by NFS and will not require the same effort as cell XC-1.

To keep occupational exposures below the 5 Rem per year, 3 Rem per quarter limit, a decontamination subcontractor would be required to augment the standard crews. Five additional workers would be required for secondary cell pre-decontamination, and 84 workers for cell decontamination. The additional 39,000 manhours, costs, and exposures for Assessment D are included in Table 7.1.

The volume of decontamination wastes is half as large as Assessments A and B because of the fewer number of components requiring extensive decontamination and the smaller cell surface area in the secondary cells compared to the primary cells.

The final radiation levels in the secondary cells will permit access for in-cell activities. The values shown below represent the time spans that personnel can occupy the secondary cells per year without exceeding 10CFR 20 limits on annual exposure.

<u>Cell</u>	<u>Annual In-Cell Time Hours/Year/Worker</u>
XC-1	676
XC-2	5880
XC-3	unlimited
PPC	unlimited

7.2.5 Assessment E

Assessment E results in the highest occupational exposure of all assessments because there is no decontamination of components prior to cell entry. The number of decontamination subcontractor personnel required to augment the standard crews is approximately 1500 workers. This large number is unacceptable and not feasible from the practical standpoint of efficiently utilizing their services without increasing the overall dose. The cost for this assessment is almost 2.5 times the cost of Assessment D, and the exposure almost 18 times the exposure of Assessment D. This assessment is not considered feasible for WNYNSC.

8. RECOMMENDED DECONTAMINATION AND REMOVAL CAMPAIGN

This section provides a recommendation for the decontamination and removal campaign to be employed at WNYNSC for the primary and secondary cells. The recommendation is based on the assessment results with respect to the importance of ALARA, manpower cost, and waste volume. The parameters of activity duration and final radiation level are of secondary importance because there is little variation in results from one assessment to another.

8.1 PRIMARY CELL DECONTAMINATION AND REMOVAL

Assessment A is the recommended method for the WNYNSC primary cell decontamination campaign in preparation for solidification. The reasons for this recommendation are based on the following factors:

1. The occupational exposure of 180.3 ManRem is the lowest of all primary cell assessments, due to the availability of remote manipulator equipment and the demonstrated capability of this remote equipment for all decontamination and equipment removal.
2. The \$8,713,500 cost is the lowest cost for primary cell decontamination.
3. It requires the least number of skilled and unskilled craft workers. The 41,514 manhours of activity manpower represents approximately 20 craft workers, which would not present any difficulty of supply in the Buffalo, N.Y. area.
4. The 659,100 gal. of liquid waste generated during decontamination of the primary cells is within the expected range of values as reported in other studies. The rate of liquid waste disposal required would not unreasonably burden the liquid waste disposal system capacity.

5. The pre-decontamination and decontamination activity duration of 428 working days is not so greatly different from the other assessments to cause it to be the restrictive factor in selection.
6. The final radiation levels of 5, 6, 12, and 0.1 millirem per hour for the PMC, GPC, CPC, and SRR cells, respectively, are the same for each primary cell assessment and provide adequate in-cell residency time for activities within the cells during installation of solidification equipment.

These factors demonstrate the feasibility of Assessment A and justify the recommendation for its application at WNYNSC.

8.2 SECONDARY CELL DECONTAMINATION AND REMOVAL

Assessment D is the recommended method for the WNYNSC secondary cell decontamination campaign. The reasons for this recommendation are based on the following factors:

1. The 259 ManRem exposure is within the range of expected values for this type of decontamination campaign. This assessment makes maximum use of remote decontamination and shielding to reduce cell and equipment dose rates prior to manned entry.
2. The cost of \$11,039,800 is lower than that of Assessment E and comparable to Assessments A, B, and C on a dollar per manhour basis.
3. The 71,981 manhours of skilled and unskilled craft workers^a represents a total of 89 workers from the area. This number would not present any difficulty of supply in the Buffalo, N.Y. area.
4. The 323,800 gal. of liquid waste generated during decontamination is consistent with the volume of waste generated in the primary cells on the basis of the lower contamination levels in the secondary cells.

5. The 545 working days duration is approximately 2 calendar years; this will not greatly affect the schedule of the overall program.
6. The final radiation levels in the cells of 7.4, 0.85, < 0.1, and < 0.1 millirem per hour for XC-1, XC-2, XC-3 and the PCC, respectively, will provide virtually unlimited cell residence time for installation of solidification equipment.

These factors demonstrate the feasibility of Assessment D and justify the recommendation for application at WNYNSC if these secondary cells are required for the solidification campaign.

8.3 COMBINED ASSESSMENTS

Several combination assessments were examined for their feasibility, if it is determined that both primary and secondary cells are required for the solidification equipment. The logical choices for combination include those with low occupational exposure, low cost, and low waste volume.

If both primary and secondary cells are required for the waste solidification program, simultaneous decontamination can reduce or eliminate duplicated costs. The cost categories that may be reduced are listed below:

- Decontamination Staff
- Security Force
- Engineering Consultants
- Nuclear Liability Insurance
- Project Management and Engineering QA
- TLD and Film Badge Service
- Upgrading XCR Equipment
- Filters
- Rubber-tired Gantry Crane Rental
- Truck Rental
- Fork Lift Rental

The primary cell activities are of shorter duration than the secondary cell activities. The idle time associated with heavy equipment rental for secondary cell activities can be more efficiently utilized for primary and secondary cells.

The combination of Assessments A or B and D are appropriate since these include system internal decontamination. Assessments C and E are appropriate to combine since these assessments excluded system internal decontamination.

The cost reductions associated with combining Assessments A and D permit a maximum reduction of \$3,420,000. Other combinations will have lesser cost reductions.

9. POTENTIAL ACCIDENT SCENARIOS

The Section lists the types of possible accidents that could occur during the decontamination activities at WNYNSC, and the possible modes of failure to cause an accident. The evaluation of the probability of occurrence, or quantitative impact from each of these potential accident scenarios is beyond the scope of this technical assessment. The potential accident, failure mode, and resultant impact are tabulated in Table 9.1.

TABLE 9.1
POTENTIAL ACCIDENT SCENARIOS

Potential Accident Classes	Failure Mode	Resultant Impact
1. Radioactive Releases	<ul style="list-style-type: none"> A. HEPA filter break-through B. Large rupture of contamination control envelope C. Fire involving radioactive materials 	Discharge of radionuclides to the environment with direct dose and ingestion by inhabitants
2. Occupational Exposure	<ul style="list-style-type: none"> A. Radioactive material release in work area B. Radioactive material release in a non-work area and not detected C. Human error D. Worker entry into an unauthorized area. 	Occupational exposure to workers
3. Hazardous Chemical Spills/Releases	<ul style="list-style-type: none"> A. Human error (e.g. improper handling/mixing of chemicals) B. Sabotage C. Corrosion of piping systems D. Equipment failure 	Toxic chemical ingestion, skin burns, loss of eyesight
4. Industrial Accidents	<ul style="list-style-type: none"> A. Falls from scaffolding, etc. B. Falling objects C. Misuse of equipment D. Equipment failure E. Electrical short circuits F. Operator error (e.g. improper crane/equipment operation) G. Pranks 	Temporary or permanent injury or loss of limbs

TABLE 9.1
(Continued)

Potential Accident Classes	Failure Mode	Resultant Impact
5. Security Threat	<ul style="list-style-type: none"> A. Unauthorized intrusion B. Security breach C. Industrial sabotage D. Internal labor relations problems E. Terrorist/intervenor sabotage F. Curiosity seekers 	Physical injury to plant personnel, damage to equipment, emotional strain
6. Criticality Control	<ul style="list-style-type: none"> A. Vacuuming radioactive "fines" in primary cells B. Sedimentation of contaminants in decontamination solvents C. Concentration of combined solvents in acid recovery system 	Assembly of a critical mass with potential thermal and radioactive releases
7. Chemical Explosives	<ul style="list-style-type: none"> A. Ignition of organic solvents or vapors B. Exothermic reaction from acid/base mixtures C. Human error (e.g. using acetylene in plasma arc torch) 	Personnel burns, injury, and plant damage.
8. Fires	<ul style="list-style-type: none"> A. Improper storage of pyrophoric materials B. Electrical failures and short circuits C. Poor housekeeping D. Human negligence 	Personnel burns, injury, and plant damage

TABLE 9.1
(Continued)

Potential Accident Classes	Failure Mode	Resultant Impact
9. Dust Ingestion	<ul style="list-style-type: none"> A. Failure of air filters in respiratory face masks B. Contamination of breathing air compressor air intake C. Rupture of supplied-air breathing hood. D. Poor housekeeping E. Human negligence 	Ingestion of toxic or nuisance dust with attendant respiratory difficulty
10. Radioactive Material Transportation	<ul style="list-style-type: none"> A. Excessive dose rate on package surface B. Breach of package integrity C. Improper handling, or dropping of package with breach of contents D. Package fires on truck E. Vehicle malfunction or fire when loaded with radioactive material 	Excessive driver and packaging crew exposure while recovering from a breach of package integrity or repair of the vehicle
11. Toxic Materials Transportation and Handling	<ul style="list-style-type: none"> A. Decontamination chemical rail/truck tanker accident B. Spills/ruptures during chemical transfers to building from tanker C. Human error (e.g. transfer of acid to a caustic storage tank) 	Highly toxic and corrosive spills; personnel chemical burns, loss of eye sight; explosions

TABLE 9.1
(Continued)

Potential Accident Classes	Failure Mode	Resultant Impact
12. Radioactive Material Storage	A. Failure of HEPA filters in temporary storage vault ventilation system	Breach of package or filtration system with on-site and off-site dose and ingestion potential.
	B. Fire causing breach of package contents	
	C. Sprinkler system initiation spreading contamination	Spread of contamination outside storage vault in the sprinkler system runoff
	D. Improper handling and storage of highly radioactive packages	Excessive dose rate to workers
13. Earthquake/Tornadoes	A. Failure of temporary contamination control envelopes	Potential release of radioactive material on site
	B. Leak or rupture of acid, caustic or radioactive liquid storage tanks	Spills causing personnel injury and plant damage
	C. Industrial accidents causing electrical shorts, fires, falling objects, missiles	Fires, personnel injury, and plant damage.

10. REFERENCES

1. Supplied by W.A. Oldham, Nuclear Fuel Services in a letter to L.F. Munson, United Nuclear Corporation, March 30, 1978.
2. Munson, L.F., Nemec, J.F., and Koochi, A.K.: Decommissioning Alternatives for the West Valley, New York, Fuel Reprocessing Plant, Argonne National Laboratory, UNI-1050 (June 1978).
3. Broothearts, J. et. al.: Experience Gained with Decontamination of a Shut-Down Reprocessing Plant, Eurochemic, Mol, Belgium, IAEA-SM-234/9.
4. Barrett, T.R. and Thom, D.: The Decommissioning and Reconstruction of the Fast Reactor Fuel Reprocessing Plant, Dounreay, IAEA-SM-234/9.
5. Schneider, K.J., Jenkins, C.E., et. al., Technology, Safety, and Costs of Decommissioning a Reference Fuel Reprocessing Plant, NUREG/CR-0278 (October, 1977).
6. Supplied by T. Bauer, Vice-President Imperial Professional Coatings, New Orleans, Louisiana, in a conversation with T.S. LaGuardia, Nuclear Energy Services, Inc., Danbury, Connecticut, March 14, 1980.
7. Manion, W.J. and LaGuardia, T.S.: An Engineering Evaluation of Nuclear Power Reactor Decommissioning Alternatives, AIF/NESP-009 (November, 1976).
8. Hershey, J.H.: Separations Canyon Decontamination Facilities, E.I. duPont de Nemours and Company, Savannah River Plant, Aiken, South Carolina, DPSPU 75-30-5 (May, 1975).
9. Moore, P.R.: Decontamination of a Highly Radioactive Chemical Processing Facility, E.I. duPont de Nemours and Company, Savannah River Plant, Aiken, South Carolina, DPSPU 74-30-10 (June 1975).

10. Bacca, J.P., et. al.: Decontamination and Refurbishment of the Hot Fuel Examination Facility South (HFEF/S) Argon Cell, Argonne National Laboratory, Idaho Falls, Idaho (September 16, 1979).
11. U.S. Department of Labor, Bureau of Labor Statistics: Employment and Earnings - October, 1979.
12. R.S. Means Company, Inc., Kingston, Massachusetts: Building Construction Cost Data - 1980 (1979).
13. 1980 Dodge Guide to Public Works and Heavy Construction Costs, Annual Edition No. 12, McGraw Hill, New York (1979).
14. Supplied by R. Jones, American Nuclear Insurers, in a conversation with R. Hykys, Nuclear Energy Services, Inc., April, 1980.
15. Occupational Radiation Exposure at Commercial Nuclear Power Reactors, NUREG-0594 (1978).
16. Western New York Nuclear Service Center: Safety Analysis Report, Vol. VII, Section 9.2, Revision 1 (December 13, 1974).
17. Technology, Safety, and Costs of Decommissioning a Reference Pressurized Water Reactor Power Station, NUREG/CR-0130, Appendix G.

TABLE A-1

CONFIGURATION OF SYSTEMS AND STRUCTURES

<u>Cell</u>	<u>Major Equipment Removed</u>	<u>Decontamination</u>	<u>Comments</u>
1. General Purpose Cell (GPC)	None Small area of concrete floor surface scarified with paving breakers. Work abandoned.	None	Cladding hulls spilled on floor. Wall and floor areas contaminated with fuel particulates.
2. Process Mechanical Cell (PMC)	Original PMC saw (small saw remains).	External surfaces water flushed.	Contaminated with fuel par- ticulates. North end window seal must be replaced.
3. Chemical Process Cell (CPC)	None	Systems decontaminated internally.	Existing waste evaporators not connected to acid recovery system. New evaporators on site.
4. Extraction Cell (XC-1)	Bottom line from tank 4D-2 removed.	Extensive internal chemical decontamination. Some external decontam- ination.	Tank 4D-1 and floor of cell externally contaminated from spill from Tank 4D-2 above. Cell access through top hatch.
5. Extraction Cell (XC-2)	None	Extensive internal chem- ical decontamination. Some external decontam- ination.	Cell access through top hatch or floor level air lock.
6. Extraction Cell (XC-3)	None	Extensive internal chem- ical decontamination. Some external decontam- ination.	Cell access through top hatch or floor level air lock.

TABLE A-1
CONFIGURATION OF SYSTEMS AND STRUCTURES
(Continued)

<u>Cell</u>	<u>Major Equipment Removed</u>	<u>Decontamination</u>	<u>Comments</u>
7. Product Purification Cell (PPC)	None	Extensive internal chemical decontamination. Some external decontamination.	Cell access through top hatch or floor level air lock.
8. Liquid Waste Cell (LWC)	None	Extensive internal chemical decontamination. Some external decontamination.	Non flow-through ventilation.
9. Acid Recovery Cell (ARC)	None	Extensive internal chemical decontamination. Some external decontamination.	None

TABLE A-2.1

SUMMARY OF EQUIPMENT, PIPING, AND STRUCTURE RADIATION LEVELS

GPC

Average Area Radiation Level = 1250 R/hr*

<u>Equipment ID Numbers</u>	<u>Item Description</u>	<u>Characteristic Dimensions L x W x H, in.</u>	<u>**Estimated Radiation Exposure Rate, R/hr</u>
15E-12	GPC Cooler	75 x 40 x 30	170
2M-6	Radiation Shielding Windows, GPC (3 windows A,B&C)	54 x 48 x 42	
2M-7	Crane Maintenance Door GPC-GCR	186 x 30 x 120	65
2M-8	Radiation Shielding Window Shutters GPC (3 Shutters A,B&C)	33 x 54 x 5 165	
2V-32A	Extended Reach Master-Slave Manipulator, GPC (1/2 Pair)	84 x 5 x 5 150-400	
2V-32B	Extended Reach Master-Slave Manipulator, GPC (1/2 Pair)	84 x 5 x 5 150-400	
2V-33	Chopped Fuel Basket Loading Station	78 x 60 114 140	
2V-34	2 Ton Crane, GPC	134 x 24 x 24	65
2V-35	Chopped Fuel Storage and Cooling Rack GPC	216 x 36 x 102	140
2V-36	Empty Fuel Basket Storage Socket GPC (4)	12 x 18 x 36	115
2V-37	Loaded Fuel Basket Transfer Station Socket, GPC	24 x 24 x 42	115
2V-38	Leached Hulls Dumping Sampling and Packaging, GPC	102 x 42 x 108	355

NOTES:

* Average of cell area radiation levels reported in Ref. 1.

** Estimated exposure rates from components are at a distance of 3 feet from the component.

TABLE A-2.1

SUMMARY OF EQUIPMENT, PIPING, AND STRUCTURE RADIATION LEVELS

GPC
(Continued)

Average Area Radiation Level = 1250 R/hr*

<u>Equipment ID Numbers</u>	<u>Item Description</u>	<u>Characteristic Dimensions</u>		<u>**Estimated Radiation Exposure Rate, R/hr</u>
		<u>Length (in.)</u>	<u>Diam. (in.)</u>	
2V-42	Chopped Fuel Basket Pickup Service, GPC	24 x 12 x 12		120
2V-42A	Chopped Fuel Basket Pickup Device Storage Bracket, GPC	12 x 12 x 18		115
2V-43A	8" Chopped Fuel Basket Liner Pickup Device, GPC	87	6	115
2V-43B	7" Chopped Fuel Basket Liner Pickup Device, GPC	87	6	115
2V-43C	6.3" Chopped Fuel Basket Liner Pickup Device, GPC	87	6	150
2V-43D	Floor Mt'd Storage Stand for (2) Liner Pickup Devices, GPC	24L x 12W x 12H		150
2V-43E	Wall Mt'd Storage Stand for Liner Pickup Device, GPC	18L x 18W x 12H		150
2V-47	Power Manipulator Crane Tool and Adapter Holder, GPC	12L x 12W x 6H		350
2V-49	Master Slave Manipulator Tool and Adapter Holder, GPC	12L x 12W x 6H		250
2V-52	Leached Hull Basket Transfer Station Socket	24L x 24W x 42H		115
2V-53	Hinged Sections of Crane Rails	42L x 6W x 6H		65
2V-54	Crane Maintenance Door Operating Unit GPC-GCR	54L x 27W x 27H		
2V-55	Power Manipulator Crane Cable Shield	582L x 6W x 1H		350

TABLE A-2.1

SUMMARY OF EQUIPMENT, PIPING, AND STRUCTURE RADIATION LEVELS

GPC
(Continued)

Average Area Radiation Level = 1250 R/hr*

<u>Equipment ID Numbers</u>	<u>Item Description</u>	<u>Characteristic Dimensions</u>		<u>**Estimated Radiation Exposure Rate, R/hr</u>
		<u>Length (in.)</u>	<u>Diam. (in.)</u>	
2V-56	Criticality Guard Rails, GPC			115
2V-57	Bundle Shear Discharge Chute	135	9	65
2V-64	Leached Hull Reload Hopper	6L x 6W x 6H		200
2V-65	Leached Hull Reload Funnel	6L x 6W x 6H		200
2V-66	Packaged Hydraulic Power Unit	24L x 24W x 36H		65
2V-67	Fire Protection Packaged Unit	36L x 5H		115 & 350
2V-68A	Fire Hose Bracket	Beam 36L x 5H		350
2V-68B	Fire Hose Bracket	Beam 36L x 5H		350
2V-68C	Fire Hose Bracket	Beam 36L x 5H		350
2V-68D	Fire Hose Bracket	Beam 36L x 5H		350
2V-69A	GPC Mirror & Bracket	18L x 18W x 30H		140
2V-69B	GPC Mirror & Bracket	18L x 18W x 30H		140
2V-69C	Mirror Bracket (only)	18L x 18W x 30H		115
2V-69D	Mirror Bracket (only)	18L x 18W x 30H		115
2V-73	Power Manipulator (Bridge Mounted)	138L x 60W x 60H		
2V-74	Cable Tray 2 Ton Crane	582L x 8W x 2H		
2V-75	Chute Adapter Tip for 8" Brackets	18	12	130
2V-76	Chute Adapter Tip for 7" Brackets	18	12	120
2V-75A	Tip Storage Stands	18	8	115

TABLE A-2.1

SUMMARY OF EQUIPMENT, PIPING, AND STRUCTURE RADIATION LEVELS

GPC
(Continued)

Average Area Radiation Level = 1250 R/hr*

<u>Equipment ID Numbers</u>	<u>Item Description</u>	<u>Characteristic Dimensions</u>		<u>**Estimated Radiation Exposure Rate, R/hr</u>
		<u>Length (in.)</u>	<u>Diam. (in.)</u>	
2V-76A	Tip Storage Stands	18	8	115
2V-77	Chute Adapter Tip for 6.3" baskets	18	12	115
2V-77A	Tip Storage Stands	18	8	115
2V-78A	Chute Adapter Tip Change Tools	12L x 12W x 6H		350
2V-78B	Chute Adapter Tip Change Tools	12L x 12W x 6H		350
2V-78C	Chute Adapter Tip Change Tools	12L x 12W x 6H		350
2V-78D	Storage Stand for Change Tools	12L x 12W x 48H		140
2V-79	Chopped Fuel Storage Criticality Wall	12	270	230
2V-81A	Settling Tray (Removable)			300
2V-81C	Permanent Liner-Settling Tray Area	12L x 33W x 12H		300
2V-82	Seal Pan	18L x 18W x 48H		300
2V-83	Leached Hull Reload Scoop	24L x 12W x 12H		115
2V-84	New Fuel Basket Transfer Socket	Cone Shape 14" at Base x 42" H		250
2V-85A	Liner Capping Devices	6	36	140
2V-85B	Storage Rack for 2V-85A			140
2V-85C	Liner Cap Handling Basket			500
2V-86	Scrap Drum Handling Bails			500
2V-89	Holding Rack for Scrap Drum Lids	24	24	120

TABLE A-2.1

SUMMARY OF EQUIPMENT, PIPING, AND STRUCTURE RADIATION LEVELS

GPC
(Continued)

Average Area Radiation Level = 1250 R/hr*

<u>Equipment ID Numbers</u>	<u>Item Description</u>	<u>Characteristic Dimensions</u>		<u>**Estimated Radiation Exposure Rate, R/hr</u>
		<u>Length (in.)</u>	<u>Diam. (in.)</u>	
2V-85D	Liner Cap Adapter for 8" Basket			350
2V-85E	Liner Cap Adapter for 7" Basket		350	
2V-85F	Liner Cap Adapter for 6.3" Basket		350	
3V-21A	Spare Chopped Fuel Basket Pickup Device Storage Basket		300	
2H-1	Steam Eductor	12	6	350
2H-2	Steam Eductor	12	6	350
	Decontamination Spray Nozzles (2) for PM Arm and Hoist			
2LAH-1	Chopped Fuel Basket Level Detector & Alarm	14	12	140
2LAH-2	Chopped Fuel Basket Level Detector & Alarm	14	12	140
	Dust Pan Mechanism Scrap Drums(2)	42	36	480
3V-8	Dissolver Fuel Baskets (5)	144	12	480
	Additional Fire Protection Equipment (hoses & nozzles)			100

TABLE A-2.2

SUMMARY OF EQUIPMENT, PIPING, AND STRUCTURE RADIATION LEVELS

PMC

Average Area Radiation Level = 221 R/hr*

<u>Equipment ID Number</u>	<u>Item Description</u>	<u>Characteristic Dimensions</u>		<u>**Estimated Radiation Exposure Rate, R/hr</u>
		<u>Length (in.)</u>	<u>Diam. (in.)</u>	
15E-11	PMC Cooler	37L x 61W x 34H		100
2J-1	PMC Television System	30L x 30W x 30H		100
2M-1E	Window Plug, East MOA			
2M-1	Shielded Viewing Windows Oper. Aisle PMC, (4 windows A,B,C,&D)	66L x 60W x 60H		
2M-2	Crane Maintenance Door PMC-MCR	154L x 38W x 20H		
2M-3	Shielded Viewing Windows, Corner PMC	66L x 30W x 60H		
15T-55	PMC Filter			
15T-56A	Shear Filter (particulate)	48	12	410
15T-56B	Shear Filter (activated carbon)	48	12	410
2V-1A	Fuel Handling Bridge Crane,PMC	150L x 6W x 12H		100
2V-1B	Fuel Handling Bridge Crane,PMC	150L x 6W x 12H		100
2V-2	Disassembly Saw and Push Out Table			240
2V-4	Fuel Bundle, Shear,PMC			40
2V-5	Pin Shear,PMC			40

NOTES:

* Average of cell area radiation levels reported in Ref. 1.

** Estimated exposure rates from components are at a distance of 3 feet from the component.

TABLE A-2.2

SUMMARY OF EQUIPMENT, PIPING, AND STRUCTURE RADIATION LEVELS

PMC
(Continued)

Average Area Radiation Level = 221 R/hr*

<u>Equipment ID Numbers</u>	<u>Item Description</u>	<u>Characteristic Dimensions</u>		<u>**Estimated Radiation Exposure Rate, R/hr</u>
		<u>Length (in.)</u>	<u>Diam. (in.)</u>	
2V-8	Extended Reach H.D. Master-Slave Manipulator, PMC (4 Pair A,B,C,D)	84L x 5W x 5H		100
2V-8E	Pair M-S Manipulator Insert Plugs	66	12	100
2V-8F	Pair M-S Manipulator Insert Plugs	66	12	100
2V-8G	Pair M-S Manipulator Insert Plugs	66	12	100
2V-10	Pushout Rams,PMC			40
2V-11	Disassembly Inspection & Pushout Table, PMC	156L x 37W x 1H		240
2V-14	Maintenance Table, PMC			175
2V-24	Washdown Hoses & Nozzles, PMC			240
2V-27	PMC-CPC Hatch Cover			175
2V-30	Hatch Cover For Transfer from FRS, PMC			100
2V-44	Fuel Element Tilting Fixtures, PMC			100
2V-45	Mech. Processing Fixture and Adaptors, PMC			410
2V-46	PMC, Mirrors			175

TABLE A-2.2

SUMMARY OF EQUIPMENT, PIPING, AND STRUCTURE RADIATION LEVELS

PMC
(Continued)

Average Area Radiation Level = 221 R/hr*

<u>Equipment ID Numbers</u>	<u>Item Description</u>	<u>Characteristic Dimensions</u>		<u>**Estimated Radiation Exposure Rate, R/hr</u>
		<u>Length (in.)</u>	<u>Diam. (in.)</u>	
2V-61	Fuel Grapples, PMC			100
2V-87	Fire Protection Packaged Unit (PMC)			240
2V-92	PMC Periscope Plugs (A,B,C,D,E,F)			40
11V-2	Transfer Hatch Cover, PMC to MC			40

TABLE A-2.3

SUMMARY OF EQUIPMENT, PIPING, AND STRUCTURE RADIATION LEVELS

CPC

Average Area Radiation Level = 22 R/hr*

Equipment ID Numbers	Item Description	Characteristic Dimensions		**Estimated Radiation Exposure Rate, R/hr
		Length (in.)	Diam. (in.)	
3C-1	Dissolver	186	98	1.2
3C-2	Dissolver	186	98	1.2
3D-1	Accountability and Feed Adjustment Tank	94	82	1.2
7C-4	Rework Evaporator	94	94	1.2
7D-10	Low Level Waste Accountability and Neutralizer Tank	108	72	0.5
7D-4	Hi-Level Waste Accountability and Neutralizer Tank	96	60	1
7C-1	Hi-Level Waste Evaporator	120	60	1.2
7C-2	Low-Level Waste Evaporator	120	96	1.2
3E-1	Feed Adjustment Tank Condenser	115	13	1
3E-2	Dissolver 3C-1 Condenser	128	30	1.2
3E-3	Dissolver 3C-2 Condenser	128	30	1.2
7E-5	Hi-Level Waste Evaporating Condenser	109	15	1.2
7E-8	Rework Evaporator Condenser	133	13	1
15E-13	CPC Cooler	79L x 36W x 18H		Note A

NOTES:

A Based on available information, NES has conservatively assumed all support and service equipment has an exposure rate of 1 R/hr.

* Average of cell radiation levels reported in Ref. 1.

** Estimated exposure rates from components are at a distance of 3 feet from the component.

TABLE A-2.3

SUMMARY OF EQUIPMENT, PIPING, AND STRUCTURE RADIATION LEVELS

CPC
(Continued)

Average Area Radiation Level = 22 R/hr*

Equipment ID Numbers	Item Description	Characteristic Dimensions		**Estimated Radiation Exposure Rate, R/hr
		Length (in.)	Diam. (in.)	
15E-14	CPC Cooler	79L x 36W	x 18H	Note A
15E-15	CPC Cooler	79L x 36W	x 18H	Note A
3J1	CPC Television System	24L x 24W	x 24H	Note A
3M-4A	Radiation Shield for Viewing Window	84L	x 51W	
3M-4B	Radiation Shield for Viewing Window	84L	x 51W	
3M-4B	Radiation Shield for Viewing Window	84L	x 51W	
3M-6A	Movable Jumper Storage Rack	66L x 93W		Note A
3M-6B	Movable Jumper Storage Rack	66L x 165W		Note A
3M-9	Fuel Basket Rack	54L x 45W	x 75H	Note A
3M-10	Fuel Basket Rack	75L x 45W	x 75H	Note A
3M-11	Condenser Maint. Storage Rack	36L x 84W	x 75H	Note A
3M-17	Removable Support Frame for 7C-1	84L x 30W	x 30H	Note A
3V-1A	CPC 2 Ton Trolley on 3V-1	36L x 48W	x 36H	Note A
3V-1B	15 Ton Trolley	36L x 48W	x 36H	Note A
3V-2	Bridge Mounted Power Manipulator	168L x 24W	x 24H	Note A
3V-2A	2 Ton Trolley on 3V-2	60L x 36W	x 36H	Note A
3V-4	Viewing Periscope	18L x 18W	x 18H	
3V-7	Hinged Rails and Operating Devices	60L x 12W	x 12H	
3V-8	Dissolver Fuel Assembly	90	8.25	Note A

TABLE A-2.3

SUMMARY OF EQUIPMENT, PIPING, AND STRUCTURE RADIATION LEVELS

CPC
(Continued)

Average Area Radiation Level = 22 R/hr*

<u>Equipment ID Numbers</u>	<u>Item Description</u>	<u>Characteristic Dimensions L x W x H, in.</u>	<u>**Estimated Radiation Exposure Rate, R/hr</u>
3V-9	Dissolver Pickup Device	12L x 12W x 24H	Note A
3V-10	Impact Wrench	29L x 17W x 8H	Note A
3V-11A	Strongback for Lifting Large Vessels	120 x 60 x 24	Note A
3V-11B	Strongback for Small Vessels	96 x 60 x 24	Note A
3V-11C	Strongback for Horizontal Condenser	60 x 60 x 24	Note A
3V-11D	Adapter for Vertical Condenser	60 x 60 x 24	Note A
3V-15A	Vessel Decontamination Spray Ring Storage Bracket	36 x 6 x 6	Note A
3M-19A	Equipment Racks	84L x 30W x 30H	Note A
3M-19B	Equipment Racks	84L x 30W x 30H	Note A
15M-30	Support Frame for 15E-13	84L x 30W x 24H	Note A
15T-53	CPC Filter (3 units)	39 9	Note A
3V-1	15 Ton-2 Ton Crane	312L x 24W x 24H	Note A
3V-16	Manipulator Decontamination Spray Ring	24 x 12 x 6	Note A
3V-18A	CPC Cable Reels (part of crane)	72 x 36 x 36	
3V-18B	CPC Cable Reels (part of crane)	72 x 36 x 36	Note A
3V-18C	CPC Cable Reels (part of crane)	72 x 36 x 36	Note A
3V-18D	CPC Cable Reels (part of crane)	72 x 36 x 36	Note A

TABLE A-2.3

SUMMARY OF EQUIPMENT, PIPING, AND STRUCTURE RADIATION LEVELS

CPC
(Continued)

Average Area Radiation Level = 22 R/hr*

<u>Equipment ID Numbers</u>	<u>Item Description</u>	<u>Characteristic Dimensions L x W x H, in.</u>	<u>**Estimated Radiation Exposure Rate, R/hr</u>
3V-19	Criticality Guard CPC	60 x 54 x 60	Note A
3V-20	Crane Cable Rollers	6 x 6 x 6	
3V-21	Spare Chopped Fuel Basket Pick-up Device	12 x 12 x 24	Note A
3V-21A	Spare Chopped Fuel Storage Bracket	24 x 36 x 36	Note A
3V-22	Spare Impact Wrench	29 x 17 x 8	Note A
3V-24A	Sump Jet Support Platform	24 x 12 x 24	Note A
3V-24B	Sump Jet Support Platform	24 x 12 x 24	Note A
3V-25	Dip Tube Jumper Storage Rack		Note A
3V-26	6" Jumper Storage Rack	24 x 24 x 24	Note A
15V-14	Equipment Transfer Car	108 x 72 x 96	Note A

TABLE A-2.4

SUMMARY OF EQUIPMENT, PIPING, AND STRUCTURE RADIATION LEVELS

XC-1

Average Area Radiation Level = 30 R/hr*

Equipment ID Numbers	Item Description	Characteristic Dimensions		**Estimated Radiation Exposure Rate, R/hr
		Length (in.)	Diam. (in.)	
4C-1	Partition Cycle Extraction Column	372	6	0.5
4C-2	Partition Cycle Extraction Column	372	6	0.5
4C-3	Partition Cycle Pu Scrub Column	124	5	0.5
4C-13A	Partition Cycle Feed Pump Pot	4	18	0.06
4C-13B	Partition Cycle Feed Pump Pot	4	18	0.06
4D-1	Partition Cycle Feed Tank	11	72	0.06
4D-2	Partition Cycle Waste Catch Tank	126	72	0.06
7D-1	Hi Level Waste Evaporator Feed Tank	96	72	0.06
4E-1	Col. 4C-4 Organic Feed Preheater	210	1.5	0.06
4Y-1	Aqueous Decanter for 4C-1	24	18	0.06
4Y-5	HAP Surge Tank	120	8	0.06
4Y-6	HBD Surge Tank	120	8	0.06
4Y-13	Phase Separator for 4D-1 Air Lift Pipe	18	6	0.06
4Y-14	Measuring Head Pot for 4C-1 Feed	36	6	0.06
4Y-15	Level Control Pot for 4C-1	6	6	0.06
4Y-17	Level Control Pot for 4C-2	6	6	0.06

NOTES:

* Average of cell area radiation levels reported in Ref. 1.

** Estimated exposure rates from components are at a distance of 3 feet from the component.

TABLE A-2.4

SUMMARY OF EQUIPMENT, PIPING, AND STRUCTURE RADIATION LEVELS

XC-1
(Continued)

Average Area Radiation Level = 30 R/hr*

<u>Equipment ID Numbers</u>	<u>Item Description</u>	<u>Characteristic Dimensions</u>		<u>**Estimated Radiation Exposure Rate, R/hr</u>
		<u>Length (in.)</u>	<u>Diam. (in.)</u>	
4Y-19	Level Control Pot for 4C-2	6	6	0.06
4Y-42	Phase Separator for 4H-2 Discharge to 4C-3	18	6	0.06
4Y-48	Sample Pot for HCW Line	8	2	0.06
4Y-49	Sample Pot for 11BW Line	8	2	0.06
7Y-1	Phase Separator for 7C-1 Feed	24	6	0.06
7Y-3	Decanter for 7C-1 Feed	43	14	0.06

TABLE A-2.5
SUMMARY OF EQUIPMENT, PIPING, AND STRUCTURE RADIATION LEVELS
XC-2

Average Area Radiation Level = 0.085 R/hr*

Equipment ID Numbers	Item Description	Characteristic Dimensions		**Estimated Radiation Exposure Rate, R/hr
		Length (in.)	Diam. (in.)	
4C-4	Partition Cycle Strip Column	402	12	0.5
4C-7	Plutonium Cycle Extraction Column	456	6	0.5
4C-8	Plutonium Cycle Strip Column	374	4	0.5
4C-9	First U Cycle Extraction Column	420	12	0.5
13C-1	No. 1 Carbonate Wash Column	339	12	0.5
13C-2	No. 2 Carbonate Wash Column	339	12	0.5
13C-4	No. 1 Acid Wash Column	110	12	0.5
13C-5	No. 2 Acid Wash Column	110	12	0.5
4D-6	Plutonium Cycle Feed Conditioner	54	30	0.06
4D-9	First U Cycle Feed Tank Conditioner	108	42	0.06
13D-1	No. 1 Solvent Washer	66	48	0.06
13D-2	No. 2 Solvent Washer	66	48	0.06
13D-4	No. 1 Solvent Storage Tank	90	60	0.06
13D-5	No. 2 Solvent Storage Tank	90	60	0.06
13D-1B	Solvent Cleanup and Waste Organic Catch Tank	96	78	0.06
4E-2	1st U Cycle Strip Feed Htr	240	2	0.06

NOTES:

* Average of cell area radiation levels reported in Ref. 1.

** Estimated exposure rates from components are at a distance of 3 feet from the component.

TABLE A-2.5

SUMMARY OF EQUIPMENT, PIPING, AND STRUCTURE RADIATION LEVELS

XC-2
(Continued)

Average Area Radiation Level = 0.085 R/hr*

Equipment ID Numbers	Item Description	Characteristic Dimensions		**Estimated Radiation Exposure Rate, R/hr
		Length (in.)	Diam. (in.)	
4E-4	1st U Cycle Feed Cooler	204	12	0.06
15M-10	XC-2 Access Door	40L x 6W x 82H		0.06
4Y-7	Aqueous Decanter for 4C-7	53	8	0.06
4Y-8	Aqueous Decanter for 4C-8	43	5	0.06
4Y-9	Aqueous Decanter for 4C-9	43	24	0.06
4Y-21	IAU Surge Tank	120	8	0.06
4Y-20	Level Control Pot for 4C-4	6	6	0.06
4Y-24	Measuring Head Pot for 4C-9	36		0.06
4Y-26	Leveling Sensing Chamber for 4C-9			0.06
4Y-25	Level Control Pot for 4C-9	6	6	0.06
4Y-32	Measuring Head Pot for 4C-7	6	6	0.06
4Y-33	Level Control Pot for 4C-7	6	2	0.06
4Y-34	Level Sensing Chamber for 4C-7			0.06
4Y-35	Level Control Pot for 4C-8	6	2	0.06
4Y-40	Organic Extract Head Pot for 4C-7			0.06
4Y-41	Organic Scrub Head Pot for 4C-8			0.06
4Y-56	Phase Separator ICW Sampler	30	6	0.06
13Y-1	Phase Separator for 13C-1	6	2	0.06
13Y-2	Phase Separator	6	2	0.06

TABLE A-2.5

SUMMARY OF EQUIPMENT, PIPING, AND STRUCTURE RADIATION LEVELS

XC-2
(Continued)

Average Area Radiation Level = 0.085 R/hr*

<u>Equipment ID Numbers</u>	<u>Item Description</u>	<u>Characteristic Dimensions</u>		<u>**Estimated Radiation Exposure Rate, R/hr</u>
		<u>Length (in.)</u>	<u>Diam. (in.)</u>	
13Y-3	Phase Separator	6	2	0.06
13Y-4	Phase Separator	6	2	0.06
13Y-8	Decanter for 130-18	55	24	0.06
4Y-45	Level Control Pot for 4D-6	6	2	0.06
4Y-46	IIAW Sample Pot	8	2	0.06
4Y-54	Phase Separator HCW Sampler	30	6	0.06

TABLE A-2.6

SUMMARY OF EQUIPMENT, PIPING, AND STRUCTURE RADIATION LEVELS

XC-3

Average Area Radiation Level = 0.012 R/hr*

<u>Equipment ID Numbers</u>	<u>Item Description</u>	<u>Characteristic Dimensions</u>		<u>**Estimated Radiation Exposure Rate, R/hr</u>
		<u>Length (in.)</u>	<u>Diam. (in.)</u>	
4C-10	First U Cycle Strip Column	414	6	0.5
4C-11	Second U Cycle Extraction Column	408	12	0.5
4C-12	Second U Cycle Strip Column	414	6	0.5
13C-3	No. 3 Carbonate Wash Column	340	12	0.5
13C-6	No. 3 Acid Wash Column	125	12	0.5
4D-12	Second U Cycle Feed Tank Conditioner	108	42	0.06
5D-1	Pu 1X Feed Conditioner	42L x 2.5W x 48H		0.06
5D-2	Pu 1X Waste Catch Tank	48	36	0.06
13D-3	No. 3 Solvent Washer	66	48	0.06
13D-6	No. 3 Solvent Storage Tank	90	60	0.06
4E-3	Second U Cycle Strip Feed Htr	240 x 1" pipe 2" Jacket		0.06
4E-5	Second U Cycle Feed Cooler	150	10	0.06
15M-11	XC-3 Access Door	40L x 4W x 82H		0.06
4Y-11	Aqueous Decanter for 4C-11	43	24	0.06
4Y-12	Aqueous Decanter for 4C-12	43	18	0.06
4Y-22	IDU Surge Tank	120	8	0.06

NOTES:

* Average of cell area radiation levels reported in Ref. 1.

** Estimated exposure rates from components are at a distance of 3 feet from the component.

TABLE A-2.6

SUMMARY OF EQUIPMENT, PIPING, AND STRUCTURE RADIATION LEVELS

XC-3
(Continued)

Average Area Radiation Level = 0.012 R/hr*

<u>Equipment ID Numbers</u>	<u>Item Description</u>	<u>Characteristic Dimensions</u>		<u>**Estimated Radiation Exposure Rate, R/hr</u>
		<u>Length (in.)</u>	<u>Diam. (in.)</u>	
4Y-27	Level Control Pot for 4C-10	6	6	0.06
4Y-28	Measuring Head Pot for 4C-11	36	6	0.06
4Y-29	Level Control Pot for 4C-11	6	6	0.06
4Y-31	Level Control Pot for 4C-12	6	6	0.06
4Y-57	Phase Separator IEW Sample	30	6	0.06
4Y-51	Sample Pot for ICW Line	8	2	0.06
4Y-53	Sample Pot for IEW Line	8	2	0.06
13Y-5	Phase Separator for 13C-3	6	2	0.06
13Y-6	Phase Separator for 13D-3	6	2	0.06
5E-9	Ion Exchanger Waste Cooler	360 of 1" Pipe in 2" Jacket		

TABLE A-2.7

SUMMARY OF EQUIPMENT, PIPING, AND STRUCTURE RADIATION LEVELS

PPC

Average Area Radiation Level = 0.005 R/hr*

Equipment ID Numbers	Item Description	Characteristic Dimensions		**Estimated Radiation Exposure Rate, R/hr
		Length (in.)	Diam. (in.)	
5C-1A	No. 1 Pu Ion Exchanger	102	6	0.06
5C-1B	No. 2 Pu Ion Exchanger	102	6	0.06
5C-1C	No. 3 Pu Ion Exchanger	102	6	0.06
5C-2	Pu Product Evaporator	150	6	0.06
5C-4	Low Enrichment U Product Evaporator	135	36	0.06
		146	12 Bottom	0.06
5C-5	Hi-Enrichment U Product Evaporator	135	36 Top	0.06
		146	6 Bottom	0.06
5C-6A	No. 1 Uranium Silica Gel Bed	135	12	0.06
5C-6B	No. 2 Uranium Silica Gel Bed	135	12	0.06
5D-4	Pu Product Evaporator Feed Tank	51L x 2.5W x 60H		0.06
5D-5A	No. 1 Pu Product Storage Tank	60L x 2.5W x 60H		0.06
5D-5B	No. 2 Pu Product Storage Tank	60L x 2.5W x 60H		0.06
5D-6	Pu Evaporator Condensate Tank	48	16	0.06
5D-7	U Product Evaporator Feed Tank	54	36	0.06
5D-8	U Product Condensate Tank	72	36	0.06
5D-9	U Product Surge Tank	66	42	0.06
5D-11	Regeneration Waste Tank	66	30	0.06

NOTES:

* Average of cell area radiation levels reported in Ref. 1.

** Estimated exposure rates from components are at a distance of 3 feet from the component.

TABLE A-2.7

SUMMARY OF EQUIPMENT, PIPING, AND STRUCTURE RADIATION LEVELS

PPC
(Continued)

Average Area Radiation Level = 0.005 R/hr *

Equipment ID Numbers	Item Description	Characteristic Dimensions		**Estimated Radiation Exposure Rate, R/hr
		Length (in.)	Diam. (in.)	
5D-12A	No. 1 U Product Sample Tank	72	54	0.06
5D-12B	No. 2 U Product Sample Tank	72	54	0.06
5D-13A	Hi Enrichment Uranium Evaporator Surge Tank	51	24	0.06
5D-13B	Hi Enrichment Uranium Storage Tank	51	24	0.06
5D-13C	Hi Enrichment Uranium Off-Spec. Tank	51	24	0.06
5E-3	Low Enrichment U Product Evaporator Reboiler	164	12	0.06
5E-4	Low Enrichment U Product Evaporator Condenser	154	10	0.06
5E-5	Hi Enrichment U Product Evaporator Reboiler	154	6	0.06
5E-6	Hi Enrichment U Product Evaporator Condenser	110	10	0.06
5E-7	Pu Product Evaporator Condenser	62	4	0.06
5E-9	Ion Exchanger Waste Cooler			0.06
5E-10	Low Enrichment U Evaporator Product Cooler	600 of 1.5" Pipe in 3" Jacket		0.06
5E-11	Hi Enrichment U Evaporator Product Cooler	600 of .5" Pipe in 1.5" Jacket		0.06
15M-12	PPC Access Door	4L x 36W x 82H		0.06
15T-61	Trolley for PPC			0.06
5Y-2	Flow Control Pot 5D-7 to 5D-9	12	6	0.06

TABLE A-2.7

SUMMARY OF EQUIPMENT, PIPING, AND STRUCTURE RADIATION LEVELS

PPC
(Continued)

Average Area Radiation Level = 0.005 R/hr*

Equipment ID Numbers	Item Description	Characteristic Dimensions		**Estimated Radiation Exposure Rate, R/hr
		Length (in.)	Diam. (in.)	
5Y-3	Flow Control Pot 5D-7 to 5D-4	12	6	0.06
5Y-4	Level Control Pot for 5C-4	6	4	0.06
5Y-5	Level Control Pot for 5C-5	6	6	0.06
5Y-10	Pu Product Transfer Pot	12	2	0.06
5Y-11	Pu Product Transfer Pot	12	2	0.06
5Y-13	Separator for 5C-1A	6	2	0.06
5Y-14	Sample Pot for 5C-1A	2	2	0.06
5Y-15	Separator for 5C-1B	6	2	0.06
5Y-16	Sample Pot for 5C-1B	2	2	0.06
5Y-17	Separator for 5C-1C	6	2	0.06
5Y-18	Sample Pot for 5C-1C	2	2	0.06
5Y-26	Flow Control Pot 5D-6 to 5D-4	6	2	0.06
5Y-27	Flow Control Pot 5D-6 to 4D-8	6	2	0.06
5Y-28	Flow Control Pot 5D-7 to 5D-5	12	6	0.06
5Y-29	Head Pot for 5C-6A Feed	96	1.5	0.06
5Y-30	Head Pot for 5C-6B Feed	96	1.5	0.06
5Y-31	Syphon Breaker 5C-6A Discharge	12	6	0.06
5Y-32	Syphon Breaker 5C-6B Discharge	12	6	0.06
5Y-33	Sample Pot for Wash Line From 5C-6	4	2	0.06

APPENDIX B

DECONTAMINATION METHODS

TABLE B-1.1

**PRIMARY CELL DECONTAMINATION
ASSESSMENTS A AND B
PMC**

<u>Decontamination Activity</u>	<u>DF</u>
1. Dry vacuum cell equipment and structures	-
2. High pressure water lance cell equipment and structures using sequential application of the following aqueous mixtures:	
10% HNO ₃	
10% NaOH	
10% HNO ₃ + hydroxylamine acid sulfate	
80°C water rinse	
Total DF of 1 and 2	100
3. Scrub surfaces with remotely operated rotating scrub brush with Radiacwash	20
4. Remove equipment from cells	2
5. Paint cell walls and floors with strippable latex coating and install local lead shielding	10
Overall DF	40,000
Initial cell exposure rate = 221 R/hr	
Final cell exposure rate = 5 mR/hr	

TABLE B-1.2

PRIMARY CELL DECONTAMINATION
ASSESSMENTS A AND B
GPC

<u>Decontamination Activity</u>	<u>DF</u>
1. Dry vacuum cell equipment and structures	-
2. High pressure water lance cell equipment and structures as in the PMC. (GPC contains particulate "fines" which are readily removed by vacuuming and water lancing)	-
Total DF of 1 and 2	500
3. Scrub equipment and structures with remote scrub brush and Radiacwash	20
4. Remove equipment from cell	2
5. Paint cell and install local shielding as in the PMC	10
Overall DF	200,000

Initial cell exposure rate = 1250 R/hr
• Final cell exposure rate = 6 mR/hr

TABLE B-1.3

**PRIMARY CELL DECONTAMINATION
ASSESSMENTS A AND B
CPC**

<u>Decontamination Activity</u>	<u>DF</u>
1. Dry vacuum cell equipment and structures (walls and floor)	-
2. High pressure water lance cell equipment and structures as in the PMC (walls and floor).	-
Total DF of 1 and 2	100
3. High pressure water lance concrete cell walls with hot water (2nd application)	2
4. High pressure water lance cell walls with hot water (3rd application)	2
5. High pressure water lance stainless steel lined cell floor with hot water (2nd application)	10
6. Chemically decontaminate system internal surfaces using decontamination sequence of Section 6.1.1	-
7. Remove equipment from cell	-
Total DF for 6 and 7	50
8. Paint cells and install local shielding as in the PMC. (No credit taken for area dose reduction because the CPC cell is too large to have local hot spots affect the area dose.)	-
9. Overall DF:	1850 *

* NOTE: The CPC dose rate varied from 32 R/hr at the south end to 12 R/hr at the north end. NES assumed 98% of the dose was from the equipment and 2% from the cell walls and floors. Applying an equipment DF of 50 and wall and floor DF's as described above, the overall DF was approximately 1850.

Initial cell exposure rate = 22 R/hr
Final cell exposure rate = 12 mR/hr

TABLE B-2.1

PRIMARY CELL DECONTAMINATION
ASSESSMENT C
PMC and GPC

The overall DF's for the PMC and the GPC are identical to Assessments A and B with respect to the final area radiation dose rate. The sequence of events vary slightly, owing to the equipment removal without decontamination.

<u>Decontamination Activity</u>	<u>DF</u>
PMC Overall DF	40,000
Initial cell exposure rate = 221 R/hr Final cell exposure rate = 5 mR/hr	
GPC Overall DF	200,000
Initial cell exposure rate = 1250 R/hr Final cell exposure rate = 6 mR/hr	

TABLE B-2.2

**PRIMARY CELL DECONTAMINATION
ASSESSMENT C
CPC**

<u>Decontamination Activity</u>	<u>DF</u>
1. Remove equipment from cell	50
2. Dry vacuum cell equipment and structures	-
3. High pressure water lance cell floor using aqueous mixtures in Table B-1	
Total DF of 2 and 3	100
4. High pressure water lance concrete cell walls with aqueous mixtures in Table B-1	2
5. High pressure water lance concrete cell walls with hot water (2nd application)	2
6. High pressure water lance stainless steel lined cell floor with hot water (2nd application)	10
7. Paint cells and install local shielding. (No credit taken for area dose reductions)	-
CPC Overall DF:	1850

Refer to Table B-1 (CPC) for an explanation of the CPC overall DF.

Initial cell exposure rate = 22 R/hr

Final cell exposure rate = 12 mR/hr

TABLE B-3.1

SECONDARY CELL DECONTAMINATION
ASSESSMENT D
XC-1

<u>Decontamination Activity</u>	<u>DF</u>
1. High pressure water lance bottom stainless steel liner and Tank 4D-2 exterior, using aqueous chemical mixture as in the PMC	50
2. Chemically decontaminate system internal surfaces using decontamination sequence of Section 6.1.1	-
3. Remove equipment from cell	
Total DF of 2 and 3	50
4. Remove concrete wall surfaces near Tank 4D-2 using drill and spall method.	-
5. High pressure water lance remaining wall surface.	
Total DF of 4 of 5	2
6. High pressure water lance the stainless steel floor liner	50
Overall DF:	4500

NOTE: The overall DF for cell XC-1 was developed as described in a similar manner as described in Table B-1 for the CRC with respect to splitting the dose rate into walls, floors, and component dose rates. The application of the aforementioned DF's to walls, floors, and equipment resulted in an overall DF of 4500.

Initial cell exposure rate = 33.3 R/hr
Final cell exposure rate = 7.4 mR/hr

TABLE B-3.2

SECONDARY CELL DECONTAMINATION
ASSESSMENT D
XC-2, XC-3, and PPC

<u>Decontamination Activity</u>	<u>DF</u>
1. Chemically decontaminate system internal surfaces using decontamination sequence of Section 6.1.1	-
2. Remove components from cell	
Total DF for 1 and 2	50
3. High pressure water lance cell walls and floors using aqueous chemical mixture as in the PMC	2
Overall DF	100

<u>XC-2</u> -	Initial cell exposure rate = 85 mR/hr Final cell exposure rate = 0.85 mR/hr
<u>XC-3</u> -	Initial cell exposure rate = 11.5 mR/hr Final cell exposure rate = 0.12 mR/hr
<u>PPC</u>	Initial cell exposure rate = 5 mR/hr Final cell exposure rate = 0.05 mR/hr

TABLE B-4
SECONDARY CELL DECONTAMINATION
ASSESSMENT E
ALL CELLS

The decontamination methods in Assessment E are the same as in Assessment D except that there is no equipment chemical decontamination. The cell area dose rate is not affected by the equipment decontamination. Therefore, the overall DF is 4500 for XC-1 and 100 for cells XC-2, XC-3, and the PPC.

<u>XC-1</u> -	Initial cell exposure rate = 33.3 mR/hr Final cell exposure rate = 7.4 mR/hr
<u>XC-2</u> -	Initial cell exposure rate = 85 mR/hr Final cell exposure rate = 0.85 mR/hr
<u>XC-3</u> -	Initial cell exposure rate = 11.5 mR/hr Final cell exposure rate = 0.12 mR/hr
<u>PPC</u>	Initial cell exposure rate = 5 mR/hr Final cell exposure rate = 0.1 mR/hr

THIS PAGE
WAS INTENTIONALLY
LEFT BLANK

TABLE C-1
SUMMARY OF CONTAINERS FOR ON-SITE STORAGE

<u>CONTAINER TYPE AND SIZE (ft.)</u>	<u>NUMBER OF CONTAINERS</u>	
	<u>PRIMARY CELLS</u>	<u>SECONDARY CELLS</u>
LSA METAL CONTAINERS		
4 x 4 x 8	11	0
6 x 8 x 12	12	0
8 x 8 x 12	5	1
6 x 8 x 24	1	0
8 x 8 x 24	1	5
SUPER-TIGER STEEL LINES		
17.1 x 8 x 8	1	7
POLY-PANTHER STEEL LINERS		
6 x 4.2 x 4.9	1	1
SPECIAL METAL CONTAINERS		
9 x 9 x 16.5	2	0
44 x 3 x 3	0	1
50 x 6 x 6	0	1
48 x 6 x 6	0	1
28 x 6 x 6	0	1
TOTAL CONTAINERS	33	18
TOTAL VOLUME ft³	17,200	21,200

TABLE C-2
DESIGN PARAMETERS OF TEMPORARY STORAGE FACILITY

Dimensions:	120' long x 100' wide x 27' high
Volume:	324,000 cubic feet
Floor Area:	12,000 square feet
Construction:	concrete construction with steel framework
Base:	Compacted soil, crushed stone and a reinforced concrete slab
Doors:	2 sliding concrete doors

Building includes the following equipment and services:

Electric power

HVAC with HEPA filters

Radiation monitoring system

Building sumps with pipes to low-level waste treatment system

Fire protection system

Estimated Cost: \$ 1,217,300
(\$ 2,701,800 with extra shielding for Assessments C and E only)

APPENDIX D
COST FACTORS

TABLE D-1
COST FACTOR SUMMARY

<u>In Cell and EDR Manual Pipe Cutting and Welding</u>	<u>Cost Factor</u>
Pipe 3" (Torch Cutting)	\$ 22.43/cut
Pipe 6" (Torch Cutting)	\$ 44.86/cut
Pipe 3" Welding	\$ 28.26/weld
Pipe 6" Welding	\$ 56.56/weld
 <u>Crew Costs for Work Performed in Cells (a)</u>	
Crew A - to be used in CPC (Remote activities)	\$ 66.80/hr.
Crew B - to be used in PMC and GPC (Remote activities)	\$ 85.94/hr.
Crew C - packaging in EDR & outside MCR	\$146.32/hr.
Crew D - to be used in CPC (Manual activities)	\$141.90/hr.
Crew E - to be used in PMC and GPC (Manual activities)	\$ 99.57/hr.
 <u>Chemical Solutions</u>	
50% HNO ₃	\$.80/lb.
2% KMNO ₄	\$ 2.19/lb.
20% NaOH	\$.59/lb.
2% Tartaric Acid	\$ 2.00/lb.
1M HF	\$.88/lb.
20% HNO ₃	\$.80/lb.

These cost factors include base wages, fringe benefits, per diem (for travel), and a factor of 60% to cover prime contractor and subcontractor overhead and profit.

<u>Equipment</u>	<u>Cost Factor</u>
Crane - 200 Ton, 150 Ft. Boom	\$ 11,000/mo.
Flatbed Truck	\$ 1,525/mo.
Heavy Duty Fork Lift	\$ 2,700/mo.
Drott Travel Lift	\$ 6,600/mo.
Heavy Duty Electric Hoist	\$ 10,150/ea.

TABLE D-1
COST FACTOR SUMMARY
(Continued)

10 Ton Chain Hoist	\$ 1,750/ea.
Heavy Gentries - 20,000 lb. cap.	\$ 22,000/ea.
39,000 lb. Load Rated Chain - 1,500 ft.	\$ 23,200/ea.
20,000 lb. Load Rated Chain - 500 ft.	\$ 4,200/ea.
4 Ton Winch	\$ 450/ea.
4,000 lb. Gantry	\$ 1,600/ea.
Light Chain Hoist	\$ 950/ea.

Metal Container Fabrication:

4' x 4' x 8'	\$ 3,800/ea.
6' x 8' x 12'	\$ 11,100/ea.
8' x 8' x 12'	\$ 11,500/ea.
6' x 8' x 24'	\$ 19,700/ea.
8' x 8' x 24'	\$ 22,700/ea.
9' x 9' x 16.5'	\$ 15,800/ea.

Steel Fabrication

Steel Liner Fabrication	\$ 220/cwt.
Dot Spec. 17C Steel Drum (55 gal.)	\$ 77.90/drum
Dot Spec. 7A Steel Box	\$ 1,675/bin
Steel Liner for Super Tiger	\$ 7,500/liner

Gantry Loading, Transportation and Unloading	\$ 580/trip
Flatbed Truck Loading, Transportaion and Gantry Unloading	\$ 48/trip

TABLE D-2

ADMINISTRATIVE COSTS

<u>Position</u>	<u>Total Cost \$</u>
Contracts Manager	49,700
Project Superintendent	38,600
Project Engineer	33,600
Project Accountant	31,600
Packaging and Shipping Supervisor	20,300
Engineers - 3	84,000
Engineering Aide	14,400
Clerks - 2	33,200
Health Physics Technicians - 3	58,200
Health and Safety Supervisor	25,000
Plant Maintenance Supervisor	25,000
Radiation Safety Specialist	19,000
Industrial Safety Specialist	19,000
Operations Manager	32,000
Procurement Specialist	18,000
Custodians - 2	32,000
Foremen - 3	75,000
Total Annual Cost	608,600
Plus 25% overhead	760,750

APPENDIX E

ASSESSMENT A

ACTIVITIES, COSTS, SCHEDULES, MANPOWER AND EXPOSURE

TABLE E-1.1

ASSESSMENT A

PREPARATIONS FOR PRIMARY CELL EQUIPMENT DECONTAMINATION AND REMOVAL

1. Obtain and review plant drawings and photographs
2. Perform detailed radiation survey
3. Estimate residual by product inventory
4. Prepare possession-only amendment to operating license
5. Prepare end product description
6. Perform detailed calculations of by product inventory
7. Sequence major work activities
8. Prepare safety analysis of decontamination and equipment removal operations
9. Prepare and submit a dismantling plan to NRC
10. Receive approval of possession-only amendment
11. Receive dismantling order
12. Prepare activity specifications
13. Prepare detailed work procedures
14. Prepare detailed work sequence
15. Procure decontamination chemicals and equipment
16. Procure equipment for material handling and miscellaneous tools for cell component removal
17. Procure waste storage containers
18. Repair cell windows and seal cell doors
19. Replace ventilation system HEPA filters
20. Design and construct a temporary storage facility on site
21. Build plywood structure atop MCR
22. Decontaminate MCR, GCR, CCR, and EDR
23. Decontaminate primary cell and EDR cranes, power manipulators, and master-slave manipulators
24. Repair primary cell and EDR cranes, power manipulators, and master-slave manipulators
25. Prepare XCR equipment for internal chemical decontamination of primary cell components
26. Prepare acid recovery system for use
27. Prepare liquid waste disposal system for use

TABLE E-1.2
ASSESSMENT A

ACTIVITIES FOR PRIMARY CELL EQUIPMENT DECONTAMINATION AND REMOVAL

PMC

1. Prepare the PMC for decontamination of cell
2. Decontaminate PMC in-cell equipment and structure surfaces
3. Prepare PMC for equipment removal
4. Remotely remove and package PMC equipment
5. Transfer packaged equipment to temporary storage facility
6. Decontaminate crane, power manipulator, and the MCR
7. Remotely survey the PMC
8. Survey the MCR
9. Remotely paint PMC in-cell surfaces
10. Install lead shielding on hot spots
11. Perform a final radiation survey

TABLE E-1.3
ASSESSMENT A

ACTIVITIES FOR PRIMARY CELL EQUIPMENT DECONTAMINATION AND REMOVAL

GPC

1. Prepare the GPC for decontamination of cell
2. Decontaminate GPC in-cell equipment and structure surfaces
3. Prepare GPC for equipment removal
4. Remotely remove and package GPC equipment
5. Transfer packaged equipment to temporary storage facility
6. Decontaminate crane, power manipulator, and the GCR
7. Remotely survey the GPC
8. Survey the GCR
9. Remotely paint GPC in-cell surfaces
10. Install lead shielding on hot spots
11. Perform final radiation survey

TABLE E-1.4

ASSESSMENT A

ACTIVITIES FOR PRIMARY CELL EQUIPMENT DECONTAMINATION AND REMOVAL

SRR

1. Survey scrap removal room
 2. Prepare SRR for decontamination
 3. Decontaminate SRR in-cell surfaces
 4. Survey scrap removal room
 5. Paint SRR in-cell surfaces
 6. Perform final radiation survey
-

TABLE E-1.5

ASSESSMENT A

ACTIVITIES FOR PRIMARY CELL EQUIPMENT DECONTAMINATION AND REMOVAL
CPC

1. Prepare EDR for remote packaging
2. Prepare the CPC for decontamination
3. Decontaminate piping and component internals
4. Decontaminate in-cell equipment and structure surfaces
5. Prepare CPC for equipment removal
6. Remotely remove and package CPC equipment
7. Transfer packaged equipment to temporary storage facility
8. Decontaminate crane, power manipulator, the CCR, and the EDR
9. Remotely survey the CPC
10. Survey the CCR and the EDR
11. Remotely paint CPC in-cell surfaces
12. Install lead shielding on hot spots
13. Remove dissolver criticality plugs
14. Perform final radiation survey

TABLE E-2.1
ASSESSMENT A
PRE-DECONTAMINATION COSTS

<u>Activity Description</u>	<u>Cost</u> \$
1. Obtain and review plant drawings and photographs	39,600
2. Perform detailed radiation survey	29,600
3. Estimate residual by-product inventory	8,400
4. Prepare possession-only amendment to license application	24,800
5. Prepare end-product description	5,500
6. Perform detailed calculations of by-product inventory	17,600
7. Sequence major work activities	8,800
8. Perform safety analysis of removal activities	19,800
9. Prepare and submit dismantling plan to NRC for approval	13,800
10. Receive possession-only license amendment from NRC	2,200
11. Receive dismantling order	-
12. Prepare activity specifications	184,800
13. Prepare detailed work procedures	79,200
14. Prepare detailed work sequence	19,800
15. Procure decontamination chemicals and equipment	8,800
16. Procure equipment for material handling and miscellaneous tools for cell component removal	8,800
17. Procure waste storage containers	4,400
18. Repair cell windows and door seals and upgrade lighting	5,000

TABLE E-2.1
ASSESSMENT A
PRE-DECONTAMINATION COSTS
(Continued)

<u>Activity Description</u>	<u>Cost</u> \$
19. Replace HEPA and roughing filters	2,200
20. Design temporary storage facility	13,200
21. Build plywood structure atop MCR	4,200
22. Decontaminate MCR, GCR, CCR, and EDR	131,400
23. Decontaminate primary cell and EDR cranes, power manipulators, and master-slave manipulators	22,600
24. Repair primary cell and EDR cranes, power manipulators, and master-slave manipulators	89,000
25. Prepare XCR equipment for internal chemical decontamination	39,600
26. Prepare acid recovery system for use	25,000
27. Prepare liquid waste disposal system for use	Note A
Subtotal Pre-decontamination	<u>808,100</u>

Note A: This cost included in WNYNSC Task 4.

TABLE E-2.2
ASSESSMENT A
DECONTAMINATION COSTS
PMC

<u>Activity Description</u>	<u>Total \$</u>
1) Prepare PMC for decontamination of cell	21,700
2) Decontaminate PMC in-cell equipment and structure surfaces	72,400
3) Prepare PMC for equipment removal	5,500
4) Remotely remove and package PMC equipment	76,000
5) Transfer packaged equipment to temporary storage facility	400
6) Decontaminate crane, power manipulator, and MCR	16,700
7) Remotely survey the PMC	700
8) Survey the MCR	400
9) Remotely paint PMC in-cell surfaces	10,300
10) Install lead shielding on hot spots	24,500
11) Perform final radiation survey	1,100
Subtotal PMC	<u>229,700</u>

TABLE E-2.3
ASSESSMENT A
DECONTAMINATION COSTS
GPC

<u>Activity Description</u>	<u>Total \$</u>
1) Prepare GPC for decontamination of cell	26,700
2) Decontaminate GPC in-cell equipment and structure surfaces	45,200
3) Prepare GPC for equipment removal	1,000
4) Remotely remove and package GPC equipment	43,600
5) Transfer packaged equipment to temporary storage facility	200
6) Decontaminate crane, power manipulator, and GCR	17,600
7) Remotely survey the GPC	600
8) Survey the GCR	200
9) Remotely paint GPC in-cell surfaces	6,500
10) Install lead shielding on hot spots	24,500
11) Perform final radiation survey	800
Subtotal GPC	<u>166,900</u>

TABLE E-2.4
ASSESSMENT A
DECONTAMINATION COSTS
SRR

<u>Activity Description</u>	<u>Total \$</u>
1) Survey Scrap Removal room	900
2) Prepare room for decontamination	1,000
3) Decontaminate Scrap Removal room	28,900
4) Survey Scrap Removal room	900
5) Paint surfaces in Scrap Removal room	10,400
6) Final radiation survey	900
Subtotal SRR	<u>43,000</u>

TABLE E-2.5
ASSESSMENT A
DECONTAMINATION COSTS
CPC

<u>Activity Description</u>	<u>Total \$</u>
1) Prepare EDR for remote packaging	11,600
2) Prepare for decontamination of CPC	18,200
3) Decontaminate internal piping and components	285,800
4) Decontaminate in-cell equipment and structure surfaces	186,100
5) Prepare CPC for equipment removal	1,000
6) Remotely remove and package CPC equipment	266,500
7) Transfer packaged equipment to temporary storage facility	900
8) Decontaminate crane, power manipulator, CCR and EDR	149,000
9) Remotely survey the CPC	1,200
10) Survey the CCR and EDR	600
11) Remotely paint CPC in-cell surfaces	15,300
12) Install lead shielding on hot spots	33,300
13) Remove dissolver criticality plugs	12,400
14) Perform final radiation survey	2,300
Subtotal CPC	<u>984,200</u>

TABLE E-2.6
ASSESSMENT A
DECONTAMINATION COSTS

	<u>Total</u> <u>\$</u>
<u>Sub-Total Decontamination Work Activities</u>	2,231,900
<u>Undistributed Costs:</u>	
Decontamination Staff	1,356,800
Security Force	1,251,900
Engineering Consultants	322,100
Nuclear Liability Insurance	52,600
Project Management and Engineering QA	271,800
TLD and Film Badge Service	86,200
Bagging Supplies (plastic and tape)	6,000
Temporary Storage Facility	558,700
Plasma Torch Cutter	9,500
Electric Materials	2,000
Flexible Hose (4 filters)	3,600
Misc. Cutting and Hoisting Equipment	25,000
Radiation Monitoring Systems	1,200
Scaffold Equipment	3,100
Upgrade XCR equipment	39,600
Filters	5,600
Misc. Tools and Hardware	10,000
Service Air Hose	2,000
Remote TV Monitor	6,000
Rubber-Tired Gantry Crane Rental	142,300
Lighting	1,600
Anti-contamination Clothing	18,700
Laundry Service	10,500
Breathing Air Compressor	9,800
Truck Rental	131,500
Fork Lift Rental	14,500
LSA Waste Container, Shipping and Burial	51,800
Decontamination Subcontractor	344,500
 Sub-total Undistributed Costs	 <u>4,738,900</u>
 Total Decontamination Cost	 <u>6,970,800</u>
 Cost of Assessment A including 25% Contingency	 <u>8,713,500</u>

TABLE E-3.1
ASSESSMENT A
PRE-DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE

<u>Activity Description</u>	<u>Duration</u> (days)	<u>Manpower</u> (manhours)	<u>Exposure</u> (manRem)
1. Obtain and review plant drawings and photographs	20	720	-
2. Perform detailed radiation survey	40	420	2.1
3. Estimate residual by-product inventory	10	160	-
4. Prepare possession-only amendment to license application	28	450	-
5. Prepare end-product description	7	100	-
6. Perform detailed calculations of by-product inventory	20	320	-
7. Sequence major work activities	10	160	-
8. Perform safety analysis of removal activities	20	360	-
9. Prepare and submit dismantling plan to NRC for approval	16	250	-
10. Receive possession-only license amendment from NRC	20	40	-
11. Receive dismantling order	60	-	-
12. Prepare activity specifications	70	1440	-
13. Prepare detailed work procedures	45	1440	-
14. Prepare detailed work sequence	23	360	-

TABLE E-3.1
ASSESSMENT A
PRE-DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE
(Continued)

<u>Activity Description</u>	<u>Duration</u> (days)	<u>Manpower</u> (manhours)	<u>Exposure</u> (manRem)
15. Procure decontamination chemicals and equipment	20	160	-
16. Procure equipment for material handling and miscellaneous tools for component removal	20	160	-
17. Procure waste storage containers	10	80	-
18. Repair cell windows and door seals and upgrade lighting	11	253	0.71
19. Replace HEPA and roughing filters	3	24	13.9
20. Design temporary storage facility	15	240	-
21. Build plywood structure atop MCR	5	160	-
22. Decontaminate MCR, GCR, CCR, and EDR	39	3217	41.7
23. Decontaminate primary cell and EDR cranes, power manipulators, and master-slave manipulators	7	650	41.6
24. Repair primary cell and EDR cranes, power manipulators, and master-slave manipulators	70	1552	16.8
25. Prepare XCR equipment for internal chemical decontamination	9	396	-
26. Prepare acid recovery system for use	56	454	Note B
27. Prepare liquid waste disposal system for use	Note A	Note A	Note A
Subtotal Pre-decontamination		13,566	116.8

Note A: This information is part of WNYNSC Task 4.

Note B: The calculation is beyond the scope of this report.

TABLE E-3.2
ASSESSMENT A
DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE
PMC

<u>Activity Description</u>	<u>Duration (days)</u>	<u>Manpower (manhours)</u>	<u>Exposure (manRem)</u>
1) Prepare PMC for decontamination of cell	4	140	1
2) Decontaminate PMC in-cell equipment and structure surfaces	56	1665	5.4
3) Prepare PMC for equipment removal	4	134	0.9
4) Remotely remove and package PMC equipment	13	532	1.6
5) Transfer packaged equipment to temporary storage facility	1	18	0.5
6) Decontaminate crane, power manipulator, and MCR	9	441	14.7
7) Remotely survey the PMC	1	37	0.2
8) Survey the MCR	0.5	20	0.2
9) Remotely paint PMC in-cell surfaces	2	22	0.1
10) Install lead shielding on PMC hot spots	0.5	16	0.2
11) Perform final radiation survey	1	34	0.2
Subtotal PMC	<u>NA*</u>	<u>3059</u>	<u>25</u>

* The individual cell activity duration is dependent upon the critical path of all cell removal activities.

TABLE E-3.3
ASSESSMENT A
DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE

GPC			
<u>Activity Description</u>	<u>Duration (days)</u>	<u>Manpower (manhours)</u>	<u>Exposure (manRem)</u>
1) Prepare GPC for decontamination of cell	4	140	0.2
2) Decontaminate GPC in-cell equipment and structure surfaces	35	1087	5.4
3) Prepare GPC for equipment removal	2	34	0.2
4) Remotely remove and package GPC equipment	9	336	0.1
5) Transfer packaged equipment to temporary storage facility	1	10	0.3
6) Decontaminate crane, power manipulator, and GCR	19	768	7.9
7) Remotely survey the GPC	1	33	0.1
8) Survey the GCR	0.25	12	0.1
9) Remotely paint GPC in-cell surfaces	1	12.3	0.1
10) Install lead shielding on hot spots	0.5	16	0.1
11) Perform final radiation survey	1	29	0.2
Subtotal GPC	<u>NA*</u>	<u>2477</u>	<u>14.7</u>

* The individual cell activity duration is dependent upon the critical path of all cell removal activities.

TABLE E-3.4
ASSESSMENT A
DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE
SRR

	<u>Activity Description</u>	<u>Duration (days)</u>	<u>Manpower (manhours)</u>	<u>Exposure (manRem)</u>
1)	Survey Scrap Removal room	1	44	0.2
2)	Prepare room for decontamination	1	48	0.0
3)	Decontaminate Scrap Removal room	10	190	0.1
4)	Survey Scrap Removal room	1	44	0.1
5)	Paint surfaces in Scrap Removal room	4	137	0.1
6)	Final radiation survey	1	44	0.1
Subtotal SRR		<u>NA*</u>	<u>507</u>	<u>0.6</u>

* The individual cell activity duration is dependent upon the critical path of all cell removal activities.

TABLE E-3.5
ASSESSMENT A
DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE

		CPC		
	<u>Activity Description</u>	<u>Duration (days)</u>	<u>Manpower (manhours)</u>	<u>Exposure (manRem)</u>
1)	Prepare EDR for remote packaging	3	75	0.6
2)	Prepare for decontamination of CPC	5	146	0.2
3)	Decontaminate internal piping and components	62	1412	0.7
4)	Decontaminate in-cell equipment and structure surfaces	114	3450	3.5
5)	Prepare CPC for equipment removal	2	34	0.1
6)	Remotely remove and package CPC equipment	67	1835	1.8
7)	Transfer packaged equipment to temporary storage facility	3	38	1.1
8)	Decontaminate crane, power manipulator, CCR, and EDR	62	3000	15
9)	Remotely survey the CPC	3	51	0.1
10)	Survey the CCR and EDR	1	30	0.1
11)	Remotely paint CPC in-cell surfaces	4	76	0.1
12)	Install lead shielding on hot spots	1	12	0.1
13)	Remove dissolver criticality plugs	3	76	0.9
14)	Perform final radiation survey	3	110	1.0
Subtotal CPC		<u>NA*</u>	<u>10345</u>	<u>25.3</u>
Total Assessment A			<u>29,954</u>	<u>182.4</u>

* The individual cell activity duration is dependent upon the critical path of all cell removal activities.

THIS PAGE
WAS INTENTIONALLY
LEFT BLANK

TABLE F-1.1

ASSESSMENT B

PREPARATIONS FOR PRIMARY CELL EQUIPMENT DECONTAMINATION AND REMOVAL

1. Obtain and review plant drawings and photographs
2. Perform detailed radiation survey
3. Estimate residual by product inventory
4. Prepare possession-only amendment to operating license
5. Prepare end product description
6. Perform detailed calculations of by product inventory
7. Sequence major work activities
8. Prepare safety analysis of decontamination and equipment removal operations
9. Prepare and submit a dismantling plan to NRC
10. Receive approval of possession-only amendment
11. Receive dismantling order
12. Prepare activity specifications
13. Prepare detailed work procedures
14. Prepare detailed work sequence
15. Procure decontamination chemicals and equipment
16. Procure equipment for material handling and miscellaneous tools for cell component removal
17. Procure waste storage containers
18. Repair cell windows and seal cell doors
19. Replace ventilation system HEPA filters
20. Design and construct a temporary storage facility on site
21. Build plywood structure atop MCR
22. Decontaminate MCR, GCR, CCR, and EDR
23. Decontaminate primary cell and EDR cranes, power manipulators, and master-slave manipulators
24. Repair primary cell and EDR cranes, power manipulators, and master-slave manipulators
25. Prepare XCR equipment for internal chemical decontamination of primary cell components
26. Prepare acid recovery system for use
27. Prepare liquid waste disposal system for use

TABLE F-1.2

ASSESSMENT B

ACTIVITIES FOR PRIMARY CELL EQUIPMENT DECONTAMINATION AND REMOVAL

PMC

1. Prepare the PMC for decontamination of cell
2. Decontaminate PMC in-cell equipment and structure surfaces
3. Prepare PMC for equipment removal
4. Remotely survey the PMC
5. Manually remove and package PMC equipment
6. Transfer packaged equipment to temporary storage facility
7. Decontaminate crane, power manipulator, and the MCR
8. Manually survey the PMC
9. Survey the MCR
10. Remotely paint PMC in-cell surfaces
11. Install lead shielding on hot spots
12. Perform a final radiation survey

TABLE F-1.3

ASSESSMENT B

ACTIVITIES FOR PRIMARY CELL EQUIPMENT DECONTAMINATION AND REMOVAL

GPC

1. Prepare the GPC for decontamination of cell
2. Decontaminate GPC in-cell equipment and structure surfaces
3. Prepare GPC for equipment removal
4. Remotely survey the GPC
5. Manually remove and package GPC equipment
6. Transfer packaged equipment to temporary storage facility
7. Decontaminate crane, power manipulator, and the GCR
8. Manually survey the GPC
9. Survey the GCR
10. Remotely paint GPC in-cell surfaces
11. Install lead shielding on hot spots
12. Perform final radiation survey

TABLE F-1.4

ASSESSMENT B

ACTIVITIES FOR PRIMARY CELL EQUIPMENT DECONTAMINATION AND REMOVAL

SRR

1. Survey scrap removal room
2. Prepare SRR for decontamination
3. Decontaminate SRR in-cell surfaces
4. Survey scrap removal room
5. Paint SRR in-cell surfaces
6. Perform final radiation survey

TABLE F-1.5

ASSESSMENT B

ACTIVITIES FOR PRIMARY CELL EQUIPMENT DECONTAMINATION AND REMOVAL

CPC

1. Prepare EDR for remote packaging
2. Prepare the CPC for decontamination
3. Decontaminate piping and component internals
4. Decontaminate in-cell equipment and structure surfaces
5. Prepare CPC for equipment removal
6. Remotely survey the CPC
7. Manually remove and package CPC equipment
8. Transfer packaged equipment to temporary storage facility
9. Decontaminate crane, power manipulator, the CCR, and the EDR
10. Manually survey the CPC
11. Survey the CCR and the EDR
12. Remotely paint CPC in-cell surfaces
13. Install lead shielding on hot spots
14. Remove dissolver criticality plugs
15. Perform final radiation survey

TABLE F-2.1
ASSESSMENT B
PRE-DECONTAMINATION COSTS

<u>Activity Description</u>	<u>Cost</u> \$
1. Obtain and review plant drawings and photographs	39,600
2. Perform detailed radiation survey	29,600
3. Estimate residual by-product inventory	8,400
4. Prepare possession-only amendment to license application	24,800
5. Prepare end-product description	5,500
6. Perform detailed calculations of by-product inventory	17,600
7. Sequence major work activities	8,800
8. Perform safety analysis of removal activities	19,800
9. Prepare and submit dismantling plan to NRC for approval	13,800
10. Receive possession-only license amendment from NRC	2,200
11. Receive dismantling order	-
12. Prepare activity specifications	184,800
13. Prepare detailed work procedures	79,200
14. Prepare detailed work sequence	19,800
15. Procure decontamination chemicals	8,800
16. Procure equipment for material handling and miscellaneous tools for cell component removal	8,800
17. Procure waste storage containers	4,400
18. Repair cell windows and door seals and upgrade lighting	5,000

TABLE F-2.1
ASSESSMENT B
PRE-DECONTAMINATION COSTS
(Continued)

<u>Activity Description</u>	<u>Cost</u> \$
19. Replace HEPA and roughing filters	2,200
20. Design temporary storage facility	13,200
21. Build plywood structure atop MCR	4,200
22. Decontaminate MCR, GCR, CCR, and EDR	131,400
23. Decontaminate primary cell and EDR cranes, power manipulators, and master-slave manipulators	22,600
24. Repair primary cell and EDR cranes, power manipulators, and master-slave manipulators	89,000
25. Prepare XCR equipment for internal chemical decontamination	39,600
26. Prepare acid recovery system for use	25,000
27. Prepare liquid waste disposal system for use	Note A
Subtotal Pre-decontamination	<u>807,300</u>

Note A: This cost included in WNYNSC Task 4.

TABLE F-2.2
ASSESSMENT B
DECONTAMINATION COSTS
PMC

<u>Activity Description</u>	<u>Total \$</u>
1) Prepare PMC for decontamination of cell	21,700
2) Decontaminate PMC in-cell equipment and structure surfaces	72,400
3) Remotely survey the PMC	700
4) Prepare PMC for equipment removal	5,500
5) Manually remove and package PMC equipment	78,200
6) Transfer packaged equipment to temporary storage facility	400
6) Decontaminate crane, power manipulator, and MCR	16,700
7) Remotely survey the PMC	700
8) Manually survey the MCR	700
9) Remotely paint PMC in-cell surfaces	10,300
10) Install lead shielding on hot spots	24,500
11) Perform final radiation survey	1,100
Subtotal PMC	<u>232,900</u>

TABLE F_2.3
ASSESSMENT B
DECONTAMINATION COSTS
GPC

<u>Activity Description</u>	<u>Total \$</u>
1) Prepare GPC for decontamination of cell	26,700
2) Decontaminate GPC in-cell equipment and structure surfaces	45,200
3) Remotely survey the GPC	600
4) Prepare GPC for equipment removal	1,000
5) Manually remove and remotely package GPC equipment	42,800
6) Transfer packaged equipment to temporary storage facility	200
7) Decontaminate crane, power manipulator, and GCR	17,600
8) Manually survey the GPC	600
9) Survey the GCR	200
10) Remotely paint GPC in-cell surfaces	6,500
11) Install lead shielding on hot spots	24,500
12) Perform final radiation survey	800
Subtotal GPC	<u>166,700</u>

TABLE F-2.4
ASSESSMENT B
DECONTAMINATION COSTS
SRR

<u>Activity Description</u>	<u>Total \$</u>
1) Survey Scrap Removal room	900
2) Prepare room for decontamination	1,000
3) Decontaminate Scrap Removal room	28,900
4) Survey Scrap Removal room	900
5) Paint surfaces in Scrap Removal room	10,400
6) Final radiation survey	900
Subtotal SRR	<u>43,000</u>

TABLE F-2.5
ASSESSMENT B
DECONTAMINATION COSTS
CPC

<u>Activity Description</u>	<u>Total \$</u>
1) Prepare EDR for remote packaging	11,600
2) Prepare for decontamination of CPC	18,200
3) Decontaminate internal piping and components	285,800
4) Decontaminate in-cell equipment and structure surfaces	186,100
5) Prepare CPC for equipment removal	1,000
6) Remotely survey CPC	1,200
7) Manually remove and package CPC equipment	290,100
8) Transfer packaged equipment to temporary storage facility	900
9) Decontaminate crane, power manipulator, CCR, and EDR	149,000
10) Manually survey the CPC	1,700
11) Survey the CCR and EDR	600
12) Remotely paint CPC in-cell surfaces	15,300
13) Install lead shielding on hot spots	33,300
14) Remove dissolver criticality plugs	12,400
15) Perform final radiation survey	2,300
Subtotal CPC	<u>1,009,500</u>

TABLE F-2.6
ASSESSMENT B
DECONTAMINATION COSTS

	<u>Total</u> <u>\$</u>
<u>Sub-Total Decontamination Work Activities</u>	2,259,400
<u>Undistributed Costs:</u>	
Decontamination Staff	1,214,100
Security Force	1,120,300
Engineering Consultants	288,800
Nuclear Liability Insurance	52,600
Project Management and Engineering QA	243,200
TLD and Film Badge Service	75,000
Bagging Supplies (plastic and tape)	6,000
Temporary Storage Facility	558,700
Plasma Torch Cutter	9,500
Electric Materials	2,000
Flexible Hose (4 filters)	3,600
Misc. Cutting and Hoisting Equipment	25,000
Radiation Monitoring Systems	1,200
Scaffold Equipment	3,100
Upgrade XCR equipment	39,600
Filters	5,600
Misc. Tools and Hardware	10,000
Service Air Hose	2,000
Remote TV Monitor	6,000
Rubber-Tired Gantry Crane Rental	117,800
Lighting	1,600
Anti-contamination Clothing	23,500
Laundry Service	13,300
Breathing Air Compressor	8,100
Truck Rental	108,900
Fork Lift Rental	12,000
LSA Waste Container, Shipping and Burial	45,000
Decontamination Subcontractor	870,900
 <u>Sub-total Undistributed Costs</u>	 <u>4,867,400</u>
<u>Total Decontamination Cost</u>	<u>7,126,800</u>
<u>Cost of Assessment B including 25% Contingency</u>	<u>8,908,500</u>

TABLE F-3.1
ASSESSMENT B
PRE-DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE

<u>Activity Description</u>	<u>Duration</u> (days)	<u>Manpower</u> (manhours)	<u>Exposure</u> (manRem)
1. Obtain and review plant drawings and photographs	20	720	-
2. Perform detailed radiation survey	40	420	2.1
3. Estimate residual by-product inventory	10	160	-
4. Prepare possession-only amendment to license application	28	450	-
5. Prepare end-product description	7	100	-
6. Perform detailed calculations of by-product inventory	20	320	-
7. Sequence major work activities	10	160	-
8. Perform safety analysis of removal activities	20	360	-
9. Prepare and submit dismantling plan to NRC for approval	16	250	-
10. Receive possession-only license amendment from NRC	20	40	-
11. Receive dismantling order	60	-	-
12. Prepare activity specifications	70	1440	-
13. Prepare detailed work procedures	45	1440	-
14. Prepare detailed work sequence	23	360	-

TABLE F-3.1
ASSESSMENT B
PRE-DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE
(Continued)

<u>Activity Description</u>	<u>Duration</u> (days)	<u>Manpower</u> (manhours)	<u>Exposure</u> (manRem)
15. Procure decontamination chemicals and equipment	20	160	-
16. Procure equipment for material handling and miscellaneous tools for component removal	20	160	-
17. Procure waste storage containers	10	80	-
18. Repair cell windows and door seals and upgrade lighting	11	253	0.71
19. Replace HEPA and roughing filters	3	24	13.9
20. Design temporary storage facility	15	240	-
21. Build plywood structure atop MCR	5	160	-
22. Decontaminate MCR, GCR, CCR, and EDR	39	3217	41.7
23. Decontaminate primary cell and EDR cranes, power manipulators, and master-slave manipulators	7	650	41.6
24. Repair primary cell and EDR cranes, power manipulators, and master-slave manipulators	70	1552	16.8
25. Prepare XCR equipment for internal chemical decontamination	9	396	-
26. Prepare acid recovery system for use	56	454	Note B
27. Prepare liquid waste disposal system for use	Note A	Note A	Note A
Subtotal Pre-decontamination		<u>13,556</u>	<u>116.8</u>

Note A: This information is part of WNYNSC Task 4.

Note B: The calculation is beyond the scope of this report.

TABLE F-3.2
ASSESSMENT B
DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE

<u>Activity Description</u>	PMC		
	<u>Duration (days)</u>	<u>Manpower (manhours)</u>	<u>Exposure (manRem)</u>
1) Prepare PMC for decontamination of cell	4	140	1
2) Decontaminate PMC in-cell equipment and structure surfaces	56	1665	5.4
3) Remotely survey the PMC	1	37	0.2
4) Prepare PMC for equipment removal	4	134	0.9
5) Manually remove and remotely package PMC equipment	4	489	11.9
6) Transfer packaged equipment to temporary storage facility	1	18	0.5
7) Decontaminate crane, power manipulator, and MCR	9	441	14.7
8) Manually survey the PMC	1	34	1.7
9) Survey the MCR	0.5	20	0.2
10) Remotely paint PMC in-cell surfaces	2	22	0.1
11) Install lead shielding on hot spots	0.5	16	0.2
12) Perform final radiation survey	1	34	0.2
Subtotal PMC	<u>NA*</u>	<u>3050</u>	<u>37</u>

* The individual cell activity duration is dependent upon the critical path of all cell removal activities.

TABLE F-3.3
ASSESSMENT B
DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE

		GPC		
	<u>Activity Description</u>	<u>Duration (days)</u>	<u>Manpower (manhours)</u>	<u>Exposure (manRem)</u>
1)	Prepare GPC for decontamination of cell	4	140	0.2
2)	Decontaminate GPC in-cell equipment and structure surfaces	35	1087	5.4
3)	Remotely survey the GPC	1	33	0.1
4)	Prepare GPC for equipment removal	2	34	0.2
5)	Manually remove and remotely package GPC equipment	4	118	8.7
6)	Transfer packaged equipment to temporary storage facility	1	10	0.3
7)	Decontaminate crane, power manipulator, and GCR	19	768	7.9
8)	Manually survey the GPC	1	29	1.8
9)	Survey the GCR	0.25	12	0.1
10)	Remotely paint GPC in-cell surfaces	1	12.3	0.1
11)	Install lead shielding on hot spots	0.25	16	0.1
12)	Perform final radiation survey	1	29	0.2
	Subtotal GPC	<u>NA*</u>	<u>2288</u>	<u>25.1</u>

* The individual cell activity duration is dependent upon the critical path of all cell removal activities.

TABLE F-3.4
ASSESSMENT B
DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE
SRR

	<u>Activity Description</u>	<u>Duration (days)</u>	<u>Manpower (manhours)</u>	<u>Exposure (manRem)</u>
1)	Survey Scrap Removal room	1	44	0.2
2)	Prepare room for decontamination	1	48	0.0
3)	Decontaminate Scrap Removal room	10	190	0.1
4)	Survey Scrap Removal room	1	44	0.1
5)	Paint surfaces in Scrap Removal room	4	137	0.1
6)	Final radiation survey	1	44	0.1
	Subtotal SRR	<u>NA*</u>	<u>507</u>	<u>0.6</u>

* The individual cell activity duration is dependent upon the critical path of all cell removal activities.

TABLE F-3.5

ASSESSMENT B

DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE

		CPC		
	<u>Activity Description</u>	<u>Duration (days)</u>	<u>Manpower (manhours)</u>	<u>Exposure (manRem)</u>
1)	Prepare EDR for remote packaging	3	75	0.6
2)	Prepare for decontamination of CPC	5	146	0.2
3)	Decontaminate internal piping and components	62	1412	0.7
4)	Decontaminate in-cell equipment and structure surfaces	114	3450	3.5
5)	Prepare CPC for equipment removal	2	34	0.1
6)	Remotely survey CPC	3	51	0.1
7)	Manually remove and package CPC equipment	19	1324	138.4
8)	Transfer packaged equipment to temporary storage facility	3	38	1.1
9)	Decontaminate crane, power manipulator, CCR and EDR	62	3000	15
10)	Manually survey the CPC	2	80	1
11)	Survey the CCR, and EDR	1	30	0.1
12)	Remotely paint CPC in-cell surfaces	4	76	0.1
13)	Install lead shielding on hot spots	1	12	0.1
14)	Remove dissolver criticality plugs	3	76	0.9
15)	Perform final radiation survey	3	110	1.1
	Subtotal CPC	NA*	9914	163.9
	Total Assessment B		29,325	343.4

* The individual cell activity duration is dependent upon the critical path of all cell removal activities

APPENDIX G
ASSESSMENT C

ACTIVITIES, COSTS, SCHEDULE, MANPOWER, AND EXPOSURE

TABLE G-1.1

ASSESSMENT C

PREPARATIONS FOR PRIMARY CELL EQUIPMENT DECONTAMINATION AND REMOVAL

1. Obtain and review plant drawings and photographs
2. Perform detailed radiation survey
3. Estimate residual by product inventory
4. Prepare possession-only amendment to operating license
5. Prepare end product description
6. Perform detailed calculations of by product inventory
7. Sequence major work activities
8. Prepare safety analysis of decontamination and equipment removal operations
9. Prepare and submit a dismantling plan to NRC
10. Receive approval of possession-only amendment
11. Receive dismantling order
12. Prepare activity specifications
13. Prepare detailed work procedures
14. Prepare detailed work sequence
15. Procure decontamination chemicals and equipment
16. Procure equipment for material handling and miscellaneous tools for cell component removal
17. Procure waste storage containers
18. Repair cell windows and seal cell doors
19. Replace ventilation system HEPA filters
20. Design and construct a temporary storage facility on site
21. Build plywood structure atop MCR
22. Decontaminate MCR, GCR, CCR, and EDR
23. Decontaminate primary cell and EDR cranes, power manipulators, and master-slave manipulators
24. Repair primary cell and EDR cranes, power manipulators, and master-slave manipulators
25. Prepare acid recovery system for use
26. Prepare liquid waste disposal system for use

TABLE G-1.2

ASSESSMENT C

ACTIVITIES FOR PRIMARY CELL EQUIPMENT DECONTAMINATION AND REMOVAL

PMC

1. Prepare the PMC for equipment removal
 2. Remotely remove and package PMC equipment
 3. Transfer packaged equipment to temporary storage facility
 4. Prepare PMC for decontamination of cell
 5. Decontaminate PMC in-cell surfaces
 6. Decontaminate crane, power manipulator, and the MCR
 7. Remotely survey the PMC
 8. Survey the MCR
 9. Remotely paint PMC in-cell surfaces
 10. Install lead-shielding on hot spots
 11. Perform a final radiation survey
-

TABLE G-1.3

ASSESSMENT C

ACTIVITIES FOR PRIMARY CELL EQUIPMENT DECONTAMINATION AND REMOVAL

GPC

1. Prepare the GPC for equipment removal
2. Remotely remove and package GPC equipment
3. Transfer packaged equipment to temporary storage facility
4. Prepare the GPC for decontamination of cell
5. Decontaminate GPC in-cell surfaces
6. Decontaminate crane, power manipulator, and the GCR
7. Remotely survey the GPC
8. Survey the GCR
9. Remotely paint GPC in-cell surfaces
10. Install lead shielding on hot spots
11. Perform final radiation survey

TABLE G-1.4

ASSESSMENT C

ACTIVITIES FOR PRIMARY CELL EQUIPMENT DECONTAMINATION AND REMOVAL

SRR

1. Survey scrap removal room
2. Prepare SRR for decontamination
3. Decontaminate SRR in-cell surfaces
4. Survey scrap removal room
5. Paint SRR in-cell surfaces
6. Perform final radiation survey

TABLE G-1.5
ASSESSMENT C
ACTIVITIES FOR PRIMARY CELL EQUIPMENT DECONTAMINATION AND REMOVAL
CPC

1. Prepare EDR for remote packaging
2. Prepare CPC for equipment removal
3. Remotely remove and package CPC equipment
4. Transfer packaged equipment to temporary storage facility
5. Prepare the CPC for decontamination of in-cell surfaces
6. Decontaminate in-cell surfaces
7. Decontaminate crane, power manipulator, the CCR, and the EDR
8. Remotely survey the CPC
9. Survey the CCR and the EDR
- ~~10. Remotely paint CPC in-cell surfaces~~
11. Install lead shielding on hot spots
12. Remove dissolver criticality plugs
13. Perform final radiation survey

TABLE G-2.1
ASSESSMENT C
PRE-DECONTAMINATION COSTS

<u>Activity Description</u>	<u>Cost</u> \$
1. Obtain and review plant drawings and photographs	39,600
2. Perform detailed radiation survey	29,600
3. Estimate residual by-product inventory	8,400
4. Prepare possession-only amendment to license application	24,800
5. Prepare end-product description	5,500
6. Perform detailed calculations of by-product inventory	17,600
7. Sequence major work activities	8,800
8. Prepare safety analysis of removal activities	19,800
9. Prepare and submit dismantling plan to NRC for approval	13,800
10. Receive possession-only license amendment from NRC	2,200
11. Receive dismantling order	-
12. Prepare activity specifications	184,800
13. Prepare detailed work procedures	79,200
14. Prepare detailed work sequence	19,800
15. Procure decontamination chemicals and equipment	8,800
16. Procure equipment for material handling and miscellaneous tools for cell component removal	8,800
17. Procure waste storage containers	4,400
18. Repair cell windows and door seals and upgrade lighting	5,000

TABLE G-2.1
ASSESSMENT C
PRE-DECONTAMINATION COSTS
(Continued)

<u>Activity Description</u>	<u>Cost</u> \$
19. Replace HEPA and roughing filters	2,200
20. Design temporary storage facility	13,200
21. Build plywood structure atop MCR	4,200
22. Decontaminate MCR, GCR, CCR, and EDR	131,400
23. Decontaminate primary cell and EDR cranes, power manipulators, and master-slave manipulators	22,600
24. Repair primary cell and EDR cranes, power manipulators, and master-slave manipulators	89,000
25. Prepare acid recovery system for use	25,000
27. Prepare liquid waste disposal system for use	Note A
Subtotal Pre-decontamination	<u>768,500</u>

Note A: This cost included in WNYNSC Task 4.

TABLE G-2.2
ASSESSMENT C
DECONTAMINATION COSTS
PMC

<u>Activity Description</u>	<u>Total \$</u>
1) Prepare PMC for equipment removal	5,500
2) Remotely remove and package PMC equipment	76,000
3) Transfer packaged equipment to temporary storage facility	400
4) Prepare PMC for decontamination of cell	21,700
5) Decontaminate in-cell surfaces	39,600
6) Decontaminate crane, power manipulator, and MCR	16,700
7) Remotely survey the PMC	700
8) Survey the MCR	400
9) Remotely paint PMC in-cell surfaces	10,300
10) Install lead shielding on hot spots	24,500
11) Perform final radiation survey	1,100
Subtotal PMC	<u>196,900</u>

TABLE G-2.3
ASSESSMENT C
DECONTAMINATION COSTS
GPC

<u>Activity Description</u>	<u>Total \$</u>
1) Prepare GPC for equipment removal	1,000
2) Remotely remove and package GPC equipment	43,600
3) Transfer packages equipment to temporary storage facility	200
4) Prepare GPC for decontamination of cell	26,700
5) Decontaminate in-cell surfaces	28,100
6) Decontaminate crane, power manipulator, and GCR	17,600
7) Remotely survey the GPC	600
8) Survey the GCR	200
9) Remotely paint GPC in-cell surfaces	6,500
10) Install lead shielding on hot spots	24,500
11) Perform final radiation survey	800
Subtotal GPC	<u>149,800</u>

TBALE G-2.4
ASSESSMENT C
DECONTAMINATION COSTS
SRR

<u>Activity Description</u>	<u>Total \$</u>
1) Survey Scrap Removal room	900
2) Prepare room for decontamination	1,000
3) Decontaminate Scrap Removal room	28,900
4) Survey Scrap Removal room	900
5) Paint surfaces in Scrap Removal room	10,400
6) Final radiation survey	900
Subtotal SRR	<u>43,000</u>

TABLE G-2.5
ASSESSMENT C
DECONTAMINATION COSTS
CPC

<u>Activity Description</u>	<u>Total \$</u>
1) Prepare EDR for remote packaging	11,600
2) Prepare CPC for equipment removal	1,000
3) Remotely remove CPC equipment and package for storage	266,500
4) Transfer packaged equipment to temporary storage facility	900
5) Prepare CPC for decontamination of in-cell structure surfaces	2,500
6) Decontaminate in-cell surfaces (floor, walls) or CPC	185,000
7) Decontaminate crane, power manipulator, CCR and EDR	149,000
8) Remotely survey CPC	1,200
9) Survey the CCR and EDR	600
10) Remotely paint CPC in-cell surfaces	15,300
11) Install lead shielding on hot spots	33,300
12) Remove dissolver criticality plugs	12,400
13) Perform final radiation survey	2,300
Subtotal CPC	<u>681,600</u>

TABLE G-2.6
ASSESSMENT C
DECONTAMINATION COSTS

	<u>Total</u> <u>\$</u>
<u>Sub-Total Decontamination Work Activities</u>	1,839,800
<u>Undistributed Costs:</u>	
Decontamination Staff	1,280,700
Security Force	1,181,700
Engineering Consultants	304,700
Nuclear Liability Insurance	52,600
Project Management and Engineering QA	256,500
TLD and Film Badge Service	80,200
Bagging Supplies (plastic and tape)	6,000
Temporary Storage Facility	1,240,100
Plasma Torch Cutter	9,500
Electric Materials	2,000
Flexible Hose (4 filters)	3,600
Misc. Cutting and Hoisting Equipment	25,000
Radiation Monitoring Systems	1,200
Scaffold Equipment	3,100
Filters	5,600
Misc. Tools and Hardware	10,000
Service Air Hose	2,000
Remote TV Monitor	6,000
Rubber-Tired Gantry Crane Rental	129,200
Lighting	1,600
Anti-contamination Clothing	19,700
Laundry Service	11,100
Breathing Air Compressor	8,900
Truck Rental	119,500
Fork Lift Rental	13,200
LSA Waste Container, Shipping and Burial	48,200
Decontamination Subcontractor	1,081,400
 Sub-total Undistributed Costs	 <u>5,903,300</u>
Total Decontamination Cost	<u>7,743,100</u>
Cost of Assessment C including 25% Contingency	<u>9,678,900</u>

TABLE G-3.1
ASSESSMENT C
PRE-DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE

<u>Activity Description</u>	<u>Duration (days)</u>	<u>Manpower (manhours)</u>	<u>Exposure (manRem)</u>
1. Obtain and review plant drawings and photographs	20	720	-
2. Perform detailed radiation survey	40	420	2.1
3. Estimate residual by-product inventory	10	160	-
4. Prepare possession-only amendment to license application	28	450	-
5. Prepare end-product description	7	100	-
6. Perform detailed calculations of by-product inventory	20	320	-
7. Sequence major work activities	10	160	-
8. Perform safety analysis of removal activities	20	360	-
9. Prepare and submit dismantling plan to NRC for approval	16	250	-
10. Receive possession-only license amendment from NRC	20	40	-
11. Receive dismantling order	60	-	-
12. Prepare activity specifications	70	1440	-
13. Prepare detailed work procedures	45	1440	-
14. Prepare detailed work sequence	23	360	-

TABLE G-3.1
ASSESSMENT C
PRE-DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE
(Continued)

<u>Activity Description</u>	<u>Duration</u> (days)	<u>Manpower</u> (manhours)	<u>Exposure</u> (manRem)
15. Procure decontamination chemicals and equipment	20	160	-
16. Procure equipment for material handling and miscellaneous tools for component removal	20	160	-
17. Procure waste storage containers	10	80	-
18. Repair cell windows and door seals and upgrade lighting	11	253	0.71
19. Replace HEPA and roughing filters	3	24	13.9
20. Design temporary storage facility	15	240	-
21. Build plywood structure atop MCR	5	160	-
22. Decontaminate MCR, GCR, CCR, and EDR	39	3217	41.7
23. Decontaminate primary cell and EDR cranes, power manipulators, and master-slave manipulators	7	650	41.6
24. Repair primary cell and EDR cranes, power manipulators, and master-slave manipulators	70	1552	16.8
25. Prepare acid recovery system for use	56	454	Note B
26. Prepare liquid waste disposal system for use	Note A	Note A	Note A
Subtotal Pre-decontamination		<u>13,170</u>	<u>116.8</u>

Note A: This information is part of WNYNSC Task 4.

Note B: The calculation is beyond the scope of this report.

TABLE G-3.2

ASSESSMENT C

DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE

PMC

<u>Activity Description</u>	<u>Duration (days)</u>	<u>Manpower (manhours)</u>	<u>Exposure (manRem)</u>
1) Prepare PMC for equipment removal	4	134	0.9
2) Remotely remove and package PMC equipment	13	532	1.6
3) Transfer packages equipment to temporary storage facility	1	18	59.6
4) Prepare PMC for decontamination of cell	4	140	1
5) Decontaminate in-cell surfaces	29	912	2.7
6) Decontaminate crane, power manipulator, and MCR	9	441	14.7
7) Remotely survey the PMC	1	37	0.2
8) Survey the MCR	0.5	20	0.2
9) Remotely paint PMC in-cell surfaces	2	22	0.1
10) Install lead shielding on hot spots	0.5	16	0.2
11) Perform final radiation survey	1	34	0.2
Subtotal PMC	<u>NA*</u>	<u>2306</u>	<u>81.4</u>

* The individual cell activity duration is dependent upon the critical path of all cell removal activities.

TABLE G-3.3
ASSESSMENT C
DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE

GPC			
<u>Activity Description</u>	<u>Duration (days)</u>	<u>Manpower (manhours)</u>	<u>Exposure (manRem)</u>
1) Prepare GPC for equipment removal	2	34	0.2
2) Remotely remove and package GPC equipment	9	336	0.1
3) Transfer packaged equipment to temporary storage facility	1	10	33.1
4) Prepare GPC for decontamination of cell	4	140	0.2
5) Decontaminate in-cell surfaces	21	654	3.2
6) Decontaminate crane, power manipulator, and GCR	19	768	7.9
7) Remotely survey the GPC	1	33	0.1
8) Survey the GCR	0.25	12	0.1
9) Remotely paint GPC in-cell surfaces	1	12.3	0.1
10) Install lead shielding on hot spots	0.5	16	0.1
11) Perform final radiation survey	1	29	0.2
Subtotal GPC	<u>NA*</u>	<u>2044</u>	<u>45.3</u>

* The individual cell activity duration is dependent upon the critical path of all cell removal activities.

TABLE G-3.4
ASSESSMENT C
DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE
SRR

	<u>Activity Description</u>	<u>Duration (days)</u>	<u>Manpower (manhours)</u>	<u>Exposure (manRem)</u>
1)	Survey Scrap Removal room	1	44	0.2
2)	Prepare room for decontamination	1	48	0.0
3)	Decontaminate Scrap Removal room	10	190	0.1
4)	Survey Scrap Removal room	1	44	0.1
5)	Paint surfaces in Scrap Removal room	4	137	0.1
6)	Final radiation survey	1	44	0.1
	Subtotal SRR	<u>NA*</u>	<u>507</u>	<u>0.6</u>

* The individual cell activity duration is dependent upon the critical path of all cell removal activities.

TABLE G-3.5
ASSESSMENT C
DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE

		CPC		
	<u>Activity Description</u>	<u>Duration (days)</u>	<u>Manpower (manhours)</u>	<u>Exposure (manRem)</u>
1)	Prepare EDR for remote operations	3	75	0.6
2)	Prepare CPC for equipment removal	2	34	0.1
3)	Remotely remove CPC equipment and package for storage	67	1835	1.8
4)	Transfer packaged equipment to temporary storage facility	3	38	125.8
5)	Prepare CPC for decontamination of in-cell structure surfaces	4	116	0.1
6)	Decontaminate in-cell surfaces (floor, walls) of CPC	88	2692	2.7
7)	Decontaminate crane, power manipulator, CCR, and EDR	62	3000	15
8)	Remotely survey CPC	3	51	0.1
9)	Survey the CCR and EDR	1	30	0.1
10)	Remotely paint CPC in-cell surfaces	4	76	0.1
11)	Install lead shielding on hot spots	1	12	0.1
12)	Remove dissolver criticality plugs	3	76	0.9
13)	Perform final radiation survey	3	110	1.0
	Subtotal CPC	<u>NA*</u>	<u>8145</u>	<u>148.4</u>
	Total Assessment C		<u>26,172</u>	<u>392.5</u>

* The individual cell activity duration is dependent upon the critical path of all cell removal activities.

APPENDIX H

ASSESSMENT D

ACTIVITIES, COSTS, SCHEDULE, MANPOWER AND EXPOSURE

TABLE H-1.1

ASSESSMENT D

PREPARATIONS FOR SECONDARY CELL EQUIPMENT DECONTAMINATION AND REMOVAL

1. Obtain and review plant drawings and photographs
2. Perform detailed radiation survey
3. Estimate residual by product inventory
4. Prepare possession-only amendment to operating license
5. Prepare end product description
6. Perform detailed calculations of by product inventory
7. Sequence major work activities
8. Prepare safety analysis of decontamination and equipment removal operations
9. Prepare and submit a dismantling plan to NRC
10. Receive approval of possession-only amendment
11. Receive dismantling order
12. Prepare activity specifications
13. Prepare detailed work procedures
14. Prepare detailed work sequence
15. Procure decontamination chemicals and equipment
16. Procure equipment for material handling and miscellaneous tools for cell component removal
17. Procure waste storage containers
18. Design and procure equipment and materials for contamination control envelope in XCR
19. Repair cell entry hatches
20. Replace ventilation system HEPA filters
21. Design a temporary storage facility on site
22. Prepare XCR equipment for internal chemical decontamination of secondary cell components
23. Prepare acid recovery system for use
24. Prepare liquid waste disposal system for use
25. Install high capacity monorail in XCR
26. Design and fabricate water lance for XC-1 special decontamination

TABLE H-1.2

ASSESSMENT D.

ACTIVITIES FOR SECONDARY CELL EQUIPMENT REMOVAL WITH DECONTAMINATION
PRIOR TO EQUIPMENT REMOVAL

XC-1 and XC-2

1. Install high capacity monorail crane in extraction chemical room
2. Construct contamination control envelope in XCR
3. Install ancillary equipment for removal operation
4. Prepare XC-2 for internal decontamination
5. Perform internal decontamination of XC-2 (processing of all liquid wastes generated is included in Activity 23 "Process Liquid Wastes")
6. Remove piping and components from XC-2 and package for storage
7. Prepare for decontamination of external surfaces in XC-2
8. Decontaminate walls, floors, and framework in XC-2
9. Paint surfaces and remove framework from XC-2 and package for storage
10. Core drill walls into XC-1 from XC-2 and LWA
11. Prepare for decontamination of external surfaces in XC-1
12. Decontaminate XC-1 floor and tank 4D-2 from XC-2 and LWA
13. Perform final radiation survey of XC-2 and final clean-up
14. Prepare XC-1 for internal decontamination
15. Close XC-2
16. Perform internal decontamination of XC-1
17. Remove piping and components from XC-1 and package for storage
18. Prepare for decontamination of walls, floors, and framework in XC-1
19. Decontaminate walls, floors, and framework in XC-1
20. Paint surfaces and remove framework from XC-1 and package for storage
21. Perform final radiation survey and final clean-up of XC-1
22. Close XC-1
23. Process all liquid wastes generated by decontamination activities
24. Transfer all packaged equipment from previous removal activities to temporary storage facility.

TABLE H-1.3

ASSESSMENT D

ACTIVITIES FOR SECONDARY CELL EQUIPMENT REMOVAL WITH DECONTAMINATION PRIOR TO EQUIPMENT REMOVAL

XC-3

1. Install high capacity monorail crane in extraction chemical room
2. Design and construct contamination control envelope in XCR
3. Install ancillary equipment for removal operation
4. Prepare XC-3 for internal decontamination
5. Perform internal decontamination of XC-3
6. Remove piping and components from XC-3 and package for storage
7. Prepare for decontamination of external surfaces in XC-3
8. Decontaminate walls, floors, and framework (processing of all liquid wastes generated is included in Activity 12 "Process Liquid Wastes")
9. Paint surfaces and remove framework from XC-3 and package for storage
10. Perform final radiation survey of XC-3 and final clean-up
11. Close XC-3
12. Process all liquid wastes generated by decontamination activities
13. Transfer all packaged equipment from previous removal activities to temporary storage facility

TABLE H-1.4

ASSESSMENT D

ACTIVITIES FOR SECONDARY CELL EQUIPMENT REMOVAL WITH DECONTAMINATION
PRIOR TO EQUIPMENT REMOVAL

PPC

1. Install high capacity monorail crane in extraction chemical room
2. Design and construct contamination control envelope in XCR
3. Install ancillary equipment for removal operation
4. Prepare PPC for internal decontamination
5. Perform internal decontamination of PPC (processing of all liquid wastes generated is included in Activity 13 "Process Liquid Wastes")
6. Remove piping and components from PPC and package for storage
7. Prepare for decontamination of external surfaces in PPC
8. Decontaminate walls, floors, and framework in PPC
9. Paint surfaces and remove framework from PPC and package for storage
10. Perform final radiation survey of PPC and final clean-up
11. Close PPC
12. Remove contamination control envelope
13. Process all liquid wastes generated by decontamination activities
14. Transfer all packaged equipment from previous removal activities to temporary storage facility

TABLE H-2.1
ASSESSMENT D
PRE-DECONTAMINATION COSTS

<u>Activity Description</u>	<u>Cost</u> \$
1. Obtain and review as-built drawings	39,600
2. Perform detailed radiation survey	29,600
3. Estimate residual by-product inventory	8,400
4. Prepare and submit possession-only license application	24,800
5. Prepare end-product description	5,500
6. Perform detailed calculations of by-product inventory	17,600
7. Define major sequence of work activities	8,800
8. Perform safety analysis of removal activities	19,800
9. Prepare and submit dismantling plan to NRC for approval	13,800
10. Receive possession-only license amendment from NRC	2,200
11. Receive dismantling order	-
12. Prepare activity specifications	184,800
13. Prepare detailed work procedures	79,200
14. Prepare detailed work sequence	19,800
15. Procure decontamination chemicals and equipment	8,800
16. Procure equipment for material handling and miscellaneous tools for cell component removal	8,800
17. Procure waste storage containers	4,400
18. Design and procure equipment and materials for contamination control envelope in XCR	4,400

TABLE H-2.1
ASSESSMENT D
PRE-DECONTAMINATION COSTS
(Continued)

<u>Activity Description</u>	<u>Cost</u> \$
19. Repair cell entry hatches	300
20. Replace ventilation system HEPA filters	2,200
21. Design temporary storage facility on-site	13,200
22. Prepare XCR equipment for internal chemical decontamination of secondary cell components	39,600
23. Prepare acid recovery system for use	25,000
24. Prepare liquid waste disposal system for use	Note A
25. Install high capacity monorail in XCR	71,700
26. Design and fabricate water lance for XC-1 special decontamination	400
Subtotal Pre-decontamination	<u>632,700</u>

Note A: This cost included in WNYNSC Task 4.

TABLE H-2.2
ASSESSMENT D
DECONTAMINATION COSTS
XC-1 and XC-2

<u>Activity Description</u>	<u>Total \$</u>
<u>XC-2 and XC-1</u>	
1) Install high capacity mon-orail crane in extraction chemical room	41,400
2) Design and construct contamination control envelope in XCR	12,800
3) Install ancillary equipment for removal operation	6,800
4) Prepare XC-2 for internal decontamination	7,900
5) Perform internal decontamination of XC-2	105,200
6) Remove piping and components from XC-2 and package for storage	142,000
7) Prepare for decontamination of external surfaces in XC-2	7,600
8) Decontaminate walls, floors and framework in XC-2	108,000
9) Paint surfaces and remove framework from XC-2 and package for storage	38,800
10) Core drill walls into XC-1 from XC-2 and LWA	12,800
11) Prepare for decontamination for external surfaces in XC-1	20,700
12) Decontaminate XC-1 floor and tank 4D-2 from XC-2 and LWA	7,000
13) Perform final radiation survey of XC-2 and final clean-up	1,000

TABLE H-2.2
ASSESSMENT D
DECONTAMINATION COSTS

XC-1 and XC-2
(Continued)

<u>Activity Description</u>	<u>Total \$</u>
14) Prepare XC-1 for internal decontamination	20,300
15) Close XC-2	1,600
16) Perform internal decontamination of XC-1	88,800
17) Remove piping and components from XC-1 and package for storage	86,300
18) Prepare for decontamination of walls, floors, and framework in XC-1	20,700
19) Decontaminate walls, floors, and framework in XC-1	72,200
20) Paint surfaces and remove framework from XC-1 and package for storage	36,700
21) Perform final radiation survey and final clean-up of XC-1	1,000
22) Close XC-1	1,600
23) Transfer for all packaged equipment from previous removal activities to temporary storage	6,600
Subtotal XC-1 and XC-2	<u>847,800</u>

TABLE H-2.3
ASSESSMENT D
DECONTAMINATION COSTS
XC-3

<u>Activity Description</u>	<u>Total \$</u>
1) Install high capacity monorail crane in extraction chemical room	Included in Activity XC-2 and XC-1
2) Design and construct contamination control envelope in XC-R	Included in Activity XC-2 and XC-1
3) Install ancillary equipment for removal operation	Included in Activity XC-2 and XC-1
4) Prepare XC-3 for internal decontamination	7,900
5) Perform internal decontamination of XC-3	63,800
6) Remove piping and components from XC-3 and package for storage	107,900
7) Prepare for decontamination of external surfaces in XC-3	7,600
8) Decontaminate walls, floors, and framework in XC-3	98,600
9) Paint surfaces and remove framework from XC-3 and package for storage	39,400
10) Perform final radiation survey of XC-3 and final cleanup	1,000
11) Close XC-3	1,500
12) Transfer all packaged from previous removal activities to temperature storage facility	3,300
Subtotal XC-3	<u>331,000</u>

TABLE H-2.4
ASSESSMENT D
DECONTAMINATION COSTS
PPC

<u>Activity Description</u>	<u>Total \$</u>
1) Install high capacity monorail crane in extraction chemical room	Included in Activity XC-1 and XC-
2) Design and construct contamination control envelope in XCR	Included in Activity XC-1 and XC-
3) Install ancillary equipment for removal operation	Included in Activity XC-1 and XC-
4) Prepare PPC for internal decontamination	7,900
5) Perform internal decontamination of PPC	70,100
6) Remove piping and components from PPC and package for storage	93,400
7) Prepare for decontamination of external surfaces in PPC	7,600
8) Decontaminate walls, floors, and framework in PPC	100,600
9) Paint surfaces and remove framework from PPC and package for storage	38,800
10) Perform final radiation survey of PPC and final clean-up	1,000
11) Close PPC	1,500
12) Remove contamination control envelope	7,800
13) Transfer all packaged equipment from previous removal activities to temporary storage facility	3,300
Subtotal PPC	<u>332,000</u>

TABLE H-2.5
ASSESSMENT D
DECONTAMINATION COSTS

	<u>Total</u> <u>\$</u>
<u>Sub-Total Decontamination Work Activities</u>	2,143,500
<u>Undistributed Costs:</u>	
Decontamination Staff	1,727,600
Security Force	1,594,100
Engineering Consultants	411,000
Nuclear Liability Insurance	52,600
Project Management and Engineering QA	346,100
TLD and Film Badge Service	115,500
Bagging Supplies (plastic and tape)	6,000
Temporary Storage Facility	658,600
Plasma Torch Cutter	9,500
Electric Materials	2,000
Flexible Hose (4 filters)	3,600
Misc. Cutting and Hoisting Equipment	25,000
Radiation Monitoring Systems	1,200
Scaffold Equipment	3,100
Upgrade XCR equipment	39,600
Filters	5,600
Misc. Tools and Hardware	10,000
Service Air Hose	2,000
Remote TV Monitor	6,000
Rubber-Tired Gantry Crane Rental	205,800
Lighting	1,600
Anti-contamination Clothing	251,700
Laundry Service	142,000
Breathing Air Compressor	14,200
Truck Rental	190,300
Fork Lift Rental	21,000
LSA Waste Container, Shipping and Burial	94,200
Decontamination Subcontractor	748,400
 Sub-total Undistributed Costs	 <u>6,688,300</u>
Total Decontamination Cost	<u>8,831,800</u>
Cost of Assessment D, including 25% Contingency	<u>11,039,800</u>

TABLE H-3.1
ASSESSMENT D
PRE-DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE

<u>Activity Description</u>	<u>Duration</u> (days)	<u>Manpower</u> (manhours)	<u>Exposure</u> (manRem)
1. Obtain and review as-built drawings	20	720	-
2. Perform detailed radiation survey	40	420	2.1
3. Estimate residual by-product inventory	10	160	-
4. Prepare and submit possession-only license application	28	450	-
5. Prepare end-product description	7	100	-
6. Perform detailed calculations of by-product inventory	20	320	-
7. Define major sequence of work activities	10	160	-
8. Perform safety analysis of removal activities	20	360	-
9. Prepare and submit dismantling plan to NRC for approval	16	250	-
10. Receive possession-only license amendment from NRC	20	40	-
11. Receive dismantling order	60	-	-
12. Prepare activity specifications	70	1440	-
13. Prepare detailed work procedures	45	1440	-
14. Prepare detailed work sequence	23	360	-

TABLE H-3.1

ASSESSMENT D

PRE-DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE
(Continued)

<u>Activity Description</u>	<u>Duration</u> (days)	<u>Manpower</u> (manhours)	<u>Exposure</u> (manRem)
15. Procure decontamination chemicals and equipment	20	160	-
16. Procure equipment for material handling and miscellaneous tools for cell component removal	20	160	-
17. Procure waste storage containers	10	80	-
18. Design and procure equipment and materials for contamination control envelope in XCR	10	80	-
19. Repair cell entry hatches	1	12	0.12
20. Replace HEPA and roughing filters	3	24	13.9
21. Design temporary storage facility on-site	15	240	-
22. Prepare XCR equipment for internal chemical decontamination	9	396	0.2
23. Prepare acid recovery system for use	Note B	454	Note B
24. Prepare liquid waste disposal system for use	Note A	Note A	Note A
25. Install high capacity monorail in XCR	2	168	0.08
26. Design and fabricate water lance for XC-1 special decontamination	1	16	-
Subtotal Pre-decontamination		<u>8010</u>	<u>16.4</u>

Note A: This information is part of WNYNSC Task 4.

Note B: The calculation is beyond the scope of this report.

TABLE H-3.2

ASSESSMENT D

DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE

XC-1 and XC-2

<u>Activity Description</u>	<u>Duration</u> (days)	<u>Manpower</u> (manhours)	<u>Exposure</u> (manRem)
1) Install high capacity monorail crane in extraction chemical room	2	168	0.1
2) Design and construct contamination control envelope in XCR	7	346	0.2
3) Install ancillary equipment for removal operation	7	276	0.1
4) Prepare XC-2 for internal decontamination	11	228	0.1
5) Perform internal decontamination of XC-2	58	1275	0.6
6) Remove piping and components from XC-2 and package for storage	40	2126	3
7) Prepare for decontamination of external surfaces in XC-2	8	340	0.3
8) Decontaminate walls, floors, and framework in XC-2	50	3144	3
9) Remove framework from XC-2 and package from storage	9	923	0.8
10) Core drill walls into XC-1 from XC-2 and LWA	15	253	0.6
11) Prepare for decontamination of external surfaces in XC-1	2	20	0.1
12) Decontaminate XC-1 floor and tank 4D-2 from XC-2 and LWA	15	312	0.1
13) Perform final radiation survey of XC-2 and final clean-up	2	48	0.1
14) Prepare XC-1 for internal decontamination	11	256	8

TABLE H-3.2
ASSESSMENT D
DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE

XC-1 and XC-2
(Continued)

	<u>Activity Description</u>	<u>Duration</u> (days)	<u>Manpower</u> (manhours)	<u>Exposure</u> (manRem)
15)	Close XC-2	3	70	0.1
16)	Perform internal decontamination of XC-1	55	1168	0.6
17)	Remove piping and components from XC-1 and package for storage	24	1213	197
18)	Prepare for decontamination of walls, floor and framework in XC-1	8	474	23.3
19)	Decontaminate walls, floors, and framework in XC-1	40	2497	7.1
20)	Paint surfaces and remove framework from XC-1 and package for storage	9	886	2.7
21)	Perform final radiation survey and final clean-up of XC-1	2	48	0.1
22)	Close XC-1	3	70	0.2
23)	Transfer all packaged equipment from previous removal activities to temporary storage	3	576	0.7
	Subtotal XC-1 and XC-2	<u>NA*</u>	<u>16,717</u>	<u>248.9</u>

* The individual cell activity duration is dependent upon the critical path of all cell removal activities.

TABLE H-3.3
ASSESSMENT D
DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE
XC-3

<u>Activity Description</u>		<u>Duration</u> (days)	<u>Manpower</u> (manhours)	<u>Exposure</u> (manRem)
1)	Install high capacity monorail crane in extraction chemical room	Included in Activity XC-2 and XC-1		
2)	Design and construct contamination control envelope in XC-R	Included in Activity XC-2 and XC-1		
3)	Install ancillary equipment for removal operation	Included in Activity XC-2 and XC-1		
4)	Prepare XC-3 for internal decontamination	11	228	1.3
5)	Perform internal decontamination in XC-3	51	1007	0.5
6)	Remove piping and components from XC-3 and package for storage	37	1837	1.4
7)	Prepare for decontamination of external surfaces in XC-3	8	340	0.1
8)	Decontaminate walls, floors, and framework	55	2824	1.6
9)	Paint surfaces and remove framework from XC-3 and package for storage	9	905	0.4
10)	Perform final radiation survey of XC-3 and final clean-up	2	48	0.1
11)	Close XC-3	2	62	0.1
12)	Transfer all packaged equipment from previous removal activities to temporary storage facility	Included in Activity XC-2 and XC-1		
Subtotal XC-3		NA*	7251	5.5

* The individual cell activity duration is dependent upon the critical path of all cell removal activities.

TABLE H-3.4

ASSESSMENT D

DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE

PPC

<u>Activity Description</u>		<u>Duration</u> (days)	<u>Manpower</u> (manhours)	<u>Exposure</u> (manRem)
1)	Install high capacity monorail crane in extraction chemical room	Included in Activity XC-2 and XC-1		
2)	Design and construct contamination control envelope in XCR	Included in Activity XC-2 and XC-1		
3)	Install ancillary equipment for removal operations	Included in Activity XC-2 and XC-1		
4)	Prepare PPC for internal decontamination	11	228	0.6
5)	Perform internal decontamination of PPC	52	1048	0.5
6)	Remove piping and components from PPC and package for storage	30	1634	1.1
7)	Prepare for decontamination of external surfaces in PPC	8	340	0.1
8)	Decontaminate walls, floors, and framework in PPC	46	2891	1.5
9)	Paint surfaces and remove framework from PPC and package for storage	9	908	0.4
10)	Perform final radiation survey of PPC and final clean-up	2	48	0.1
11)	Close PPC	3	62	0.1
12)	Remove contamination control envelope	10	280	0.5
13)	Transfer all packaged equipment from previous removal activities to temporary storage facility	Included in Activity XC-2 and XC-1		
Subtotal PPC		NA*	7439	4.9
Total Assessment D			39,417	275.7

* The individual cell activity duration is dependent upon the critical path of all cell removal activities.

APPENDIX I

ASSESSMENT E

ACTIVITIES, COSTS, SCHEDULE, MANPOWER, AND EXPOSURE

TABLE I-1.1

ASSESSMENT E

PREPARATIONS FOR PRIMARY CELL EQUIPMENT DECONTAMINATION AND REMOVAL

1. Obtain and review plant drawings and photographs
2. Perform detailed radiation survey
3. Estimate residual by product inventory
4. Prepare possession-only amendment to operating license
5. Prepare end product description
6. Perform detailed calculations of by product inventory
7. Sequence major work activities
8. Prepare safety analysis of decontamination and equipment removal operations
9. Prepare and submit a dismantling plan to NRC
10. Receive approval of possession-only amendment
11. Receive dismantling order
12. Prepare activity specifications
13. Prepare detailed work procedures
14. Prepare detailed work sequence
15. Procure decontamination chemicals and equipment for cell surface decontamination
16. Procure equipment for material handling and miscellaneous tools for cell component removal
17. Procure waste storage containers
18. Design and procure equipment and materials for contamination control envelope in XCR
19. Repair cell entry hatches
20. Replace ventilation system HEPA filters
21. Design a temporary storage facility on site
22. Prepare acid recovery system for use
23. Prepare liquid waste disposal system for use
24. Install high capacity monorail in XCR
25. Design and fabricate water lance for XC-1 special decontamination

TABLE I-1.2

ASSESSMENT E

ACTIVITIES FOR SECONDARY CELL EQUIPMENT REMOVAL WITH DECONTAMINATION
PRIOR TO EQUIPMENT REMOVAL

XC-1 and XC-2

1. Install high capacity monorail crane in extraction chemical room
2. Design and construct contamination control envelope in XCR
3. Install ancillary equipment for removal operation
4. Remove piping and components from XC-2 and package for storage
5. Prepare for decontamination of walls, floors, and framework in XC-2
6. Decontaminate walls, floors, and framework in XC-2 (processing of all liquid wastes generated is included in Activity 20, "Process Liquid Wastes")
7. Paint surfaces and remove framework from XC-2 and package for storage
- ~~8. Core-drill walls into XC-1 from XC-2 and LWA~~
9. Prepare for decontamination of external surfaces in XC-1
10. Decontaminate XC-1 floor and tank 4D-2 from XC-2 and LWA
11. Perform final radiation survey of XC-2 and final clean-up
12. Close XC-2
13. Remove piping and components from XC-1 and package for storage
14. Prepare for decontamination of walls, floors, and framework in XC-1
15. Decontaminate walls, floors, and framework in XC-1
16. Paint surfaces and remove framework from XC-1 and package for storage
17. Perform final radiation survey and final clean-up of XC-1
18. Close XC-1
19. Remove contamination control envelope
20. Process all liquid wastes generated by decontamination activities
21. Transfer all packaged equipment from previous removal activities to temporary storage facility.

TABLE I-1.3

ASSESSMENT E

**ACTIVITIES FOR SECONDARY CELL EQUIPMENT REMOVAL WITH DECONTAMINATION
PRIOR TO EQUIPMENT REMOVAL**

XC-3

1. Install high capacity monorail crane in extraction chemical room
2. Design and construct contamination control envelope in XCR
3. Install ancillary equipment for removal operation
4. Remove piping and components from XC-3 and package for storage
5. Prepare for decontamination of walls, floors, and framework in XC-3
6. Decontaminate walls, floors, and framework (processing of all liquid wastes generated is included in Activity 12 "Process Liquid Wastes")
7. Paint surfaces and remove framework from XC-3 and package for storage
8. Perform final radiation survey of XC-3 and final clean-up
9. Close XC-3
10. Process all liquid wastes generated by decontamination activities
11. Transfer all packaged equipment from previous removal activities to temporary storage facility

TABLE I-1.4

ASSESSMENT E

**ACTIVITIES FOR SECONDARY CELL EQUIPMENT REMOVAL WITH DECONTAMINATION
PRIOR TO EQUIPMENT REMOVAL**

PPC

1. Install high capacity monorail crane in extraction chemical room
2. Design and construct contamination control envelope in XCR
3. Install ancillary equipment for removal operation
4. Remove piping and components from PPC and package for storage
5. Prepare for decontamination of walls, floors, and framework in PPC
6. Decontaminate walls, floors, and framework in PPC (processing of all liquid wastes generated is included in Activity 10 "Process Liquid Wastes")
7. Paint surfaces and remove framework from PPC and package for storage
8. Perform final radiation survey of PPC and final clean-up
9. Close PPC
10. Process all liquid wastes generated by decontamination activities
11. Transfer all packaged equipment from previous removal activities to temporary storage facility

TABLE I-2.1
ASSESSMENT E
PRE-DECONTAMINATION COSTS

<u>Activity Description</u>	<u>Cost</u> \$
1. Obtain and review as-built drawings	39,600
2. Perform detailed radiation survey	29,600
3. Estimate residual by-product inventory	8,400
4. Prepare and submit possession-only license application	24,800
5. Prepare end-product description	5,500
6. Perform detailed calculations of by-product inventory	17,600
7. Define major sequence of work activities	8,800
8. Perform safety analysis of removal activities	19,800
9. Prepare and submit dismantling plan to NRC for approval	13,800
10. Receive possession-only license amendment from NRC	2,200
11. Receive dismantling order	-
12. Prepare activity specifications	184,800
13. Prepare detailed work procedures	79,200
14. Prepare detailed work sequence	19,800
15. Procure decontamination chemicals and equipment for cell surface decontamination	8,800
16. Procure equipment for material handling and miscellaneous tools for cell component removal	8,800
17. Procure waste storage containers	4,400
18. Design and procure equipment and materials for contamination control envelope in XCR	4,400

TABLE I-2.1
ASSESSMENT E
PRE-DECONTAMINATION COSTS
(Continued)

<u>Activity Description</u>	<u>Cost</u> \$
19. Repair cell entry hatches	300
20. Replace ventilation system HEPA filters	2,200
21. Design temporary storage facility	13,200
22. Prepare acid recovery system for use	25,000
23. Prepare liquid waste disposal system for use	Note A
24. Install high capacity monorail in XCR	71,700
25. Design and fabricate water lance for XC-1 special decontamination	400
Subtotal Pre-decontamination	<u>593,100</u>

Note A: This cost included in WNYNSC Task 4.

TABLE I-2.2
ASSESSMENT E
DECONTAMINATION COSTS
XC-1 and XC-2

<u>Activity Description</u>	<u>Total \$</u>
1) Install high capacity monrail crane in extraction chemical room	41,400
2) Design and construct contamination control envelope in XCR	12,800
3) Install ancillary equipment for removal operation	6,800
4) Remove piping and components from XC-2 and package for storage	142,000
5) Prepare for decontamination of walls, floors, and framework in XC-2	7,600
6) Decontaminate walls, floors and framework in XC-2	108,000
7) Paint surfaces and remove framework from XC-2 and package for storage	38,800
8) Core drill XC-1 from XC-2 and LWA	12,800
9) Prepare for decontamination of external surfaces in XC-1	20,700
10) Decontaminate XC-1 floor and tank 4D-2 from XC-2 and LWA	7,000
11) Perform final radiation survey of XC-2 and final clean-up	1,000
12) Close XC-2	1,600
13) Remove piping and components from XC-1 and package for storage	86,300

TABLE I-2.2
ASSESSMENT E
DECONTAMINATION COSTS

XC-1 and XC-2
(Continued)

<u>Activity Description</u>	<u>Total \$</u>
14) Prepare for decontamination of walls, floors, and framework in XC-1	20,700
15) Decontaminate walls, floors and framework in XC-1	72,200
16) Paint surfaces and remove framework from XC-1 and package for storage	36,700
17) Perform final radiation survey and final clean-up of XC-1	1,000
18) Close XC-1	1,600
19) Remove contamination control envelope	7,800
20) Transfer all packaged equipment from previous removal activities to temporary storage facility	6,600
Subtotal XC-1 and XC-2	<u>633,400</u>

TABLE I-2.3
ASSESSMENT E
DECONTAMINATION COSTS

XC-3

<u>Activity Description</u>	<u>Total \$</u>
1) Install high capacity monorail in extraction chemical room	Included in Activity XC-2 and XC-1
2) Design and construct contamination control envelope in XCR	Included in Activity XC-2 and XC-1
3) Install ancillary equipment for removal operation	Included in Activity XC-2 and XC-1
4) Remove piping and components from XC-3 and package for storage	107,900
5) Prepare for decontamination of walls, floors, and framework in XC-3	7,600
6) Decontaminate walls, floors and framework in XC-3	98,600
7) Paint surfaces and remove framework from XC-3 and package for storage	39,400
8) Perform final radiation survey of XC-3 and final clean-up	1,000
9) Close XC-3	1,500
10) Transfer all packaged equipment from previous removal activities to temporary storage facility	3,300
Subtotal XC-3	<u>259,300</u>

TABLE I-2.4

ASSESSMENT E

DECONTAMINATION COSTS

PPC

<u>Activity Description</u>	<u>Total \$</u>
1) Install high capacity monorail in extraction chemical room	Included in Activity XC-2 and XC-1
2) Design and construct contamination control envelope in XCR	Included in Activity XC-2 and XC-1
3) Install ancillary equipment for removal operations	Included in Activity XC-2 and XC-1
4) Remove piping and components from PPC and package for storage	93,400
5) Prepare for decontamination of walls, floors and framework in PPC	7,600
6) Decontaminate walls, floors, and framework in PPC	100,600
7) Paint surfaces and remove framework from PPC and package for storage	38,800
8) Perform final radiation survey of PPC and final clean-up	1,000
9) Close PPC	1,500
10) Transfer all packaged equipment from previous removal activities to temporary storage facility	3,300
Subtotal PPC	<u>246,200</u>

TABLE I-2.5
ASSESSMENT E
DECONTAMINATION COSTS

	<u>Total</u> <u>\$</u>
<u>Sub-Total Decontamination Work Activities</u>	1,732,000
<u>Undistributed Costs:</u>	
Decontamination Staff	1,318,700
Security Force	1,216,800
Engineering Consultants	313,700
Nuclear Liability Insurance	52,600
Project Management and Engineering QA	264,200
TLD and Film Badge Service	83,200
Bagging Supplies (plastic and tape)	6,000
Temporary Storage Facility	1,461,700
Plasma Torch Cutter	9,500
Electric Materials	2,000
Flexible Hose (4 filters)	3,600
Misc. Cutting and Hoisting Equipment	25,000
Radiation Monitoring Systems	1,200
Scaffold Equipment	3,100
Upgrade XCR equipment	39,600
Filters	5,600
Misc. Tools and Hardware	10,000
Service Air Hose	2,000
Remote TV Monitor	6,000
Rubber-Tired Gantry Crane Rental	135,700
Lighting	1,600
Anti-contamination Clothing	207,500
Laundry Service	117,100
Breathing Air Compressor	9,400
Truck Rental	125,500
Fork Lift Rental	13,900
LSA Waste Container, Shipping and Burial	74,800
Decontamination Subcontractor	14,354,400
 <u>Sub-total Undistributed Costs</u>	 <u>19,855,400</u>
<u>Total Decontamination Cost</u>	<u>21,587,400</u>
<u>Cost of Assessment D including 25% Contingency</u>	<u>26,984,300</u>

TABLE I-3.1
ASSESSMENT E
PRE-DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE

<u>Activity Description</u>	<u>Duration</u> (days)	<u>Manpower</u> (manhours)	<u>Exposure</u> (manRem)
1. Obtain and review as-built drawings	20	720	-
2. Perform detailed radiation survey	40	420	2.1
3. Estimate residual by-product inventory	10	160	-
4. Prepare and submit possession-only license application	28	450	-
5. Prepare end-product description	7	100	-
6. Perform detailed calculations of by-product inventory	20	320	-
7. Define major sequence of work activities	10	160	-
8. Perform safety analysis of removal activities	20	360	-
9. Prepare and submit dismantling plan to NRC for approval	16	250	-
10. Receive possession-only license amendment from NRC	20	40	-
11. Receive dismantling order	60	-	-
12. Prepare activity specifications	70	1440	-
13. Prepare detailed work procedures	45	1440	-
14. Prepare detailed work sequence	23	360	-

TABLE I-3.1
ASSESSMENT E
PRE-DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE
(Continued)

<u>Activity Description</u>	<u>Duration</u> (days)	<u>Manpower</u> (manhours)	<u>Exposure</u> (manRem)
15. Procure decontamination chemicals and equipment for cell surface decontamination	20	160	-
16. Procure equipment for material handling and miscellaneous tools for cell component removal	20	160	-
17. Procure waste storage containers	10	80	-
18. Design and procure equipment and materials for contamination control envelope in XCR	10	80	-
19. Repair cell entry hatches	1	12	0.12
20. Replace HEPA and roughing filters	3	24	13.9
21. Design temporary storage facility	15	240	-
22. Prepare acid recovery system for use	Note B	454	Note B
23. Prepare liquid waste disposal system for use	Note A	Note A	Note A
24. Install high capacity monorail in XCR	2	168	0.084
25. Design and fabricate water lance for XC-1 special decontamination	1	16	-
Subtotal Pre-decontamination		<u>7614</u>	<u>16.2</u>

Note A: This information is part of WNYNSC Task 4.

Note B: The calculation is beyond the scope of this report.

TABLE I-3.2
ASSESSMENT E
DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE
XC-1 and XC-2

<u>Activity Description</u>	<u>Duration (days)</u>	<u>Manpower (manhours)</u>	<u>Exposure (manRem)</u>
1) Install high capacity monorail crane in extraction chemical room	2	168	0.1
2) Design and construct contamination control envelope in XCR	7	346	0.2
3) Install ancillary equipment for removal operation	7	276	0.1
4) Remove piping and components from XC-2 and package for storage	40	2126	40
5) Prepare for decontamination of walls, floors, and framework in XC-2	8	340	0.3
6) Decontaminate walls, floors, and framework in XC-2	50	3144	2.7
7) Paint surfaces and remove framework from XC-2 and package for storage	9	923	0.8
8) Core drill XC-1 from XC-2 and LWA	15	253	0.6
9) Prepare for decontamination of external surfaces in XC-1	2	20	1.4
10) Decontaminate XC-1 floor and tank 4D-2 from XC-2 and LWA	15	312	0.1
11) Perform final radiation survey of XC-2 and final clean-up	2	48	0.1
12) Close XC-2	3	70	0.1
13) Remove piping and components from XC-1 and package for storage	24	1213	4460

TABLE I-3.2
ASSESSMENT E
DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE

XC-1 and XC-2
(Continued)

<u>Activity Description</u>	<u>Duration</u> (days)	<u>Manpower</u> (manhours)	<u>Exposure</u> (manRem)
14) Prepare for decontamination of walls, floors, and framework in XC-1	8	474	23.3
15) Decontaminate walls, floors and framework in XC-1	39	2497	7
16) Paint surfaces and remove framework from XC-1 and package for storage	9	886	2.7
17) Perform final radiation survey and final clean-up of XC-1	2	48	0.1
18) Close XC-1	3	70	0.5
19) Remove contamination control envelope	10	280	1.1
20) Transfer all packaged equipment from previous removal activities to temporary storage facility		576	0.7
Subtotal XC-1 and XC-2	<u>NA*</u>	<u>14,070</u>	<u>4,541.9</u>

* The individual cell activity duration is dependent upon the critical path of all cell removal activities.

TABLE I-3.3
ASSESSMENT E
DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE
XC-3

<u>Activity Description</u>	<u>Duration</u> (days)	<u>Manpower</u> (manhours)	<u>Exposure</u> (manRem)
1) Install high capacity monorail in extraction chemical room	Included in Activities XC-2 and XC-1		
2) Design and construct contamination control envelope in XCR	Included in Activities XC-2 and XC-1		
3) Install ancillary equipment for removal operations	Included in Activities XC-2 and XC-1		
4) Remove piping and components from XC-3 and package for storage	37	1837	5.4
5) Prepare for decontamination of walls, floors, and framework in XC-3	8	340	0.1
6) Decontaminate walls, floors, and framework in XC-3	45	2824	1.5
7) Paint surfaces and remove framework from XC-3 and package for storage	9	905	0.4
8) Perform final radiation survey of XC-3 and final clean-up	2	48	0.1
9) Close XC-3	2	62	0.1
10) Transfer all packaged equipment from previous removal activities to temporary storage facility	Included in Activities XC-2 and XC-1		
Subtotal XC-3	<u>NA*</u>	<u>6016</u>	<u>7.6</u>

* The individual cell activity duration is dependent upon the critical path of all cell removal activities.

TABLE I-3.4

ASSESSMENT E

DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE

PPC

<u>Activity Description</u>		<u>Duration</u> (days)	<u>Manpower</u> (manhours)	<u>Exposure</u> (manRem)
1)	Install high capacity monorail in extraction chemical room	Included in Activities XC-2 and XC-1		
2)	Design and construct contamination control envelope in XCR	Included in Activities XC-2 and XC-1		
3)	Install ancillary equipment for removal operations	Included in Activities XC-2 and XC-1		
4)	Remove piping and components from PPC and package for storage	30	1634	2.9
5)	Prepare for decontamination of walls, floors, and framework in PPC	83	40	0.1
6)	Decontaminate walls, floors, and framework in PPC	46	2891	1.5
7)	Paint surfaces and remove framework from PPC and package for storage	9	909	0.1
8)	Perform final radiation survey of PPC and final clean-up	2	48	0.1
9)	Close PPC	2	62	0.1
10)	Transfer all packaged equipment from previous removal activities to temporary storage facility	Included in activities XC-2 and XC-3		
Subtotal PPC		<u>NA*</u>	<u>5,884</u>	<u>4.8</u>
Total Assessment E			<u>33,584</u>	<u>4,570.5</u>

* The individual cell activity duration is dependent upon the critical path of all cell removal activities.

APPENDIX J

PERT CHARTS

WEST VALLEY
PRE-DECOMMISSIONING
PERT NETWORK (APPLICABLE
TO ALL ASSESSMENTS)

TASK 1B

RECOMMENDATIONS TO FACILITATE DECONTAMINATION AND DECOMMISSIONING OF WASTE SOLIDIFICATION EQUIPMENT

A summary of recommendations and design guidelines to incorporate methods, facilities, and equipment for periodic decontamination and eventual decommissioning of a radioactive waste solidification system.

TABLE OF CONTENTS

1.	SUMMARY	1b- 3
2.	INTRODUCTION	1b- 4
3.	REFERENCE SOLIDIFICATION SYSTEM	1b- 6
3.1	Overall Process Description	1b- 6
3.1.1	The Waste	1b- 6
3.1.2	The Process	1b- 6
3.2	Reference Equipment	1b- 8
3.2.1	Sludge Separation	1b- 8
3.2.2	Supernate Decontamination	1b- 8
3.2.3	Solidification	1b- 9
4.	RECOMMENDATIONS TO FACILITATE DECONTAMINATION	1b-10
4.1	General Design Criteria	1b-10
4.1.1	Solidification Facility	1b-10
4.1.2	Solidification System Design	1b-17
4.2	Facility Design Recommendations	1b-23
4.2.1	Existing Equipment Usage	1b-23
4.2.2	Recommended Additional Equipment	1b-24
4.3	Process Component Design Considerations	1b-25
4.3.1	Centrifuges	1b-26
4.3.2	Polishing Filter	1b-26
4.3.3	Ion Exchangers	1b-28
4.3.4	Evaporators	1b-29
4.3.5	Calciner/Vitrification System	1b-29
5.	CONCLUSIONS	1b-30
6.	REFERENCES	1b-31

1. SUMMARY

This report contains recommendations and design guidelines to pre-engineer a high-level radioactive waste solidification system for periodic decontamination and eventual decommissioning. Generic and particular recommendations for the Western New York Nuclear Service Center proposed installation are presented.

The analysis of system design ranges from component selection, arrangement, operational and process detail, to material selection, surface preparation and system decontaminability. Activities and processes are identified to simplify system maintainability and eventual disposition.

It is recommended that the solidification system be designed for remote emplacement, hookup, operation, maintenance, replacement and periodic decontamination. Component design, fabrication and arrangement should be aimed at the prevention of the radionuclides settling, pocketing, absorbing, or migrating out of the process boundary. Components should be selected for their simplicity, decontaminability, long service life and facility compatibility. Fabrication materials should be resistant to corrosion and irradiation. Finally, the system design and installation should be pre-engineered to facilitate eventual disposition whether mothballed, entombed or dismantled.

2. INTRODUCTION

The Department of Energy (DOE) is currently considering the use of the Western New York Nuclear Service Center (WNYNSC) facilities for the processing of the high level liquid waste stored on-site to a solidified form. Burns and Roe (B&R) and Nuclear Energy Services (NES) were selected to develop design criteria and recommendations to facilitate decontamination and eventual decommissioning (D&D) for the solidification system proposed for use at WNYNSC.

The objective of this task is to develop D&D design criteria and recommendations based on an identified reference solidification system. The reference solidification process selected for analysis is the calcination/vitrification* case (b), developed in the E.R. Johnson Report (Ref. 1).* This process is only in a conceptual stage with design developed to a process diagram level.

A generic approach was taken in developing design recommendations using the conceptual design as a basis. The emphasis of this study, therefore, was placed on:

- A. Design recommendations for the solidification system and facility structure to increase the effectiveness of facility decontamination;
- B. Design recommendations for the solidification system to a component level to facilitate installation/removal, in-line servicing and periodic decontamination;
- C. Identify design considerations, for the generic equipment identified in the E.R. Johnson Report, for use in the generation of system specifications;
- D. Provide guidelines on component selection, arrangement and acceptability from a D&D vantage point for a system designer.

* Calcination is a process to solidify liquid by vaporizing all volatile constituents. Vitrification is the process for melting the calcined solids with glass forming additives.

The following sections of this report describe in detail the approach, justification and conclusions reached. Design guidelines and recommendations are tabulated for quick reference. This table in conjunction with the conclusions section summarize the recommendations and can be used as a facility design guide.

3. REFERENCE SOLIDIFICATION PROCESS

Solidification of the high level waste, presently stored at the West Valley Facility, is essential to the future protection of the public and environment. Solidification places the emphasis of radionuclide containment on the waste form and not its container. The container provides an additional barrier to the biosphere and reduces the reliance on the need for perpetual care by future generations. The reference solidification process selected for analysis is described below. In brief, the waste product has low leachability, minimum volume and provides a high degree of protection to the public during its handling, shipping and final emplacement. The reference vitrification system is to be designed to use pretreatment and concentration to minimize the volume of high level waste to be encapsulated.

3.1 OVERALL PROCESS DESCRIPTION

3.1.1 The Waste

The high level liquid waste is located in two underground tanks at the West Valley Facility. Tank 8D2 contains approximately 560,000 gallons of neutralized waste, produced from spent fuel reprocessing operations. Neutralization of this waste has caused the majority of fission product elements to precipitate and form a sludge on the tank bottom. The supernate occupies the remainder of the tank volume.

Tank 8D4 contains approximately 12,000 gallons of waste from reprocessing of a small quantity of spent thorium-uranium fuel. The waste was not neutralized and little sludge is expected.

3.1.2 The Process

The reference process begins with an homogenization of waste tank 8D2 contents for transport to the processing facility. Sludge-supernate separation follows and is the major process step prior to waste solidification. Tl

FIGURE 1
REFERENCE PROCESS FOR VITRIFICATION

Notes

1. Supplemental ion exchanger may be required for isotopes not removed by primary resin columns.
2. Process could be performed by an evaporator/crystallizer.

separation will concentrate a large majority of the highly radioactive nuclides with the sludge and significantly reduce the volume of high level radioactive waste requiring vitrification and disposal. The supernate, the less active constituent, will be decontaminated by evaporation and demineralization to a level where it can be disposed of by solidification in concrete or other appropriate binders, as low level waste. The concentrated radioactive fraction from tank 8D2 will be combined with the contents of tank 8D4. This waste will then be converted to a borosilicate glass by a calcining and vitrification system. The entire process is illustrated in Figure 1.

3.2 REFERENCE EQUIPMENT

3.2.1 Sludge Separation

Homogenized waste from 8D2 will be transferred to a tank inside the solidification facility. This tank will serve as a storage and feed tank for the centrifuge system. A two stage centrifuge process will yield a high degree of supernate separation. Initial sludge-supernate separation will be through a continuous horizontal, rotating bowl machine. Secondary separation, with a solids disc centrifuge, will process material passing through first stage separation. Sludge, particulates and other insolubles are routed back to the mixing/vitrification feed tank.

Following centrifugation and prior to demineralization, the supernate is routed through a polishing filter for additional particulate removal. The supernate then undergoes additional treatment by an ion exchange system.

3.2.2 Supernate Decontamination

The supernate is processed through an ion exchange system to remove cesium, strontium and soluble actinides. After resin beds are regenerated, the chemical wash and rinse water is concentrated in an evaporator with the bottoms being routed to the vitrification feed tank.

Following demineralization, the supernate will undergo a two stage evaporation process. The supernate is initially processed in a waste evaporator and the bottoms are further concentrated by a wiped film evaporator.

Concentrated solids are discharged from the evaporators to waste liners for solidification or allowed to cool and are stored as a salt cake. Condensate from the evaporators can be recycled for use as rinse, sluice and flush water in the immobilization system.

3.2.3 Solidification

Sludge, particulates and evaporator bottoms removed by the concentration and volume reduction processes described in paragraphs 3.2.1 and 3.2.2 are routed to the mixing/vitrification feed tank. In this tank concentrated 8D2 waste can be mixed with waste from tank 8D4 prior to calcination and vitrification. The waste from 8D4 has either been pumped in directly from the tank farm or routed through an intermediary storage vessel, located in the solidification facility.

From the feed tank, the waste is fed to a spray calciner. The liquid waste is introduced to the calciner through a pneumatic atomizing nozzle. As it falls through the calciner unit, the atomized waste sequentially undergoes ion drying and calcination at the 700° C temperature produced in the unit. Calcined waste is mixed with a glass forming frit during its drop through the unit to a waste canister. This particular vitrification system uses an in-can melter where the waste canister acts as the melting crucible. The canister is heated by a multizone furnace, melting the calcine-frit mixture to form a borosilicate glass. When filled, the canister is removed from the unit, sealed, decontaminated and transferred to an interim storage area.

4. RECOMMENDATIONS TO FACILITATE DECONTAMINATION

The design of the equipment used in solidification and the supporting structures should facilitate system decontamination during and upon completion of operation. The system should be modularized to the maximum extent with components, their support piping and instrumentation mounted on free standing skids. Skids should be self-contained with centralized service and power connections for remote hookup. Interconnecting piping, not skid supported, should be minimized. This will decrease the need for personnel entry into the cells during system installation/removal and will facilitate equipment maintenance and repair during plant operation and following equipment malfunctions.

Table 1 lists a summary of design features recommended to facilitate operation, maintenance, decontamination and decommissioning of structures and components described in the E.R. Johnson Report. Elaboration of Table 1 and associated logic is presented in the following chapter.

4.1 GENERAL DESIGN CRITERIA

4.1.1 Solidification Facility

4.1.1.1 Cell Surface Preparation

The design of the facility, in general, should reflect and incorporate features to simplify its final disposition. Concrete surfaces should be covered with a strippable coating providing an expedient means of removing surface contamination and returning walls, floors, etc., to their pre-solidification state. Rough surfaces should be eliminated by the use of sealers, coatings and, in the case of metal surfaces, by polishing. Floors should be sloped for the collection of spills, leakage and equipment drainage.

TABLE 1
FEATURES TO FACILITATE OPERATION, MAINTENANCE,
DECONTAMINATION AND DECOMMISSIONING

<u>Item</u>	<u>Recommended Features</u>
Equipment Cells	<ol style="list-style-type: none"> 1) Use of sealers and strippable coatings to aid in contamination removal 2) Sloped surfaces for complete drainage 3) Treatment system for cell drainage 4) Accessibility for remote radiation monitoring and visual inspections 5) Spray headers providing complete cell coverage and hose connections for high pressure water and/or steam hookup 6) Adequate lighting for visual operations and inspection
Storage and Feed Tanks	<ol style="list-style-type: none"> 1) Skid mounted with associated piping and instrumentation for remote installation 2) Tank and skid orientated for maximum visibility and maintenance access 3) Centralized service and power hookups designed for remote connection 4) Conical tank bottoms to inhibit sludge accumulation and bottom outlet for complete drainage 5) Internal spray headers for tank decontamination, or flange entry ports sized to permit entry of a portable water lance 6) Tank heaters to prevent waste precipitation and to heat decontaminating solutions 7) High level alarm and actuation signal for inlet valve closure 8) Level and temperature indication with remote readout

TABLE 1
(CONTINUED)

- 9) Recirculation or mixing means for waste homogenization
- 10) Sample taps
- 11) Overflow and drain lines routed to cell drain system
- 12) Attachment and rigging points for installation and removal
- 13) Material selection compatible with decontaminating solutions
- 14) Tank vents routed to cell off-gas treatment system

Process Vessels

- 1) Designed for remote installation and maintenance with attachment points and appropriate guide pins, locating and hookup devices
- 2) Fill and drain connections for decontaminating solutions
- 3) Long life materials for intended service and operating duration

Centrifuges

- 1) Sluice discharge to receiving vessel
- 2) Locate for gravity discharge
- 3) Flushing connection for vessel and piping back to feed tank
- 4) Access for remote servicing and/or replacement

Filter

- 1) Access for servicing and/or replacement of filter elements
- 2) Provisions for final disposition of filter elements
- 3) Remote readout of process indicators, e.g. press differential across filter

TABLE 1
(CONTINUED)

Demineralizers

- 1) Redundant ion exchange systems for continuous processing capability
- 2) Regenerative resin bed
- 3) Resin selection for maximum fission product and actinide removal
- 4) Means of remote resin disposition and possible replacement
- 5) Remote readout of process indicators

Evaporators

- 1) High alloy steel construction for use in concentrating decontaminating acids
- 2) Cross connections between evaporator systems for process redundancy
- 3) Access for all process evaporators to the vitrification unit
- 4) Heat tracing of all lines containing evaporator concentrates

Piping

- 1) End connections for remote installation and disassembly
- 2) Direct runs, sloped, with large diameter bends and free from traps or dead legs
- 3) Smooth internal surfaces, free from cracks, crevices and other crud collection points
- 4) Material resistant to process and decontaminating solution chemistries
- 5) Tees and branch connections designed for hookup of a portable decontamination system

TABLE 1
(CONTINUED)

Valves	<ol style="list-style-type: none"> 1) Material grade equivalent to the piping 2) No crud traps in the valve body, seat or around seals 3) Ball and plug valves should be full ported 4) Override feature on check valves to permit backflushing of lines 5) Swing away ball valves can be maintained without removal from piping 6) Ram type valves in sample and waste lines will prevent crud pockets from forming 7) Actuated tank inlet and outlet valves should close upon loss of electrical power or air supply 8) Process valves should "fail as is" upon actuator power or air loss to enable processing to continue 9) Provisions for remote replacement
Pumps	<ol style="list-style-type: none"> 1) Unitized construction for remote installation or removal 2) Remote power connections 3) Polished surfaces throughout pressure boundary 4) Lifting lugs and/or attachment points with necessary guide pins to ease remote positioning 5) Radiation resistant pump seals and motor
Instruments	<ol style="list-style-type: none"> 1) Remote readout and calibration 2) Flushing connections where applicable 3) Connectors for remote installation which provide isolation of the process stream when disengaged 4) Radiation resistant

TABLE 1
(CONTINUED)

Electrical

- 1) In-cell cables replaceable by remote manipulators
- 2) Cables and connections shielded from in-cell sprays
- 3) Radiation resistant insulation and cable materials

Calciner/Vitrification
Unit

- 1) Modularized for selective inservice maintenance
- 2) Centralized power and service hookup
- 3) Physical and visual access for frequently maintained components
- 4) Components with high failure probability designed for remote removal and installation
- 5) Remote decontamination capability upon unit failure during processing

4.1.1.2 Facility Decontamination Features

The facility should have a steam/water supply and should be equipped with spray headers and hose connections for the remote attachment of a high pressure water lance. Wall and ceiling mounted spray headers should be positioned for complete cell coverage and maximum exposure to process equipment.

Drainage should be collected in a cell floor drain system which can be isolated from the rest of the facility and tied into a decontamination solvent recycling system. This will provide administrative control during system drainage, flushing and decontamination. The effluent could be sampled, a treatment process selected, and the routing established. Cross-connects should be available to enable processing of decontamination wastes by solidification equipment, e.g., use of the thin film evaporator for volume reduction.

4.1.1.3 Radiation Monitoring

Designated areas should be pre-selected for radiation monitoring during and upon completion of the solidification operation. These areas should be chosen for their field of view, i.e., a location receiving data representative of actual cell conditions. The possibility of using remote manipulators to perform radiation surveys should be considered.

Process monitors, in or off-line, and sampling station monitors should have piping connections for flushing back to the process line take-off. Upon completion of system operation, these monitoring facilities will provide an indication of progress during final decontamination and decommissioning.

4.1.1.4 Visual Accessibility

The design and arrangement of the solidification system should be conducive to visual monitoring either by use of shielded windows, periscopes, mirrors or remote CCTV cameras. Cameras should have a zoom lens and features including remote operated pan and tilt. If cell lighting is inadequate for visual monitoring, supplemental fixtures should be installed. For increased mobility, cameras and/or lights can be mounted on the bridge of the overhead cranes or power manipulators.

4.1.2 Solidification System Design

4.1.2.1 Equipment Location

Equipment location should be a function of accessibility and maintenance needs. In addition to installation access, component location and orientation from an operational and decontamination standpoint is also important. Equipment should be orientated for maximum access to high maintenance components and service hookups, and for maximum visibility. Systems should be segregated by process stage, process activity and component failure probability when possible. If a multi-cell arrangement is used, this segregation could simplify maintenance and even permit operation or repairs by personnel on the radiologically "colder" sections of the system.

4.1.2.2 Material Selection

Radioactive piping will require periodic decontamination and should be fabricated of materials resistant to decontaminating solutions as well as the process solution. Use of carbon steel

should be avoided unless it is lined or coated. Stainless steel and high nickel alloys, on the other hand, offer good chemical resistance without the use of surface coatings. Standard decontamination solutions are listed in Table 2. This table should be consulted during material selection.

In general, a good basic construction material is 304L stainless steel. It has good corrosion resistance and good resistance to stress-corrosion cracking. 304L is cost effective with good fatigue properties and good strength. For components and equipment requiring better corrosion resistance, materials such as 316 and 316L stainless steel are commercially available. In extreme conditions special materials may be required. Nickel based alloys (i.e., Hastelloy, Inconel, or Incoloy) are best suited for these applications.

Radiation resistance can be as important as chemical resistance. This is an important consideration when selecting non-metallic material for use in high radiation fields. Certain materials e.g., teflon, will degrade under these conditions and should not be used for pump and valve seals. Electrical motors and valve operators should be designed to the maximum radiation field expected.

4.1.2.3 Material Surface Finish

All "wetted" surfaces should be free from cracks, crevices and other irregularities which tend to collect contaminants. Polished surfaces are easier to decontaminate. Electropolishing will produce a smooth, polished surface on a variety of metals regardless of surface or component geometry. This process is fast, usually 5 to 30 minutes is sufficient, and is extremely effective on complex structures, threaded sections and interior surfaces. Polishing of process surfaces prior to system startup will increase the decontaminability of the system and reduce the manhours and personnel exposure needed to decontaminate the system during decommissioning.

TABLE 2
NONDESTRUCTIVE DECONTAMINATION SOLUTIONS ⁽¹⁾

<u>Decontaminate</u>	<u>Chemical Composition</u>	<u>Remarks</u>
Alkaline Permanganate	NaOH; KMnO_4	Used in multi-step decontamination programs to oxidize chromium in the corrosion film for subsequent dissolution by an alkaline solution and to expose the remaining corrosion film for chemical dissolution. AP is non-corrosive to stainless steel and mildly corrosive to carbon steel.
Sulfamic Acid	$\text{NH}_2\text{SO}_3\text{H}$	Sulfamic acid with an inhibitor is an effective decontaminant for carbon steel with good DF's and low corrosion rate.
Nitric Acid	HNO_3	An oxidizing agent used for dissolving uranium, plutonium and their oxides, fission products, sludge deposits and residual contamination. Potassium Permanganate (KMnO_4) can be added for a more effective decontamination. Nitric acid is highly corrosive to carbon steel.
Oxalate Peroxide	$\text{Na}_2\text{C}_2\text{O}_4$; $\text{H}_2\text{C}_2\text{O}_4$ H_2O_2 ; Peracetic Acid; Oxine	Used for dissolution of uranium and plutonium films and decontamination of metals. Non-corrosive to 300 series stainless steel, inconel, zirconium and aluminum.

1. Decontaminants were limited to only those dissolving the contamination film covering the base metal and not the base metal so as to maintain system integrity for continued operation.
2. DF - Decontamination Factor is the ratio of original level of radioactivity to the level remaining after decontamination.

4.1.2.4 Piping

Process piping should be run as direct as possible within the solidification system and be free of "dead legs" and "crud traps". Large radius bends should be standard practice on running "waste lines" i.e., piping containing radioactive concentrates and solidifying agents. Waste lines should be butt welded, with highly finished internal surfaces and be heat traced, where necessary, to keep the concentrates in solution. Process lines should be completely flushable between components either by the installation of "piping tees" for connection to a flushing system or by use of the system's "low point drains" for such hookups.

Process piping should slope to or from the point of origin. Service piping originating from outside the cell should be sloped toward the process system to assure free drainage. Block and check valves should be used to prevent backflow. Where service piping is a closed system (e.g., steam supply to the evaporator heater) the service system return lines should be monitored as a check for process/service boundary leakage, and isolation capability provided.

Piping should be fabricated for remote installation. Quick disconnects, flanges and single bolt connectors (pipe jumpers such as the Hanford type remote jumpers) should be an integral part of the piping system. Arrangement of remote connectors should allow piping and component removal with minimum system disruption.

4.1.2.5 Sampling

Samples should be obtained from a process component while in a recirculation or mixing mode. This will give representative sample of the component contents. For frequent sampling, a lir

can be run back to a shielded, ventilated lab hood for analysis. Sample taps should utilize "ram" type valves so as not to create crud pockets in the process piping. Sample runs should be completely flushable. This remote sampling capability will enable monitoring of the solidification system during decontamination operations.

If grab sampling is desired, all operations and procedures should be developed to match the capabilities of the remote manipulators. A pneumatic transfer system can be used for rapid transport of the sample bomb to the analyzing facility.

4.1.2.6 Feed, Storage and Process Components

The solidification system has a large number of feed, storage and process vessels (i.e., filters, demineralizers, evaporators, etc.). Vessels should be constructed from material compatible with the decontaminating solvents as well as the process fluid.

Vessels should have highly polished, sloped internal surfaces, free of crevices and wells where crud can collect. Feed and storage tanks should have sample connections on their recirculation lines for obtaining homogeneous sample content, while components without recirculation capability should have sample taps on the discharge piping. Feed and storage tanks should be designed with internal high pressure (10,000 psi) spray nozzles close to the tank walls for periodic decontamination or have flanged entry ports for entry of a high pressure water lance. Process vessels may have to be decontaminated by fill and drain type operation through "piping tees". Component drains should be routed to a controlled drain header for analysis and treatment, recycling, and/or disposal.

All process and storage vessels should have rigging attachment points and, if need be, guide pins for remote installation and

maintenance. When several components are mounted on a skid, access should be maintained for replacement and repair. All piping, pumps and instrumentation requiring servicing should be remotely removable.

Vessel vents should be routed to the equipment ventilation system. Tank overflows should be prevented by automatic closure of the inlet valve on a high-tank level signal. External service connections, heaters, insulation and instrumentation should be jacketed for spray protection.

4.1.2.7 Pumps and Valves

Pumps should be designed for easy removal from the process system. Pump seals should be chemical and radiation resistant. Pump flushing should be done through a body connection, a seal water connection, or through the process line. To facilitate decontamination, all internal pressure boundary surfaces should be machined or electropolished to a high polished finish.

Valving should be minimized in the solidification system. Valves required for proper system operation should be selected for their reliability and maintainability. Self cleaning "ram type" valves and full ported valves should keep the process lines free of crud traps. Valve seals and/or packing should not utilize materials which degrade in high radiation fields. Valve parts not in contact with the process fluid should be of equal material grade as "wetted" valve parts. All unidirectional valves should be designed to be overridden to permit backflushing of lines.

4.1.2.8 Electrical and Instrumentation Design

Service and instrument connections should be designed for quick assembly and disassembly using the remote manipulators. Instrumentation, power cables, transmitters, etc., should be resistant to

cell spray solutions, functional in high radiation fields and be completely serviceable by in-cell manipulators. Instrument calibration should be possible from outside the cell.

4.1.2.9 Solidification Package

The major components of the solidification system, with a high probability of failure or short operating life, should be accessible for remote replacement and maintenance without dismantling of the parent unit. The system should have modularized service and power connections for remote hookup. Removal of the vitrified waste containers should be possible without furnace dismantling.

4.2 FACILITY DESIGN RECOMMENDATIONS

4.2.1 Existing Equipment Usage

The E.R. Johnson proposals were based upon the maximum incorporation of existing equipment. However, consideration should be given to completely removing all cell equipment, decontaminating the walls and floors, and installing an immobilization system fabricated from all new components.

The advantages of this approach are as follows:

- A. Complete removal of existing equipment could simplify cell decontamination procedures, saving time and limiting personnel exposure;
- B. Preoperational radiation levels in the cells would be lower;
- C. Reliability of existing equipment is uncertain if returned to service. The effects of corrosion and fatigue from past operation and from chemicals, used in system decontamination, could result in catastrophic failure under load conditions;

- D. Failure of existing equipment during solidification would adversely affect the ability to decontaminate the overall system, force process stoppage, produce delays during cleanup and repair, and increase cell radiation levels at completion of the operation;
- E. New equipment could be pre-engineered and fabricated for ease of decontamination;
- F. Process piping design could be simplified;
- G. With the short solidification duration, a totally new system should reduce maintenance needs;
- H. A new system could be preassembled prior to installation for testing, trial operation and developing installation procedures;
- I. A new system could be designed and engineered within the general design criteria which may not be possible for a hybrid system.

4.2.2 Recommended Additional Equipment

4.2.2.1 Decontamination Equipment

Decontamination equipment should be included in the initial design and layout of the solidification facility. A central decontamination area with solution tanks, pumps, filters, chemical storage and portable cleaning equipment should be available to support and maintain the overall operability of the system.

In addition, soak, ultrasonic and electropolishing cleaning tanks installed in the Equipment Decontamination Room could be used for decontaminating small tools and components during operation. This would permit quick, local maintenance and reduce the need for large inventories of replacement parts.

4.2.2.2 Waste Compactor

Decontamination and general maintenance on the solidification system can generate large quantities of compactible waste, e.g., cloth, paper and crushable filters. The facility should have a waste compactor for packaging of such waste in a suitable container (e.g., a 55 gallon drum) for shipment and burial.

4.2.2.3 Auxiliary Solidification System

Spent resins and filter cartridges should be solidified prior to shipment from the facility. This could be performed by resin dissolution - calcination/vitrification and by filter compaction. However, an alternative means of solidification using cement could be more adaptable to the facility.

A small portable unit could be installed for resin and filter solidification. The availability of a cement system would complement the vitrification unit and would permit more versatility in waste disposal.

4.3 PROCESS COMPONENT DESIGN CONSIDERATIONS

Process equipment should be selected for design simplicity, reliability and operational maintainability. Continuous processing will necessitate redundancy in process components to permit their selective removal from service for maintenance or repair. While collection and feed tanks, and processing and mixing pumps can be specified to the general design criteria, processing components are actively engaged with the process fluid (e.g., filtration or demineralization). These components directly affect the overall system design, configuration and general arrangement. Sludge-supernate separation and supernate decontamination involve a number of process components which should be designed specifically for the solidification system and facility.

4.3.1 Centrifuges

Sludge-supernate separation can be accomplished through two centrifuges in series. Initial separation utilizes a continuous horizontal rotating bowl machine, followed by a solids handling disc centrifuge for finer separation. Centrifuged sludge is then returned to the feed tank while the supernate undergoes further clarification. Of the two E.R. Johnson proposals for sludge return, flush transfer appears more desirable than mechanical return, i.e., screw conveyors.

Screw conveyors perform best in short, direct, horizontal runs, but encounter problems with elevation changes, non-linear configurations and long transport lengths. Excessive flushing of the conveyor would be counterproductive to sludge concentration by the centrifuges. Also, the drive motor will require periodic maintenance and should be located for easy access.

Sludge sluicing, however, can be performed with small quantities of recycled waste water if the return line is sloped or ideally "dropped" back to the feed tank. The piping could be decontaminated through a sluice water feed connection.

4.3.2 Polishing Filter

Supernate separation is followed by filtration and three alternative methods are available: 1) a precoat; 2) cartridge; or 3) a backflushable type filter. The benefits gained by supernate filtration should be weighed against the potential problems of periodic maintenance and eventually final disposition of the active filtering components and/or filter. Filtration should be used only if a significant DF can be obtained.

4.3.2.1 Precoat

The precoat filter requires a continuous feed of precoat material during operation to encapsulate process particulates. This will require additional tankage and transfer equipment from the precoat delivery system to the filter vessel. In the case of a redundant filtering system, the precoat delivery trains should be separate and independent. This will allow continued processing by the backup filter when the primary filter goes off-line for discharge. A predetermined precoat "buildup" depth /on the filtering elements and/or pressure drop across the filter will signal the need for vessel discharge.

The precoat filter vessel is usually designed for direct "gravity" discharge to the solidification feed tank. This arrangement may not be feasible and will certainly restrict the West Valley system arrangement. Also, the use of precoat material for filtration will increase the amount of sludge material to be solidified. For this filtration application, the precoat filter is least desirable.

4.3.2.2 Cartridge

Cartridge filters provide an efficient means of particulate collection and retention. Remote removal and disposition of the cartridge could be a major drawback despite the system's simplicity. In a high radiation area the filter vessel should be designed for remote disassembly for cartridge discharge. The cartridges will require remote handling, transfer to a waste liner and possibly solidification for cartridge disposal.

4.3.2.3 Backflushable

Backflushable filters, such as the etched disc, offer the benefits of a cartridge type without the handling and disposal problems. The one drawback of the backflushable filter is in its method of renewal, i.e., filtered particulates are carried back to the feed tank by a reverse flow (flush) through the filter. Flush volume can be minimized using a liquid/gas or gas for transport. This type of filter provides a compact, simplistic means of supernate filtration.

Periodic decontamination of the filter can be performed with a connection into the flush system, whereas the cartridge and precoat filter vessels require a fill and drain type decontamination. This enables the backflushable filter to be brought back on line faster than either of the other filtration systems. With these system and operational features, the backflushable filter system is the most easily adaptable to the proposed reference West Valley solidification system.

4.3.3 Ion Exchanges

The regenerative ion exchangers may require periodic bed changes, or may last the duration of the solidification process. Resin replacement should not be as much of a problem as the eventual problem of resin disposition. While resin dissolution is suggested in the Johnson Report as a means of creating a solution acceptable for calcining and vitrification, the use of acids for dissolution could damage pump seals, valve packings and attack susceptible metals.

As an alternative, the resins could be sluiced from the vessels using recycled waste water to a liner for solidification by an auxiliary system (i.e.,

cement-additive agent could be used for resin solidification). However, if the installation of an auxiliary solidification system, in concurrence with the vitrification unit, is unacceptable, the treatment of resins for vitrification should be further investigated.

4.3.4 Evaporators

Special care should be taken to eliminate all possible crud traps in lines and vessels containing evaporator concentrates. Heat tracing and heaters should be used on lines and vessels respectively to prevent concentrate precipitation.

Evaporator vapor bodies, heaters and condensers should be constructed of high alloy material for long life and chemical resistance. The wiped film evaporator, for example, could be very effective in reducing decontamination waste volumes during final decontamination and decommissioning.

4.3.5 Calcine/Vitrification System

Section 4.1.2.9 outlines general design criteria for the solidification unit. Calcine/vitrification units, like the one developed at Battelle Northwest Laboratories (Ref. 2), are designed for remote servicing and decontamination. However, design considerations should extend beyond the main unit to the auxiliary and interfacing systems. An extensive subsystem, for example, is the calcine off-gas system.

An off-gas system is typically comprised of a series of condensers, scrubbers and filters. These components should be specified and selected to meet the design criteria developed for process vessels. Piping taps, equipment connections, internal spray headers and/or access ports necessary for in-line decontamination should be incorporated in their design.

5. CONCLUSIONS

The Johnson Report was used to develop design criteria for the proposed West Valley solidification facility. The recommendations are intended to facilitate decontamination and decommissioning of the solidification system and surrounding structure and are generic in nature. When the solidification system is designed, these recommendations should be weighed along with the operational and maintenance design considerations, and incorporated as applicable.

The solidification system should be designed for remote installation/removal, inservice maintenance and periodic decontamination. Component design, fabrication and arrangement should prevent radionuclides from settling, pocketing, absorbing or migrating out of the process boundary. Components should be remotely serviceable. Materials selected for the system should be chemically resistant to periodic decontaminating acid flushes. Piping taps, drains and access ports should be incorporated into component design to allow hookup of the flushing system. Internal surfaces should be electrochemically or mechanically polished to facilitate cleaning. The flow path should be free of pockets and dead legs where radioactive contamination could collect. Piping should be run direct, using slope, large radius bends and smooth internal surfaces to prevent crud accumulation. Piping requiring removal during component maintenance should be designed for remote disassembly.

The facility should be well lighted, with remote cameras, viewing windows, mirrors and periscopes available, to insure complete visual accessibility. Floors should be sloped for complete drainage with liners and coatings used on all surfaces to aid in contamination removal. Spray headers or connections for such should be available for periodic washdown of walls and ceilings. Most importantly, the facility should be designed to contain and treat contamination from normal calcining/vitrification operation and unexpected system /component failure.

A system designed for inservice decontamination will reduce the risk of exposure during maintenance and servicing. Periodic decontamination during the solidification campaign will reduce operational exposures and facilitate final facility decommissioning.

6. REFERENCES

1. "Final Report; Task 2: Alternative Waste Management Options, Nuclear Fuel Services, Inc., High Level Waste," prepared by E.R. Johnson Associates, Inc., for Argonne National Laboratory, 10 May 1978.
2. D.H. Siemens and W.F. Bonner: "Design Features of a Full-Scale High-Level Waste Vitrification System," Battelle Pacific Northwest Laboratories, 1976.

TASK 1C

STUDY OF POSTIMMOBILIZATION DISPOSITION

An assessment of methods for decontaminating the cells and solidification equipment, to varying degrees, considering projected facility disposition alternatives.

TABLE OF CONTENTS

1.	SUMMARY	1c- 3
2.	INTRODUCTION	1c- 4
3.	DESCRIPTION OF ASSESSMENTS	1c- 6
3.1	Decontamination to Pre-solidification Levels Assessment A	1c- 6
3.2	Decontamination for Entombment Assessment B	1c- 7
3.3	Decontamination for Dismantlement Assessment C	1c- 8
4.	STATUS OF FACILITY	1c- 9
4.1	Configuration of Equipment and Structures	1c- 9
4.2	Equipment and Structure Radiation Levels	1c-10
5.	TECHNICAL APPROACH	1c-11
5.1	Generic Activities	1c-11
5.2	Estimation of Costs	1c-18
5.3	Schedule	1c-19
5.4	Manpower Estimates	1c-20
5.5	Occupational Exposure	1c-21
5.6	Waste Volume Generated	1c-22
6.	ASSESSMENT SUMMARY	1c-24
6.1	Assessment Results	1c-24
6.2	Discussion of Results	1c-24
7.	REFERENCES	1c-27

TABLES

5.1	Summary of Decontamination Factors	1c-12
6.1	Assessment Summary	1c-26

APPENDICES

A	Solidification System Equipment List
B	Materials Handling
C	Cost Factors
D	Assessment A - Costs, Durations, Manpower, and Exposure
E	Assessment B - Costs, Durations, Manpower, and Exposure
F	Assessment C - Costs, Durations, Manpower, and Exposure

STUDY OF POSTIMMOBILIZATION DISPOSITION

I. SUMMARY

This report presents the results of a technical assessment for postimmobilization disposition of solidification equipment and facilities to be used at the Western New York Nuclear Service Center (WNYNSC). The purpose of the assessment is to quantify the decision parameters needed to select a method for disposition of the solidification facility upon completion of the solidification campaign.

The assessment is based on a reference solidification process using calcination and vitrification, currently being developed for use at WNYNSC. The system is proposed for installation in the Chemical Process Cell (CPC), and will utilize the Off Gas Treatment and Acid Recovery Building Systems.

The assessment evaluated three disposition alternatives including decontamination to: (1) levels existing at the onset of solidification, (2) levels suitable for entombment and entombing, and, (3) levels suitable for uncontrolled access. Each alternative identified the activities, estimated cost, occupational exposure, duration, manpower, waste volume and final cell radiation levels achieved with the decontamination method.

All decontamination and equipment removal methods will utilize appropriate shielding, remote manipulators and cranes to the maximum extent possible to achieve As Low As Reasonably Achievable (ALARA) radiation exposure. The solidification system was assumed to be designed to facilitate decontamination and removal. This would include fittings for internal chemical decontamination installed during fabrication, and all components skid-mounted for simplified modular removal.

The results for the important parameters of each assessment are summarized below. The overall calendar schedule for any assessment does not exceed 1.8 years.

<u>Assessment</u>	<u>Cost, \$</u>	<u>Exposure, ManRem</u>
A	6,732,400	120.4
B	4,255,000	104.1
C	7,243,400	135.8

2. INTRODUCTION

The United States Department of Energy (DOE) selected Burns and Roe (B&R) and Nuclear Energy Services (NES) to prepare a technical assessment of alternatives for decontamination of equipment and structures proposed for solidification of high level liquid wastes at the Western New York Nuclear Service Center (WNYNSC). The objective of this assessment has been to provide estimates of costs, schedule and occupational exposure to prepare the solidification equipment and cells for ultimate disposition upon completion of the solidification campaign.

The assessment is based on the reference solidification process identified in the E. R. Johnson Report (Reference 1) as the calcination/vitrification case (b). This process is being developed by Pacific Northwest Laboratory (PNL) and Vitro Engineering Corporation for the DOE, and is only in a preconceptual stage with design developed to a process diagram level. As currently proposed, the solidification process will be installed in the Chemical Process Cell (CPC) after the fuel reprocessing equipment has been removed and the cell structure decontaminated (Reference 2). The recently installed fuel reprocessing Off-Gas Treatment and Acid Recovery Building will be utilized during the solidification campaign. Other service cells and facilities will be utilized as needed such as the Equipment Decontamination Room (EDR) and Chemical Crane Room (CCR). The solidification system equipment and cell facilities were assumed to have been designed in accordance with the NES design recommendations to facilitate decontamination and decommissioning as presented in Reference 3. These include skid mounting the equipment and incorporating decontamination spray nozzles and connections to simplify remote decontamination.

Three approaches to the decontamination of the equipment and cells were assessed. Each assessment included the definition of the specific activities required to decontaminate the cell and the solidification equipment. These activities were used to develop the estimates of cost, schedule, and occupational exposure. Ultimate disposition of the cells is to be addressed at a later date in conjunction with the future disposition of WNYNSC. The three disposition alternatives are:

Assessment A

Decontamination to radioactivity levels existing at the onset of the solidification campaign.

Assessment B

Decontamination to radioactivity levels suitable for entombment and execution of the entombment activity.

Assessment C

Decontamination to radioactivity levels suitable for uncontrolled access.

The scope of each assessment included: establishment of basic assumptions, development of a detailed list of activities required to achieve the end product, determination of existing radiation levels within each cell, estimates of the manpower required to perform the activities, preparation of a cost estimate, determination of the occupational exposure, estimation of the final radiation and estimation of the waste volumes generated. The performance of the assessments was hindered by the lack of detailed information (component sizes, arrangement, piping lengths, etc.) and radiation survey data for the equipment and cells. Assumptions were made based upon the limited physical data available and expected radiation levels of the liquid wastes to be solidified. It will be necessary to verify these assumptions upon completion of the general arrangement drawings of the process, and upon receipt of any radiation data from similar facilities.

The following sections of this report describe in greater detail each assessment performed, the expected status of the solidification equipment upon termination of solidification, the end product status of the cell, the assessment results, and conclusion and recommendations. Appendices present detailed information in support of the methods and assumptions in the main text of the report.

3. DESCRIPTION OF ASSESSMENTS

This section describes each of the three decontamination assessments addressed in this study and identifies the end product.

3.1 DECONTAMINATION TO PRE-SOLIDIFICATION LEVELS - ASSESSMENT A

This assessment is based on remote decontamination and removal of solidification equipment followed by remote decontamination of cell internal walls and floors to the levels that existed at the onset of solidification. The skid mounted equipment will be removed and remotely packaged in the EDR for transportation to a waste disposal facility.

The remote decontamination techniques considered in this assessment consist of dry vacuuming of equipment, floors and walls, followed by high pressure aqueous chemical spraying (water lances) of equipment and structures with wet vacuuming of cell walls and floors (wet to pick up spray effluent), and chemical decontamination of component internals. Surface sprays will be performed in the CPC with water lances on the power manipulators. Vacuums will also be adapted for use with cell power manipulators. Remote-operated rotating wet scrub brushes will be used to remove adhering surface decontamination.

Decontaminated solidification system skid-mounted equipment will be removed using the CPC and EDR cranes and manipulators assisted by air tools and plasma torches as necessary. All necessary special handling tooling and lifting devices were assumed to have been incorporated into the skid mounted design, including pipe jumpers, electrical connections, and mounting bolts. A final high pressure spray decontamination of the cell internal walls and floors was assumed to follow removal of the solidification system components.

The Off-Gas Treatment (OGT) Cell and Acid Recovery Cell (ARC) in the Acid Recovery Building are not designed for remote equipment removal. Accordingly for this assessment, all components were acid flushed internally from the

Extraction Chemical Room (XCR) by routing the chemicals through the existing flow paths. Following internal and external surface decontamination, the individual components were manually removed and packaged for shipping and burial.

The end product for this assessment is a completely empty CPC, ARC, and OGT Cell with all walls and floors decontaminated to levels existing at the onset of solidification (Ref. 2) and the OGT Ventilation plenum to 2 mR/hr.

3.2 DECONTAMINATION FOR ENTOMBMENT - ASSESSMENT B

This assessment is based on remote decontamination of cell equipment followed by entombment of the equipment within the cell boundary. The equipment and cell surfaces should be decontaminated promptly upon termination of solidification to remove surface contamination and reduce the contamination "aging" effect which makes contamination difficult to remove. The decontamination processes are assumed to be similar to those of Assessment A but include only one pass of the water lance after any vacuuming. The OGT and ARC cell equipment will be internally decontaminated but walls and floors will remain intact because the dose rates are too high for manual contact. The cell interior radiation levels are expected to be higher because the equipment that will be entombed within the cell still retains some contamination.

Entombment of each cell will require cutting, plugging and seal welding closed all pipe penetrations, drains, and electrical conduits. The cell hatch cover from the GPC to the CPC will be locked and welded closed. All access doors will be closed and seal welded shut. The cell window shields will be lowered in place and a heavy gage steel plate will be welded over the window outer frame. The shield door from the CPC to the EDR will be lowered in place. All cell cranes, manipulators, instrumentation and lighting will be de-energized upon completion of remote entombment activities. The ARC and OGT cells will be similarly sealed closed and de-energized.

The end products for this assessment are the drained and secured solidification system, and the ARC and OGT components isolated from the remainder of the facility and entombed within the cell barriers.

3.3 DECONTAMINATION FOR DISMANTLEMENT - ASSESSMENT C

The assessment requires the complete removal of radioactivity in the cell by decontaminating and removing all cell equipment and decontaminating the cell surfaces for unrestricted access. The remaining structures may then be dismantled, if desired, using conventional demolition methods, (not in the task workscope) and the waste from the demolition activities may be used for fill either on-site or at other local areas.

The initial decontamination processes would be identical to Assessment "A" for piping, components, and cell interior wall and floor surfaces. Upon removal of all equipment and final wall and floor water lancing, the cell interior would be painted with strippable latex paint to reduce the spread of contamination. The floor steel liner would be removed, and the entire cell walls and floor concrete surfaces scarified to a depth of 1 inch to remove penetrated contamination. All concrete removed by scarifying is assumed contaminated and would be packaged and shipped for controlled burial.

After a final radiation survey to ensure that all contamination had been removed and that unrestricted access is allowable, the remaining cell structures would be released for conventional demolition and disposal.

4. STATUS OF FACILITY

The solidification system to be installed at WNYNSC will be decommissioned following the completion of the solidification campaign. The system will be installed to solidify on-site high level liquid waste from spent fuel reprocessing, and will be designed, engineered, and fabricated in accordance with those recommendations developed to facilitate decontamination and decommissioning (Ref. 3). The CPC will be used to house the solidification system. The cells in the Off-Gas and Acid Recovery Building will be the only other cells used in solidification operation and support.

4.1 CONFIGURATION OF EQUIPMENT AND STRUCTURES

The configuration of the CPC and Off-Gas/Acid Recovery Building structures and equipment following the immobilization campaign were estimated from projected system operation. General operating descriptions for a calcining/vitrification system and a preliminary process flow diagram proposed for the West Valley installation were consulted during estimate development. The solidification system equipment list is shown in Appendix A.

4.1.1 Chemical Process Cell (CPC)

The solidification system in the CPC will be deactivated at the end of the waste solidification phase. Only those portions of the system necessary for system and cell monitoring are expected to remain operational. All filtering elements and resin beds will be removed during system shutdown. Solidification components will be left empty; the liquid and solid radwaste will have been processed and shipped off-site.

The solidification system was assumed to be located on 20 self-contained skids. The skids contained an average of 4 process components, associated interconnecting piping, centralized power, and service hookups and were designed for remote installation/removal. Durations and manpower assumed for skid removal were based on the remote disconnection of all interface piping and services by a power manipulator/overhead crane crew.

4.1.2 Off-Gas and Acid Recovery Building Cells

All components in the two process cells will be emptied following system operation. Any filtering elements will be removed, packaged, and shipped off-site.

No modification is expected to the equipment presently in the process cells. This equipment is not modularized and will require a component-by-component removal scheme.

4.2 EQUIPMENT AND STRUCTURAL RADIATION LEVELS

General area radiation levels in the process cells and the radiation from major components in each cell were developed using an estimated operational history of the solidification system. The estimated maximum radiation level on solidification system components is approximately 240 R/hr at shutdown, based on data provided in Reference 5.

Personnel radiation exposure for the activities performed inside each cell results from two sources: general area dose rates and equipment dose rates. The cell area dose rate contributes to the occupational exposure for the duration the worker is inside a particular cell. The equipment dose rate, at an assumed working distance of 3 feet, contributes to the occupational exposure for the duration of the activity.

5. TECHNICAL APPROACH

The technical approach used in preparation of this study is based on the techniques developed for use by NES and the AIF/NESP-009 study (Ref. 4). The techniques are directly applicable to the WNYNSC facility and the same approach was used to identify the individual elements of an activity, and to estimate the costs, schedule, and manpower required, the occupational exposure incurred, waste volume generated and the final radiation levels achieved. In areas where additional information was required specific to decontamination of solidification plants, data from reports of actual results from decontamination of similar facilities was used (Ref. 5). This section presents the generic techniques used for the aforementioned parameters.

5.1 GENERIC ACTIVITIES

A list of activities was prepared for each assessment of the study to identify the major work elements. Each assessment contains a post-solidification Preparation Phase for data collection, equipment maintenance and repair, DOE review and approval, engineering and planning, and a Decontamination Phase for cell equipment and structure decontamination, and equipment removal. The Preparation Phase activities are essentially identical for all assessments with only minor differences identified for manual removal activities. The Decontamination Phase activities are identified for each cell, and include the cell-specific preparations, decontamination, equipment removal and cell closure activities. The generic decontamination and removal methods assumed for this study are identified in this section.

The estimated post-decontamination radiation levels in each cell were developed using an overall decontamination factor (DF) approach. A decontamination factor is the ratio of initial radiation level divided by final radiation level. DF's depend on such factors as the contaminated component or structure surface finish, corrosion-film element or compound constituents, nuclide constituents, adherence of the corrosion film layer, aging of the corrosion layer and degree of prior decontamination performed.

The selection of suitable solvent DF's to use in any study without benefit of actual laboratory test data for samples from the contaminated systems is a difficult task. However, for study purposes, conservative DF's may be selected from decontamination campaigns at similar facilities to provide a rapid, consistent basis for comparative decontamination scenarios. A summary of decontamination factors for various applications is shown in Table 5.1.

TABLE 5.1

SUMMARY OF DECONTAMINATION FACTORS

	Overall <u>DF</u>
Wall and floor decontamination (stainless steel)	100
Wall and floor decontamination (concrete walls)	2
Equipment removal	50
Internal chemical flush	
- (previously decontaminated equipment)	2
Internal chemical flush	
- (not previously decontaminated equipment)	50

5.1.1 Internal System Decontamination

The general process for internal system decontamination assumed for this study consisted of the major activities identified below. This process is similar to that used for the successful decontamination of the Eurochemic fuel reprocessing plant at Mol, Belgium (Ref. 6), and incorporates some of the procedural guidance provided in NUREG-0278 (Ref. 7).

Internal Decontamination

1. Install decontamination flushing system in set-up area and connect plumbing and electrical utilities. Test the system.
2. Install temporary directional gamma detectors at strategic locations on equipment in each process area.
3. Mix the required chemical solutions in the flushing system mixing tanks.
4. Chemically flush and water rinse the contaminated systems with the following chemicals:
 - A. Hot potassium permanganate/nitric acid mixture
 - B. Hot sodium hydroxide/tartaric acid mixture
 - C. Hot hydrofluoric acid/nitric acid mixture
5. Perform a final radiation survey of the decontaminated equipment.

The potassium permanganate conditions the contaminated surface to improve the effectiveness of nitric acid to remove residual uranium and plutonium oxides as well as the ^{137}Cs and ^{90}Sr . The sodium hydroxide/tartaric acid removes selected elements such as zirconium and niobium that resist acid flushes. The hydrofluoric acid/nitric acid removes residual ruthenium, if present.

Decontamination factors (DF's) assumed achievable were based on actual results reported at HFEF/S (Ref. 8), Savannah River (Ref. 9), and Eurochemic (Ref. 6). These latter results indicated that decontamination factors of approximately 10 to 100 were obtainable during first-flush campaigns. A DF of only 50 has been used to allow for

inaccessibility and contamination aging. Aging is known to reduce decontamination effectiveness. For systems which had been previously decontaminated, experience shows a DF of approximately 2 is possible in subsequent decontamination campaigns of the same or similar solvents. For the WNYNSC facility, a conservative DF of 2 can be expected for internal decontamination of systems previously decontaminated. For system internals not previously decontaminated a DF of 50 can be expected.

5.1.2 External Decontamination of Components and Structures

External decontamination of surfaces can be achieved with the high pressure (up to 10,000 psi) water or chemical lance technique, similar to that used at HFEF/S (Ref. 8) and Eurochemic (Ref. 6). The lance can be mechanically held with a 2-ton power manipulator for remote decontamination, or hand-held in manual decontamination. The CPC may contain significant quantities of calcined powder deposited on walls, floors and equipment surfaces from the calciner operation. Decontamination experience at HFEF/S (Ref. 8) indicates that dry vacuuming of surfaces is very effective in removing this loose contamination. Accordingly, dry vacuuming was assumed to precede high-pressure wet lancing decontamination for all cells.

External Surface Decontamination

1. Dry vacuum all accessible surfaces with a HEPA filtered vacuum system. (The vacuum nozzle is positioned with a power manipulator in remote decontamination.)
2. Prepare the cell for high-pressure lancing by covering leaded-glass windows (not being used), plugging floor drains, piping up water supply, and installing a power manipulator lance holding fixture.

3. Connect a wet vacuum system to the liquid waste system to collect spent decontamination liquids.
4. High pressure lance all surfaces using the following dilute solutions:
 - (a) Nitric acid
 - (b) Sodium hydroxide
 - (c) Nitric acid with hydroxylamine acid sulfate
 - (d) Hot water rinse.
5. Wet scrub surfaces as necessary with power brush.
6. Perform a final radiation survey of the decontaminated surfaces.

External surface decontamination factors assumed in this study were based on actual results for steel surfaces reported by Moore (Ref. 9) (overall DF's = 136 to 177). A conservative DF = 100 was used for decontamination of stainless and carbon steel surfaces. Bacca (Ref. 8) reported DF = 2 for high pressure lancing of concrete surfaces, and this same value was used in this study.

5.1.3 Equipment Removal

Equipment removal methods differ for the CPC, and OGT and ARC Building. The CPC is designed for remote operations by virtue of crane and power manipulator capability. The OGT and ARC building has no provisions for remote operations. As such, all removal operations require manual contact.

CPC remote operations will make use of the power manipulator for decontamination of in-cell surfaces, removal of Hanford-type pipe jumpers, disconnection of electrical connectors, and removal of tie-down bolts. The cell crane will lift skids and place them on the equipment transfer cart for removal to the EDR.

Manual contact removal operations in the OGT and ARC Building will require the removal crews to work inside the cells to manually disconnect and unbolt each component. The relatively high levels of airborne alpha contamination necessitates extensive personnel protection and contamination control techniques. The controls assumed applicable for this study are described below.

Data from the Savannah River Plant (Ref. 9) suggest that removal of contaminated equipment from the cells can achieve an overall DF of approximately 50. This value is expected to be achievable for removal of solidification equipment from the CPC, and the OGT and ARC.

Personnel Protection

For cell entries, personnel are assumed to wear protective clothing similar to that used at HFEF/S (Ref. 8) consisting of three layers of clothing, the outer layer being a plastic wet-suit. Air-supplied breathing hoods are assumed, although HEPA filtered respirators are also effective. Workers are assumed to wear lead-loaded aprons (0.5 mmPb) and lead-loaded gloves (0.35 mmPb) for additional protection.

Contamination Control

Personnel access to the OGT and ARC building was assumed to be through the personnel access door. A contamination control envelope (room) was assumed to be constructed outside the cell for personnel access and small tool transfer. The envelope would be maintained at negative pressure to ensure leakage would be inward. The exhaust from the envelope would be HEPA filtered.

Equipment removal hatches would be fitted with a similar contamination control envelope with doors large enough to transfer equipment through them. Two such equipment removal envelopes are envisioned at the OGT and ARC building roof. These envelopes would be used to poly-bag all equipment prior to final packaging.

5.1.4 Materials Handling

On-site materials handling consists of removing components from their cells, and packaging for transportation to a controlled burial ground (transportation is not included in the scope of work for this task). A brief description of each activity is included in this section.

Equipment Removal From Cells

Components removed from the CPC will be transferred by crane to the Equipment Decontamination Room (EDR). Components will be remotely placed in containers and loaded onto a flatbed tractor trailer. When fully loaded, the tractor-trailer will transport the containers for burial.

Components removed from the Acid Recovery (ARC) and Off Gas Treatment (OGT) cells will be removed by a 150-foot boom mobile crane through the contamination control envelope after poly-bagging. These components will be manually boxed, and loaded onto flatbed trailers for transport to burial.

Shipping Containers

CPC solidification equipment including piping, skid mounted components, demineralizers, centrifuges, the calciner, etc., will be packaged in steel containers to fit the Super-Tiger or Poly Panther Type B shipping containers. Very large skids or long components would be packaged and loaded for shipment in the ATMX rail car (Ref. 10).

A summary of the number and size of containers expected to be generated by removal of equipment is shown in Appendix B.

5.2 ESTIMATION OF COSTS

Assessment costs were calculated by the same method used in developing the AIF/NESP-009 (Ref. 4) cost estimate, where cost factors were developed for activity-dependent and period-dependent costs. Activity-dependent costs are those directly related to a specific activity such as removal of a component from a cell. Period-dependent costs are those related to the duration of an activity or series of activities such as crane rental per month, which might be used for several unrelated activities. Both types of factors include the cost elements of labor, materials, equipment, energy and services, where applicable.

All cost factors developed for this study are 1980 costs in the West Valley, New York region. These costs were obtained from national average cost information and regional correction factors as published by the Bureau of Labor Statistics (Ref. 11) and escalated for inflation at approximately 8% per year. The decontamination and removal activities are labor intensive, and accurate representative craft labor rates for Buffalo, New York (approximately 35 miles north of the site and a logical source of craft labor) were used as the basis for labor costs. Craft labor rates (\$/hr) used in cost calculations include base wages, fringe benefits, per diem (to account for travel by workers between Buffalo and the site), and 60% contractor overhead and profit. The following sections summarize the basis for development of the cost factors used in the study. Specific cost factors are listed in Appendix C.

5.2.1 Activity-Dependent Costs

Two methods were used to estimate activity dependent costs, namely unit cost factors (\$/ft², \$/inch of cut), and hourly craft cost (\$/hour). Unit cost factors are applied to pipe cutting, penetration capping, decontamination of floors and walls, etc. Hourly costs were used for activities where activity durations, crew size and composition were known from prior experience. Supporting material and equipment costs were developed from industry guides such as R.S. Means (Ref. 12) and Dodge (Ref. 13).

Actual in-cell nuclear experience was utilized to account for workers' time spent suiting up in anti-contamination clothing, inefficiencies in working while encumbered by protective clothing and breathing apparatus, and time spent for personnel and material radiation survey and control at radiation control checkpoints. This experience indicates an in-cell radiation zone worker is capable of only 3 effective work hours per 8 hour work day. To account for these factors, the costs for in-cell manual activities in radiation zones were estimated by determining the task durations in a non-radiation zone and applying an 8/3 factor to the duration estimate.

Out-of-cell activities were based on an average 6 hour effective work day per 8 hour shift which is typical for work in a low-level radiation environment.

5.2.2 Period-Dependent Costs

Period dependent costs include engineering, staff administrative costs, insurance, site security, health physics coverage, quality assurance and associated equipment rental for the term of the waste post-solidification operation program. The estimated costs for these factors were based on experience at similar facilities, and from such sources as American Nuclear Insurers (Ref. 14) for insurance costs, and security service companies.

Period-dependent costs are determined on a monthly basis so the costs can be estimated as a function of the post-immobilization campaign duration.

5.3 SCHEDULE

The schedule to perform each assessment was developed from the individual durations of each activity in the assessment. The durations were estimated from actual experience reported by Moore (Ref. 9) and Bacca (Ref. 8), Broothaerts (Ref. 6) and Hershey (Ref. 15). As discussed in Section 5.2, the in-cell manual

decontamination activities were assumed to require considerably more time than out-of-cell activities because of the restrictive contamination control measures necessary. Only three productive work hours were assumed per eight hour shift.

Each assessment consisted of two parts: "Preparations" and "Decontamination Activities," as described in Section 5.1.

The preparations activities were common to all assessments except for minor differences where manual versus remote decontamination and removal activities were required.

A schedule was developed for each Assessment A, B, and C by establishing the longest chain of critical path activities and summing the activity durations for that path. The total duration of the longest critical path was taken as the program duration.

5.4 MANPOWER ESTIMATES

The manpower estimates for each assessment were developed using standard crews to accomplish specific decontamination and removal activities. For example, the crews required to decontaminate the CPC cell consists of the following crafts:

Crew A

Used for remote CPC external equipment decontamination and removal:

- 1 crane operator
- 1 power manipulator operator
- 1 technician
- 1 supervisor

Crew B

Used for remote packaging in the EDR:

- 2 crane operators
- 1 supervisor

Crew C

Used for CPC internal equipment decontamination:

- 2 laborers
- 2 technicians
- 1 supervisor (utilized 1/2 time)

Crew D

Used for CPC concrete removal:

- 2 laborers
- 1 crane operator
- 1 supervisor

Crew E

Used for removal of CPC stainless steel liner from floor:

- 1 steelworker/welder
- 2 laborers
- 1 crane operator
- 1 supervisor

The activity duration and standard crew composition were used to estimate the manhours required to perform the activity. Specific activities such as engineering, health physics monitoring and security were estimated directly.

5.5 OCCUPATIONAL EXPOSURE

The occupational exposure for each assessment was calculated from two major sources of radiation exposure: general area exposure rate, and individual component exposure rate. The estimated radiation levels for these two sources are described in Section 4. As discussed in Section 4, there was insufficient radiation data available from operating solidification systems on component and structure exposure levels to provide an accurate estimate of occupational exposure.

The occupational exposures calculated for each assessment are based on estimated average area exposure rates and from estimated component exposure rates. All component exposure rates were based on a 3 ft working distance from the component. For these calculations a reported exposure rate in Roentgens

per hour (R/hr) was taken to be equal to a dose rate of the same number of Roentgen Equivalent Man (Rems) per hour, without attempting to quantify the relative biological effectiveness of the radiation sources. Thus, 1 R/hr is assumed equal to 1 Rem/hr. Detailed radiation surveys of each cell must be performed prior to any further occupational exposure estimates.

The manRem dose estimates calculated in this study are based on the conservative assumptions that all crew members will be present for the entire duration required for the activity. Each worker will receive a dose contribution from the general area radiation level, and from the components being decontaminated or removed. For out-of-cell activities only the general area dose contribution is included.

5.6 WASTE VOLUME GENERATED

The wastes generated in the decontamination activities for each assessment will be high level and low specific activity liquids and solids. They will consist of neutralized internal system decontamination solvents, high-pressure lance chemical and water spray run-off, contaminated tools, spent filters and used personnel protective clothing. The solidification, ARC and OGT equipment removed from each cell (the packaged volumes are shown in Appendix B) is stored on-site for later disposition and is not included in the waste volume inventory reported in this study. Also, the waste volumes presented in this report do not consider any possible reductions that could be achieved by means such as evaporation, compaction, etc.

Liquid waste volumes generated from internal system decontamination were estimated from the decontamination sequence described in Section 5.1.1, for the number of system internal volumes of solvents and rinses required for decontamination and solvent neutralization. Liquid wastes generated from external surface decontamination were based on the reported quantities of waste per-square-foot of surface experienced during the decontamination at the Savannah River Plant (Ref. 15). This data indicated a total rate of 5 gals/ft² (solvent plus neutralizer) was used to decontaminate external surfaces, and accordingly 5gal/ft² was assumed for this study.

The neutralized liquids will be solidified on-site in the modified liquid waste treatment system (WNYNSC Task 4) and packaged for shipment for off-site disposal. These wastes produced by decontamination of systems and structures will contain large quantities of transuranics and fission products. The waste concentration and packaging methods used must assure subcritical concentration of radionuclides in each phase of disposal. Development of details where these wastes can be buried, equipment required for volume reduction and packaging, transportation, costs, etc., was not within the workscope for this study.

6. ASSESSMENT SUMMARY

This section presents a summary of the results of the detailed calculations performed for each alternative assessment (A, B and C). The important findings of each assessment of cell decontamination/entombment are identified and discussed in detail.

6.1 ASSESSMENT RESULTS

The results for each assessment are summarized in Table 6.1 which provides the final radiation level, total costs, occupational exposure, manpower and working days duration and waste volume generated. The listing of activities performed for each assessment are shown on the tables of costs, exposure, manpower and duration in Appendices D through F.

6.2 DISCUSSION OF RESULTS

The key findings of each assessment are discussed herein.

6.2.1 Assessment A

The major contribution to the total cost and exposure is during the decontaminating activities associated with preparing the EDR for removal and packaging of equipment, and decontaminating the solidification equipment. The total cost of \$6,732,400 includes the cost of a decontamination subcontractor to augment the standard crews. The decontamination subcontractor will provide the necessary manpower to ensure the individual worker dose does not exceed 5 Rem per year or 3 Rem per quarter. For Assessment A, an additional crew of 30 men will be required during the decontamination activities. The additional 15,000 manhours, costs and exposure to these workers is included in Table 6.1.

The final radiation levels in each cell are the levels existing at the onset of solidification. The ARC was essentially non-contaminated at the onset of solidification and would be decontaminated to essentially background levels.

6.2.2 Assessment B

The cost and exposure for Assessment B is lower because of the reduced decontamination effort necessary for entombment. Although additional cost and exposure reductions are possible by eliminating decontamination, the ultimate decontamination may be more difficult, because of contamination aging, and total decontamination costs and exposure may be greater.

The total cost of \$4,255,000 includes the cost of a decontamination contractor to provide an additional 12 man crew to prevent excessive exposure to the standard crews. The additional 6,000 manhours, costs and exposure to these workers are included in Table 6.1.

The final cell interior radiation levels are much higher than those of Assessment A because the entombed equipment will retain some contamination and contribute to the dose.

6.2.3 Assessment C

The cost and exposure for Assessment C is the greatest of the three assessments because of the additional concrete scarifying work necessary to remove contamination on the CPC, OGT and ARC wall surfaces. The scarifying activity is necessary to insure all surface contamination is removed and the cells can be released for uncontrolled demolition.

The total cost of \$7,243,400 includes the cost of a decontamination contractor to provide an additional 28 man crew to prevent excessive exposure to the standard crews. The additional 14,000 manhours, cost and exposure are included in Table 6.1.

The final cell radiation levels for Assessment C will be suitable for release for uncontrolled demolition of the entire facility.

TABLE 6.1
ASSESSMENT SUMMARY

<u>Assessment</u>	<u>Cell</u>	<u>Final Radiation Levels mR/hr</u>	<u>Cost \$ *</u>	<u>Duration, days</u>	<u>Exposure ** Manpower, Manhours</u>	<u>Exposure, Man/Rem</u>	<u>Solid Waste Volume ft³</u>	<u>Waste Volume, Gal.</u>
A	CPC	12						
Decon to Pre-	ARC	U.A.						
Solidification	OGT	0.2						
Status	OGT Vent.	2.0						
Totals			6,732,400	407	37,125	120.4	40,073	721,500
B	CPC	2,000						
Decon for	ARC	60						
Entombment	OGT	60						
	OGT Vent.	22						
Totals			4,255,000	377	21,825	104.1	4,522	614,000
C	CPC	U.A.						
Decon. for	ARC	U.A.						
Uncontrolled	OGT	U.A.						
Access	OGT Vent.	U.A.						
Totals			7,243,400	430	38,565	135.8	49,660	721,500

U.A. Uncontrolled Access

* Cost in 1980 dollars with 25% contingency

** In-cell exposure is based on 4 hours per 8-hour workday (3 hours working time, plus 1 hour transit time)
Out-of-cell exposure is based on 6 hours per 8-hour workday

7. REFERENCES

1. Final Report; Task 2: Alternative Waste Management Options, Nuclear Fuel Services, Inc., High Level Waste, prepared by E. R. Johnson Associates, Inc. for Argonne National Laboratory, May 10, 1978.
2. Decontamination Study for Preimmobilization Operation, prepared by Nuclear Energy Services, Inc. for the U.S. DOE, July 31, 1980.
3. Recommendations to Facilitate Decontamination and Decommissioning of Waste Solidification Equipment, prepared by Nuclear Energy Services, Inc. for the U.S. DOE, July 18, 1980.
4. Manion, W. J. and LaGuardia, T. S.: An Engineering Evaluation of Nuclear Power Reactor Decommissioning Alternatives, AIF/NESP-009 (November, 1976).
5. Supplied by D. Gradford, Exxon Nuclear, Idaho Nuclear Engineering Laboratory (INEL), Idaho Falls, Idaho, to R. Bauer, Nuclear Energy Services, Inc., August, 1980.
6. Broothearts, J. et. al.: Experience Gained with Decontamination of a Shut-Down Reprocessing Plant, Eurochemic, Mol, Belgium, IAEA-SM-234/9, November, 1978.
7. Schneider, K. J., Jenkins, E. E., et. al., Technology, Safety, and Costs of Decommissioning a Reference Fuel Reprocessing Plant, NUREG/CR-0278 (October, 1977).
8. Bacca, J. P., et. al.: Decontamination and Refurbishment of the Hot Fuel Examination Facility South (HFEF/S) Argon Cell, Argonne National Laboratory, Idaho Falls, Idaho (September 16, 1979).
9. Moore, P. R.: Decontamination of a Highly Radioactive Chemical Processing Facility, E. I. duPont de Nemours and Company, Savannah River Plant, Aiken, South Carolina, DPSPU 74-30-10 (June 1975).

10. Supplied by R. Pope, Sandia Laboratories Transportation Technology Center in a conversation with T. LaGuardia, Nuclear Energy Services, August, 1980.
11. U.S. Department of Labor, Bureau of Labor Statistics: Employment and Earnings - October, 1979.
12. R. S. Means Company, Inc., Kingston, Massachusetts: Building Construction Cost Data - 1980 (1979).
13. 1980 Dodge Guide to Public Works and Heavy Construction Costs, Annual Edition No. 12, McGraw Hill, New York (1979).
14. Supplied by R. Jones, American Nuclear Insurers, in a conversation with R. Hykys, Nuclear Energy Services, Inc., April, 1980.
15. Hershey, J. H.: Separations Canyon Decontamination Facilities, E. I. duPont de Nemours and Company, Savannah River Plant, Aiken, South Carolina, DPSPU 75-30-5 (May, 1975).

APPENDIX A

SOLIDIFICATION SYSTEM EQUIPMENT LIST

EQUIPMENT LIST

SHEET 1 OF 8

[illegible]

1c-30

EQUIPMENT LIST

SHEET 2 OF 8

[illegible]

EQUIPMENT LIST

SHEET 3 OF 9

EQUIP PIECE Nº	DESCRIPTION	APPROX. SIZE	REMARKS
TK-C-1	Cs ION EXCHANGE FEED TANK	1200 L 4'-0" ϕ x 4'-0" h	
TK-C-2	Cs CONCENTRATOR FEED TANK	300 L 2'-6" ϕ x 3'-0" h	
TK-C-3	Cs WASH & REGENERATION CATCH TK	1,000 L 3'-0" ϕ x 5'-6" h	
TK-C-4	Cs CONCENTRATE HOLDING / FEED TANK	600 L 3'-0" ϕ x 3'-6" h	
TK-C-5	Cs ELUATE MAKE-UP TANK	600 L 3'-0" ϕ x 3'-6" h	
TK-C-6	Cs ELUATE BOUNCE TANK	300 L 2'-6" ϕ x 3'-0" h	
TK-C-7	Cs/SR REWORK TANK	300 L 2'-6" ϕ x 3'-0" h	
TK-C-8	ZEOLITE SLURRY TANK	1200 L 4'-0" ϕ x 4'-0" h	
TK-C-9	Na ₂ CO ₃ CATCH TANK	300 L 2'-6" ϕ x 3'-0" h	
C-C-1	PURGE CONDENSER	6" ϕ x 6'-0" L	
C-C-2	DOWN DRAFT CONDENSER	12" ϕ x 8'-0" L	
CR-C-1	Cs CONCENTRATOR	5'-0" x 5'-0" h	WITH 8" ϕ x 10'-0" h STRIPPER COL.
F-C-1	ZEOLITE FILTER BED	1200 L 4'-0" ϕ x 4'-0" h	
S-C-1	CONCENTRATOR OFF-GAS SCRUBBER	2'-0" ϕ x 6'-0" h	
IEX-C-1	Cs ION EXCHANGE COLUMN Nº 1	12" ϕ x 8'-0" h	
IEX-C-2	Cs ION EXCHANGE COLUMN Nº 2	12" ϕ x 8'-0" h	

EQUIPMENT LIST

SHEET 4 OF 8

[illegible]

IC-33

EQUIPMENT LIST

SHEET 5 OF 8

[illegible]

EQUIPMENT LIST

SHEET 6 OF 8

[illegible]

EQUIPMENT LIST

SHEET 7 OF 8

[illegible]

EQUIPMENT LIST

SHEET 8 OF 8

[illegible]

THIS PAGE
WAS INTENTIONALLY
LEFT BLANK

TABLE B.1
ASSESSMENT A
SUMMARY OF WASTE GENERATED

<u>Containers for Burial</u>	<u>Number of Packages</u>	<u>Volume, ft.³</u>
CPC		
9' x 9' x 15'	20	24,300
OGT and ARC		
4' x 4' x 18'	6	1,728
4' x 4' x 8'	12	1,536
6' x 6' x 30'	7	7,560
Total volume for ATMX Railcar		35,124 = 13 ATMX car shipments
LSA Misc. Waste		= 673 Drums (55 gal.) = 4949 ft. ³
<u>Liquid Waste</u>		<u>Gallons</u>
CPC		
Water Lance		230,000
Internal Decontamination		240,000
OGT and ARC		
Water Lance		101,700
Internal Decontamination		144,000
Miscellaneous		5,800
Total		<hr/> 721,500

TABLE B.2
ASSESSMENT B
SUMMARY OF WASTE GENERATED

<u>Liquid Waste</u>	<u>Gallons</u>
CPC	
Water Lance	230,000
Internal Decontamination	240,000
OGT and ARC	
Internal Decontamination	144,000
Total	<hr/> 614,000
LSA Misc. Waste	= 615 Drums (55 gal.) = 4522 ft ³

TABLE B.3
ASSESSMENT C
SUMMARY OF WASTE GENERATED

<u>Containers for Burial</u>	<u>Number of Packages</u>	<u>Volume, ft.³</u>
CPC		
9" x 9" x 15"	20	24,300
8" x 8" x 16"	2	2,048
5" x 5" x 10"	2	500
4" x 4" x 8"	28	3,584
2" x 3" x 10"	1	60
OGT and ARC		
4" x 4" x 8"	36	4,608
6" x 6" x 30"	7	7,560
4" x 4" x 18"	6	1,728
Total volume for ATMX Railcar		44,388
		= 20 ATMX car shipments
LSA Misc. Waste		= 717 Drums (55 gal.)
		= 5272 ft. ³
<u>Liquid Waste</u>		<u>Gallons</u>
CPC		
Water Lance		230,000
Internal Decontamination		240,000
OGT and ARC		
Water Lance		101,700
Internal Decontamination		144,000
Miscellaneous		5,800
Total		721,500

THIS PAGE
WAS INTENTIONALLY
LEFT BLANK

TABLE C-1
COST FACTOR SUMMARY

<u>In Cell and EDR Manual Pipe Cutting and Welding</u>	<u>Cost Factor</u>
Pipe 3" (Torch Cutting)	\$ 22.43/cut
Pipe 6" (Torch Cutting)	\$ 44.86/cut
Pipe 3" Welding	\$ 28.26/weld
Pipe 6" Welding	\$ 56.56/weld

Crew Costs for Work Performed in Cells (a)

Crew A - to be used in CPC (Remote activities)	\$ 66.80/hr.
Crew B - to be used in PMC and GPC (Remote activities)	\$ 85.94/hr.
Crew C - packaging in EDR & outside MCR	\$146.32/hr.
Crew D - to be used in CPC (Manual activities)	\$141.90/hr.
Crew E - to be used in PMC and GPC (Manual activities)	\$ 99.57/hr.

Chemical Solutions

50% HNO ₃	\$.80/lb.
2% KMNO ₄	\$ 2.19/lb.
20% NaOH	\$.59/lb.
2% Tartaric Acid	\$ 2.00/lb.
1M HF	\$.88/lb.
20% HNO ₃	\$.80/lb.

These cost factors include base wages, fringe benefits, per diem (for travel), and a factor of 60% to cover prime contractor and subcontractor overhead and profit.

<u>Equipment</u>	<u>Cost Factor</u>
Crane - 200 Ton, 150 Ft. Boom	\$ 11,000/mo.
Flatbed Truck	\$ 1,525/mo.
Heavy Duty Fork Lift	\$ 2,700/mo.
Drott Travel Lift	\$ 6,600/mo.
Heavy Duty Electric Hoist	\$ 10,150/ea.

TABLE C-1
COST FACTOR SUMMARY
(Continued)

10 Ton Chain Hoist	\$ 1,750/ea.
Heavy Gentries - 20,000 lb. cap.	\$ 22,000/ea.
39,000 lb. Load Rated Chain - 1,500 ft.	\$ 23,200/ea.
20,000 lb. Load Rated Chain - 500 ft.	\$ 4,200/ea.
4 Ton Winch	\$ 450/ea.
4,000 lb. Gantry	\$ 1,600/ea.
Light Chain Hoist	\$ 950/ea.
<u>Metal Container Fabrication:</u>	
4' x 4' x 8'	\$ 3,800/ea.
6' x 8' x 12'	\$ 11,100/ea.
8' x 8' x 12'	\$ 11,500/ea.
6' x 8' x 24'	\$ 19,700/ea.
8' x 8' x 24'	\$ 22,700/ea.
9' x 9' x 16.5'	\$ 15,800/ea.
<u>Steel Fabrication</u>	
Steel Liner Fabrication	\$ 220/cwt.
Dot Spec. 17C Steel Drum (55 gal.)	\$ 77.90/drum
Dot Spec. 7A Steel Box	\$ 1,675/bin
Steel Liner for Super Tiger	\$ 7,500/liner
Gantry Loading, Transportation and Unloading	\$ 580/trip
Flatbed Truck Loading, Transportaion and Gantry Unloading	\$ 48/trip

TABLE C-2

ADMINISTRATIVE COSTS

<u>Position</u>	<u>Total Cost \$</u>
Contracts Manager	49,700
Project Superintendent	38,600
Project Engineer	33,600
Project Accountant	31,600
Packaging and Shipping Supervisor	20,300
Engineers - 1	28,000
Engineering Aide	14,400
Clerks - 1	16,600
Health Physics Technicians - 2	38,800
Health and Safety Supervisor	25,000
Plant Maintenance Supervisor	25,000
Custodians - 1	16,000
Total Annual Cost	337,600
Plus 25% overhead	422,000

APPENDIX D

ASSESSMENT A

COSTS, DURATIONS, MANPOWER, AND EXPOSURE

TABLE D.1.1
ASSESSMENT A
PRE-DECONTAMINATION COSTS

<u>Activity Description</u>	<u>Cost</u> \$
1. Obtain and review plant drawings and photographs	19,800
2. Perform detailed radiation survey	13,200
3. Estimate residual by-product inventory	4,400
4. Prepare end-product description	2,800
5. Perform detailed calculations of by-product inventory	8,800
6. Sequence major work activities	4,400
7. Perform safety analysis of removal activities	9,900
8. Prepare and submit dismantling plan to DOE for approval	7,200
9. Receive dismantling order	-
10. Prepare activity specifications	92,400
11. Prepare detailed work procedures	39,600
12. Prepare detailed work sequence	9,900
13. Procure decontamination chemicals and equipment	4,400
14. Procure equipment for material handling and miscellaneous tools for cell component removal	4,400
15. Procure waste storage containers	4,400
16. Replace HEPA and roughing filters	2,200
17. Build plywood structure atop Off Gas and Acid Recovery Building	9,800
18. Prepare XCR equipment for internal chemical decontamination	1,500
Subtotal Pre-decontamination	<u>239,100</u>

TABLE D.1.2

ASSESSMENT A
DECONTAMINATION COSTS
CPC

<u>Activity Description</u>	<u>Cost</u> \$
1. Prepare internal decontamination flushing equipment setup in EDR	3,600
2. Decontaminate internal system of solidification equipment	396,100
3. De-energize solidification equipment	2,600
4. Prepare for surface decontamination of CPC	2,500
5. Dry vacuum walls, floors, and solidification system external surfaces	4,600
6. Water lance walls, floors, and solidification system external surfaces	217,800
7. Flushing rig removal	2,200
8. Prepare EDR for remote removal operations	1,000
9. Cap all pipe penetrations	11,700
10. Remotely remove and package solidification system	347,500
11. Decontaminate CCR, EDR, cranes, and power manipulator	149,000
12. Survey CCR and EDR	1,700
13. Perform remote survey of CPC and scrub hot spots	1,700
14. Remotely paint CPC	15,100
15. Install lead shielding on hot spots	33,300
16. Perform final survey	1,700
Subtotal CPC	<u>1,192,100</u>

TABLE D.1.3
ASSESSMENT A
DECONTAMINATION COSTS
OFF GAS AND ACID RECOVERY BUILDING

<u>Activity</u>	<u>Total</u> <u>\$</u>
1. Decontaminate component internals	249,800
2. Remove and package off gas filters	2,200
3. Decontaminate Off Gas and Acid Recovery equipment	6,800
4. De-energize Off Gas and Acid Recovery equipment	400
5. Prepare for removal of equipment in Off Gas and Acid Recovery Building	4,500
6. Remove and package system pumps	8,600
7. Remove and package Off Gas ducts and blowers	41,500
8. Remove and package OGT and ARC components	334,300
9. Decontaminate Off Gas ventilation area walls and floors	99,300
10. Decontaminate cell walls and floors	104,800
11. Decontaminate Off Gas Ventilation Area	500
12. Perform radiation survey	4,800
13. Paint cell and ventilation area hot spots	31,600
14. Install lead shielding on hot spots	66,600
15. Perform final radiation survey	3,400
Subtotal GTB and ARC Bldg.	<u>959,100</u>

TABLE D.1.4
ASSESSMENT A
DECONTAMINATION COSTS

	<u>Total</u> <u>\$</u>
<u>Sub-Total Decontamination Work Activities</u>	2,390,300
<u>Undistributed Costs:</u>	
Decontamination Staff	716,300
Security Force	1,190,500
Engineering Consultants	153,500
Nuclear Liability Insurance	52,600
Project Management and Engineering QA	143,100
TLD and Film Badge Service	43,800
Electric Materials	2,000
Flexible Hose (4 filters)	3,600
Misc. Cutting and Hoisting Equipment	10,000
Radiation Monitoring Systems	1,200
Scaffold Equipment	3,100
Flushing Rig	47,300
Filters	5,600
Misc. Tools and Hardware	10,000
Service Air Hose	2,000
Anti-contamination Clothing	27,900
Laundry Service	16,000
Breathing Air Compressor (2)	22,100
Truck Rental	147,600
Fork Lift Rental	16,300
LSA Waste Container, Shipping and Burial	52,600
Decontamination Subcontractor	328,500
 Sub-total Undistributed Costs	 <u>2,995,600</u>
 Total Decontamination Cost	 <u>5,385,900</u>
 Cost of Assessment A including 25% Contingency	 <u>6,732,400</u>

TABLE D.2.1

ASSESSMENT A
PRE-DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE

<u>Activity Description</u>	<u>Duration (days)</u>	<u>Manpower (manhours)</u>	<u>Exposure (manRem)</u>
1. Obtain and review plant drawings and photographs	10	360	-
2. Perform detailed radiation survey	20	210	1.1
3. Estimate residual by-product inventory	5	80	-
4. Prepare end-product description	4	50	-
5. Perform detailed calculations of by-product inventory	10	160	-
6. Sequence major work activities	5	80	-
7. Perform safety analysis of removal activities	10	180	-
8. Prepare and submit dismantling plan to DOE for approval	8	130	-
9. Receive dismantling order	60	-	-
10. Prepare activity specifications	35	720	-
11. Prepare detailed work procedures	23	720	-
12. Prepare detailed work sequence	12	180	-
13. Procure decontamination chemicals and equipment	20	80	-
14. Procure equipment for material handling and miscellaneous tools for component removal	20	160	-
15. Procure waste storage containers	10	80	-
16. Replace HEPA and roughing filters	3	24	1.4
17. Build plywood structure atop Off Gas and Acid Recovery Bldg.	5	160	-
18. Prepare XCR equipment for internal chemical decontamination	5	80	-
Subtotal Pre-decontamination		<u>3,454</u>	<u>2.5</u>

TABLE D.2.2
ASSESSMENT A
DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE
CPC

<u>Activity Description</u>	<u>Duration (days)</u>	<u>Manpower (manhours)</u>	<u>Exposure (manRem)</u>
1. Prepare internal decontamination flushing equipment setup in EDR	6	144	1.58
2. Decontaminate internal system of solidification equipment	52	1028	2.0
3. De-energize solidification equipment	7	112	0.11
4. Prepare for surface decontamination of CPC	4	128	0.13
5. Dry vacuum walls, floors, and solidification system external surfaces	10	308	0.31
6. Water lance walls, floors, and solidification system external surfaces	115	3680	3.68
7. Flushing rig removal	3	86	0.95
8. Prepare EDR for remote removal operations	2	44	0.47
9. Cap all pipe penetrations	9	30	0.03
10. Remotely remove and package solidification system	45	1280	1.28
11. Decontaminate CCR, EDR, cranes and power manipulator	62	3000	15.0
12. Survey CCR and EDR	1	30	0.1
13. Perform remote survey of CPC	4	63	0.26
14. Remotely paint CPC	4	76	0.1
15. Install lead shielding on hot spots	1	12	0.01
16. Perform final survey	1	18	0.21
Subtotal CPC		<u>10,039</u>	<u>26.22</u>

TABLE D.2.3

ASSESSMENT A
DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE
OFF GAS AND ACID RECOVERY BUILDING

<u>Activity Description</u>	<u>Duration</u> (days)	<u>Manpower</u> (manhours)	<u>Exposure</u> (manRem)
1. Decontaminate component internals	52	1028	0.05
2. Remove and package Off Gas filters	3	100	10.0
3. Decontaminate Off Gas ductwork and blowers	3	192	19.2
4. De-energize OGT and ARC equipment	1	16	0.02
5. Prepare for Removal of equipment in OGT and ARC Building	2.5	80	0.1
6. Remove and package system pumps	1	44	1.8
7. Remove and package Off Gas ducts and blowers	3	168	6.8
8. Remove and package OGT and ARC components	46	1722	22.36
9. Decontaminate Off Gas ventilation Area walls and floors	27	1700	24.0
10. Decontaminate cell walls and floors	82	2600	2.78
11. Decontaminate remaining hot spots	1	24	1.0
12. Perform radiation survey	3	60	0.6
13. Paint cell and Ventilation Area walls and floors	16.5	800	2.3
14. Install lead shielding on hot spots	2	48	0.5
15. Perform final survey	2	48	0.2
Subtotal OGT and ARC		<u>8630</u>	<u>91.71</u>

APPENDIX E

ASSESSMENT B

COSTS, DURATIONS, MANPOWER, AND EXPOSURE

TABLE E.1.1
ASSESSMENT B
PRE-DECONTAMINATION COSTS

<u>Activity Description</u>	<u>Cost</u> \$
1. Obtain and review plant drawings and photographs	19,800
2. Perform detailed radiation survey	13,200
3. Estimate residual by-product inventory	4,400
4. Prepare end-product description	2,800
5. Perform detailed calculations of by-product inventory	8,800
6. Sequence major work activities	4,400
7. Perform safety analysis of entombment activities	9,900
8. Prepare and submit entombment plan to DOE for approval	7,200
9. Receive entombment order	-
10. Prepare activity specifications	92,400
11. Prepare detailed work procedures	39,600
12. Prepare detailed work sequence	9,900
13. Procure decontamination chemicals and equipment	4,400
14. Procure equipment for material handling and miscellaneous tools for entombment operations	4,400
15. Procure waste storage containers	900
16. Replace HEPA and roughing filters	2,200
17. Prepare XCR equipment for internal chemical decontamination	1,500
Subtotal Pre-decontamination	<u>225,800</u>

TABLE E.1.2
ASSESSMENT B
DECONTAMINATION/ENTOMBMENT COSTS
CPC

<u>Activity Description</u>	<u>Decontamination</u>	<u>Entombment</u>	<u>Totals \$</u>
1. Prepare internal decontamination flushing equipment setup in EDR			3,600
2. Decontaminate internal system of solidification equipment	396,100		396,100
3. De-energize solidification equipment			2,600
4. Prepare for surface decontamination of CPC			2,500
5. Dry vacuum walls, floors, and solidification system external surfaces	4,600		4,600
6. Water lance walls, floors, and solidification equipment external surfaces	408,300		217,300
7. Flushing rig removal			2,200
8. Decontaminate CCR, EDR, cranes, and power manipulator	149,000		149,900
9. Survey CCR and EDR			1,700
10. Cap all pipe penetrations		11,700	11,700
11. Sever and seal all vent ducts		3,100	3,100
12. Seal all hatches leading into and out of the CPC		1,300	1,300
13. Seal all viewing windows		2,500	2,500
14. Seal all doorways in CPC		1,000	1,000
15. Perform final radiation survey			1,200
16. Disconnect electrical lines to crane and power manipulator		500	500
17. Seal all CPC air locks		1,000	1,0
Subtotal CPC			<u>799,400</u>

TABLE E.1.3
ASSESSMENT B
DECONTAMINATION COSTS
OFF GAS AND ACID RECOVERY BUILDING

<u>Activity</u>	<u>Total</u> <u>\$</u>
1. Decontaminate component internals	249,800
2. Remove and package off gas filters	2,200
3. Decontaminate Off Gas ductwork and blowers	6,800
4. De-energize Off Gas and Acid Recovery equipment	400
5. Prepare for entombment of equipment in Off Gas and Acid Recovery Building	4,500
6. Decontaminate Off Gas ventilation area walls and floors	99,300
7. Sever and seal all ductwork	3,000
8. Sever and sap pipe penetrations	8,700
9. Perform radiation survey	4,800
10. Seal all hatches leading into and out of cells	4,000
11. Seal all doorways to building access	4,600
12. Perform final radiation survey	3,400
Subtotal GTB and ARC Bldg.	<u>391,500</u>

TABLE E.1.4
ASSESSMENT B
DECONTAMINATION COSTS

	<u>Total</u> <u>\$</u>
<u>Sub-Total Decontamination Work Activities</u>	1,416,700
<u>Undistributed Costs:</u>	
Decontamination Staff	66,400
Security Force	1,102,700
Engineering Consultants	142,200
Nuclear Liability Insurance	52,600
Project Management and Engineering QA	132,600
TLD and Film Badge Service	40,100
Electric Materials	2,000
Flexible Hose (4 filters)	3,600
Misc. Cutting and Hoisting Equipment	10,000
Radiation Monitoring Systems	1,200
Scaffold Equipment	3,100
Flushing Rig	47,300
Filters	5,600
Misc. Tools and Hardware	10,000
Service Air Hose	2,000
Anti-contamination Clothing	4,100
Laundry Service	2,300
Breathing Air Compressor	19,800
Truck Rental	137,300
Fork Lift Rental	14,700
LSA Waste Container, Shipping and Burial	48,100
Decontamination Subcontractor	139,400
 Sub-total Undistributed Costs	 <u>1,987,100</u>
 Total Decontamination Cost	 <u>3,403,800</u>
 Cost of Assessment A including 25% Contingency	 <u>4,255,000</u>

TABLE E.2.1

ASSESSMENT B
PRE-DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE

<u>Activity Description</u>	<u>Duration (days)</u>	<u>Manpower (manhours)</u>	<u>Exposure (manRem)</u>
1. Obtain and review plant drawings and photographs	10	360	-
2. Perform detailed radiation survey	20	210	1.1
3. Estimate residual by-product inventory	5	80	-
4. Prepare end-product description	4	50	-
5. Perform detailed calculations of by-product inventory	10	160	-
6. Sequence major work activities	5	80	-
7. Perform safety analysis of removal activities	10	180	-
8. Prepare and submit entombment plan to DOE for approval	8	130	-
9. Receive entombment order	60	-	-
10. Prepare activity specifications	35	720	-
11. Prepare detailed work procedures	23	720	-
12. Prepare detailed work sequence	12	180	-
13. Procure decontamination chemicals and equipment	20	80	-
14. Procure equipment for material handling and miscellaneous tools for entombment operations	20	160	-
15. Procure waste storage containers	2	16	-
16. Replace HEPA and roughing filters	3	24	1.4
17. Prepare XCR equipment for internal chemical decontamination	5	80	-
Subtotal Pre-decontamination		<u>3230</u>	<u>2.5</u>

TABLE E.2.2
ASSESSMENT B
DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE
CPC

<u>Activity Description</u>	<u>Duration (days)</u>	<u>Manpower (manhours)</u>	<u>Exposure (manRem)</u>
1. Prepare internal decontamination flushing equipment setup in EDR	6	144	1.6
2. Decontaminate internal system of solidification equipment	52	1028	2.0
3. De-energize solidification equipment	7	112	0.11
4. Prepare for surface decontamination of CPC	4	128	0.13
5. Dry vacuum walls, floors, and solidification system external surfaces	10	308	0.31
6. Water lance walls, floors, and solidification system external surfaces	115	3680	3.7
7. Flushing rig removal	3	86	0.95
8. Decontaminate CCR, EDR, cranes and power manipulator	62	3000	15.0
9. Survey CCR and EDR	1	30	0.1
10. Cap all pipe penetrations	9	210	0.21
11. Sever and seal all vent ducts	4	96	12
12. Seal all hatches leading into and out of the CPC	1	25	0.09
13. Seal all viewing windows	2	52	0.05
14. Seal all doorways in CPC	2	39	0.15
15. Perform final radiation survey	3	51	0.07
16. Disconnect electrical lines to crane and power manipulator	1	20	0.02
17. Seal all CPC air locks	1	16.0	0.02
Subtotal CPC		<u>9025</u>	<u>36.51</u>

TABLE E.2.3

ASSESSMENT B
DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE
OFF GAS AND ACID RECOVERY BUILDING

<u>Activity Description</u>	<u>Duration</u> (days)	<u>Manpower</u> (manhours)	<u>Exposure</u> (manRem)
1. Decontaminate component internals	52	1028	0.05
2. Remove and package Off Gas filters	3	100	10.0
3. Decontaminate Off Gas ductwork and blowers	3	192	19.2
4. De-energize OGT and ARC equipment	1	16	0.02
5. Prepare for entombment of equipment in OGT and ARC Building	2.5	80	0.10
6. Decontaminate Off Gas ventilation Area walls and floors	27	1700	26.0
7. Sever and seal ductwork	2	126	5.8
8. Sever and cap pipe penetrants	4	16	2.9
9. Perform radiation survey	3	60	0.6
10. Seal all hatches leading into and out of cells	6	132	0.17
11. Seal all doorways - building access	3	72	0.09
12. Perform final radiation survey	2	48	0.2
Subtotal OGT and ARC		<u>3570</u>	<u>65.13</u>

APPENDIX F

ASSESSMENT C

COSTS, DURATIONS, MANPOWER, AND EXPOSURE

TABLE F.1.1
ASSESSMENT C
PRE-DECONTAMINATION COSTS

<u>Activity Description</u>	<u>Cost</u> \$
1. Obtain and review plant drawings and photographs	19,800
2. Perform detailed radiation survey	13,200
3. Estimate residual by-product inventory	4,400
4. Prepare end-product description	2,800
5. Perform detailed calculations of by-product inventory	8,800
6. Sequence major work activities	4,400
7. Perform safety analysis of removal activities	9,900
8. Prepare and submit dismantling plan to DOE for approval	7,200
9. Receive dismantling order	-
10. Prepare activity specifications	92,400
11. Prepare detailed work procedures	39,600
12. Prepare detailed work sequence	9,900
13. Procure decontamination chemicals and equipment	4,400
14. Procure equipment for material handling and miscellaneous tools for cell component removal	4,400
15. Procure waste storage containers	4,400
16. Replace HEPA and roughing filters	2,200
17. Build plywood structure atop Off Gas and Acid Recovery Building	9,800
18. Prepare XCR equipment for internal chemical decontamination	1,500
Subtotal Pre-decontamination	<u>239,100</u>

TABLE F.1.2

ASSESSMENT C
DECONTAMINATION COSTS
CPC

<u>Activity Description</u>	<u>Cost</u> \$
1. Prepare internal decontamination flushing equipment setup in EDR	3,600
2. Decontaminate internal system of solidification equipment	413,600
3. De-energize solidification equipment	2,600
4. Prepare for surface decontamination of CPC	2,500
5. Dry vacuum walls, floors, and solidification system external surfaces	4,600
6. Water lance walls, floors, and solidification system external surfaces	208,300
7. Flushing rig removal	2,200
8. Prepare EDR for remote removal operations	1,000
9. Remotely remove and package solidification system	347,500
10. Decontaminate CCR, EDR, cranes, and power manipulator	149,000
11. Survey CCR and EDR	1,700
12. Perform remote survey of CPC	1,200
13. Remotely paint CPC	15,100
14. Manually remove and package contaminated concrete	89,100
15. CPC floor liner removal and packaging	41,400
16. Shield window removal and packaging	15,700
17. Crane and power manipulator removal and packaging	31,900
18. Crane rail removal and packaging	3,200
19. Perform final clean-up and survey	7,40
Subtotal CPC	<u>1,341,600</u>

TABLE F.1.3
ASSESSMENT C
DECONTAMINATION COSTS
OFF GAS AND ACID RECOVERY BUILDING

<u>Activity</u>	<u>Total</u> <u>\$</u>
1. Decontaminate component internals	249,800
2. Remove and package off gas filters	2,200
3. Decontaminate Off Gas ductwork and blowers	6,800
4. De-energize Off Gas and Acid Recovery equipment	400
5. Prepare for removal of equipment in Off Gas and Acid Recovery Building	4,500
6. Remove and package system pumps	8,600
7. Remove and package Off Gas ducts and blowers	41,500
8. Remove and package OGT and ARC components	334,300
9. Decontaminate Off Gas ventilation area walls and floors	99,300
10. Decontaminate cell walls and floors	104,800
11. Paint cell and ventilation area walls and floors	31,600
12. Remove and package contaminated concrete	187,800
13. Remove and package steel floor liners	9,200
14. Perform radiation survey	4,800
15. Decontaminate remaining hot spots	4,200
16. Perform final radiation survey	3,400
Subtotal GTB and ARC Bldg.	<u>1,093,200</u>

TABLE F.1.4
ASSESSMENT C
DECONTAMINATION COSTS

	<u>Total</u> <u>\$</u>
<u>Sub-Total Decontamination Work Activities</u>	2,673,900
<u>Undistributed Costs:</u>	
Decontamination Staff	756,800
Security Force	1,257,800
Engineering Consultants	162,200
Nuclear Liability Insurance	52,600
Project Management and Engineering QA	151,200
TLD and Film Badge Service	46,700
Electric Materials	2,000
Flexible Hose (4 filters)	3,600
Misc. Cutting and Hoisting Equipment	10,000
Radiation Monitoring Systems	1,200
Scaffold Equipment	3,100
Flushing Rig	47,300
Filters	5,600
Misc. Tools and Hardware	10,000
Service Air Hose	2,000
Concrete Scabblers	8,400
Anti-contamination Clothing	35,300
Laundry Service	19,800
Breathing Air Compressor (2)	23,800
Truck Rental	159,100
Fork Lift Rental	17,600
LSA Waste Container, Shipping and Burial	56,000
Decontamination Subcontractor	288,700
 Sub-total Undistributed Costs	 <u>3,120,800</u>
 Total Decontamination Cost	 <u>5,794,700</u>
 Cost of Assessment A including 25% Contingency	 <u>7,243,400</u>

TABLE F.2.1

ASSESSMENT C
PRE-DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE

<u>Activity Description</u>	<u>Duration (days)</u>	<u>Manpower (manhours)</u>	<u>Exposure (manRem)</u>
1. Obtain and review plant drawings and photographs	10	360	-
2. Perform detailed radiation survey	20	210	1.1
3. Estimate residual by-product inventory	5	80	-
4. Prepare end-product description	4	50	-
5. Perform detailed calculations of by-product inventory	10	160	-
6. Sequence major work activities	5	80	-
7. Perform safety analysis of removal activities	10	180	-
8. Prepare and submit dismantling plan to DOE for approval	8	130	-
9. Receive dismantling order	60	-	-
10. Prepare activity specifications	35	720	-
11. Prepare detailed work procedures	23	720	-
12. Prepare detailed work sequence	12	180	-
13. Procure decontamination chemicals and equipment	20	80	-
14. Procure equipment for material handling and miscellaneous tools for component removal	20	160	-
15. Procure waste storage containers	10	80	-
16. Replace HEPA and roughing filters	3	24	1.4
17. Build plywood structure atop Off Gas and Acid Recovery Bldg.	5	160	-
18. Prepare XCR equipment for internal chemical decontamination	5	80	-
Subtotal Pre-decontamination		<u>3454</u>	<u>2.5</u>

TABLE F.2.2
ASSESSMENT C
DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE
CPC

<u>Activity Description</u>	<u>Duration (days)</u>	<u>Manpower (manhours)</u>	<u>Exposure (manRem)</u>
1. Prepare internal decontamination flushing equipment setup in EDR	6	144	1.58
2. Decontaminate internal system of solidification equipment	52	1028	2.0
3. De-energize solidification equipment	7	112	0.11
4. Prepare for surface decontamination of CPC	4	128	0.13
5. Dry vacuum walls, floors, and solidification system external surfaces	10	308	0.31
6. Water lance walls, floors, and solidification system external surfaces	115	3680	3.68
7. Flushing rig removal	3	86	0.95
8. Prepare EDR for remote removal operations	2	44	0.47
9. Remotely remove and package solidification system	45	1280	1.28
10. Decontaminate CCR, EDR, cranes and power manipulator	62	3000	15.0
11. Survey CCR and EDR	1	30	0.1
12. Perform remote survey of CPC	3	51	0.065
13. Remotely paint CPC	4	76	0.1
14. Manually remove and package contaminated concrete	22	872	8.93
15. CPC floor liner removal and packaging	5	232	2.75

TABLE F.2.2
ASSESSMENT C
DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE
CPC
(Continued)

	<u>Activity Description</u>	<u>Duration</u> (days)	<u>Manpower</u> (manhours)	<u>Exposure</u> (manRem)
16.	Shield window removal and packaging	4	128	1.28
17.	Crane and power manipulator removal and packaging	3	96	0.072
18.	Crane rail removal and packaging	2	64	0.77
19.	Perform final clean-up and survey	3	60	0.03
	Subtotal CPC		<u>11,419</u>	<u>39.61</u>

TABLE F.2.3

ASSESSMENT C
DECONTAMINATION DURATION, MANPOWER, AND EXPOSURE
OFF GAS AND ACID RECOVERY BUILDING

<u>Activity Description</u>	<u>Duration (days)</u>	<u>Manpower (manhours)</u>	<u>Exposure (manRem)</u>
1. Decontaminate component internals	52	1028	0.05
2. Remove and package Off Gas filters	3	100	10.0
3. Decontaminate Off Gas ductwork and blowers	3	192	19.2
4. De-energize OGT and ARC equipment	1	16	0.02
5. Prepare for Removal of equipment in OGT and ARC Building	2.5	80	0.1
6. Remove and package system pumps	1	44	1.8
7. Remove and package Off Gas ducts and blowers	3	168	6.8
8. Remove and package OGT and ARC components	46	1722	22.36
9. Decontaminate Off Gas ventilation Area walls and floors	27	1700	24.0
10. Decontaminate cell walls and floors	82	2600	2.78
11. Paint cell and ventilation area walls and floors	16.5	800	2.3
12. Contaminated concrete removal and packaging	87	1049	4.26
13. Removal and packaging of steel floor liners	2	60	0.01
14. Perform radiation survey	3	60	-
15. Decontaminate remaining hot spots	1	24	> 0.01
16. Perform final radiation survey	2	48	-
Subtotal OGT and ARC		<u>9691</u>	<u>93.69</u>

TASK 2

FACILITY UTILIZATION STUDIES

TABLE OF CONTENTS

	<u>Page No.</u>
1.0 <u>INTRODUCTION</u>	1
2.0 <u>INTERIM STORAGE OF SOLIDIFIED WASTE IN HOT CELLS</u>	2
2.1 Introduction	2
2.2 Discussion	2
2.3 Cell Specific Evaluation	4
2.4 Cost Estimate and Schedule	10
2.5 Conclusions	11
3.0 <u>INTERIM STORAGE OF WASTE CONTAINERS IN THE FUEL RECEIVING AND STORAGE POOL (FRS)</u>	13
3.1 Introduction	13
3.2 Description and Status of Facility	13
3.3 Storage Scheme	13
3.4 Arrangement of Containers	14
3.5 Storage Incorporating Compaction of Spent Fuel	15
3.6 Cooling of Stored Waste	16
3.7 Accessibility and Transport	16
3.8 Plant Changes and Additional Equipment Required for Interim Storage of Solidified Waste Containers in the FRS	17
3.9 Cost and Schedule	19
3.10 Conclusions	20
4.0 <u>CONCEPTUAL PLAN FOR SEGREGATION OF THE FUEL RECEIVING AND STORAGE (FRS) OPERATION</u>	21
4.1 Introduction	21
4.2 Discussion of FRS Separation	24
4.3 Segregation Plan	29
4.4 Cost and Schedule	39
4.5 Conclusions	40

LIST OF FIGURES

Figure 2-1	Waste Canister
Figure 2-2	General Purpose Cell Process Mechanical Cell Plans and Sections
Figure 2-3	General Purpose Cell Process Mechanical Cell Elevations
Figure 2-4	Chemical Process Cell Plan and Section One Tier Arrangement
Figure 2-5	Chemical Process Cell Elevation One Tier Arrangement
Figure 2-6	Chemical Process Cell Plan and Section Two Tier Arrangement
Figure 2-7	Chemical Process Cell Elevation Two Tier Arrangement
Figure 3-1	Interim Storage of Immobilized Waste in Fuel Storage Pool - Study
Figure 4-1	Site Plan Segregation of FRS Operation

TASK 2 - FACILITY UTILIZATION STUDIES

1.0 INTRODUCTION

The overall objective of this study is to establish the feasibility of using existing facilities at the West Valley nuclear fuel reprocessing complex for the removal and solidification of currently stored high level wastes (HLW), to examine the costs required to implement appropriate modifications and to establish a suitable construction schedule.

For the purpose of this study, a base case solidification process will be used. In the base case, the stored HLW will be calcined, the calcined waste will be mixed with glass frit and solidified in stainless steel canisters.

A schedule has been proposed to solidify the West Valley HLW as soon as possible, probably in the latter part of the 1980's. This schedule could precede the schedule for the construction of a Federal repository for the disposal of the HLW on a lag storage facility pending availability of the repository; consequently, it is necessary to examine the feasibility of utilizing existing onsite facilities for interim storage.

This task examines the feasibility of using the General Purpose Cell (GPC), the Process Mechanical Cell (PMC), the Chemical Process Cell (CPC) and the Fuel Receiving and Storage (FRS) pool to store canisters of solidified waste until such time as they can be shipped to terminal storage.

The cells and the FRS are being considered for storage because they are already designed for remote movement of material by cranes, for viewing of area contents through lead glass windows and water, for shielding with concrete walls and water, and for heat removal.

The third part of this task considers the steps which must be taken to segregate the FRS operations from the solidification operations conducted in the rest of the plant. As mentioned, this task examines the areas into which solidified waste may be placed for interim storage. Segregation of the FRS is considered for the following reason. If the facility is modified to solidify stored liquid HLW and space is available in the processing building or elsewhere to store the solidified waste, the fuel storage function can be reasonably separated from the rest of the facility.

2.0 SUBTASK 2A - INTERIM STORAGE OF SOLIDIFIED WASTE IN HOT CELLS

2.1 Introduction

The objective of this subtask is to investigate the feasibility of storing canisters containing solidified radioactive waste within the GPC, the PMC and the CPC of the Western New York Nuclear Service Center (WNYNSC). These canisters are configured as shown on Figure 2-1. They have an outside diameter of two feet and the material of construction is 304L stainless steel. For the purposes of this investigation, the canister height was considered variable.

The quantity of waste to be stored is based on solidification Option 1 in the WNYNSC Study Companion Report (Reference 1), Section 4.4.2.3, that is, incorporation of sludge, thorex waste and ion-exchange resin from supernate processing in a glass matrix.

If a waste canister with an overall height of 10 feet is selected and is filled to a height of 9 feet, then 224 containers will be required to accommodate the waste. Alternately, a waste canister with an overall height of 8 feet was considered. If filled to within one foot of the top of the container, 1512 kg of waste can be disposed within each container and 288 canisters will be required to store the waste.

2.2 Discussion

The waste canisters, described in the preceding section, were arranged on 33 inch centers in a square array in the PMC, the GPC, and the CPC. Since the canisters are 24 inches in diameter, 9 inches remain between canisters to accommodate the structural grid that accepts and supports them. This spacing must also be satisfactory for accommodating convective air currents cooling the canisters and for accommodating crane misalignment when locating canisters.

2.2.1 Structural Considerations

A conceptual design for a canister grid structure that could support the dead weight and seismic loads imparted to the structure by the canisters and building was prepared. Since selection of wide structural members detracted from storage space, an effort was made to minimize the width of the steel beams comprising the grid. Six inch wide beams were tentatively selected. This results in a 1-1/2 inch clearance

Figure 2 -1

WASTE CANISTER

(GLASTAINER)
TYPE 304 L SST

TASK 2

around each canister to accommodate crane misalignment. This was judged marginally satisfactory provided the crane locating the canister has an "inching" motor. In addition, a "locating funnel" detail should be generated for any final grid structure design. This would accommodate crane misalignments as great as four inches. It is also noted that structural considerations require that the clearance around each waste canister in its stored position shall be equal to or less than 1/2 inch. A clearance greater than this will result in unacceptable forces imparted to the grid structure during seismic events.

During the detailed design phase of this project, seismic design spectra at appropriate elevations will have to be generated to assure that the general conclusions and design guidance contained herein are compatible with the project seismic design requirements.

2.2.2 Two Tier Storage Evaluation

A two tier storage pattern was considered as an option for increasing the number of waste canisters that could be stored in a given cell. Evaluation of the seismic, constructibility and operations considerations associated with this concept revealed the following:

- (a) Seismic - The canister support structure must withstand as yet undefined seismic loadings. However, it is reasonable to assume that seismic loadings will be a significant factor in grid design which is magnified in the second tier due to elevation differences. The second tier would, therefore, be a structure requiring a significant effort to construct.
- (b) Constructibility - Construction of the canister support structure will be of structural members brought through the access ways into the cells. These paths limit the extent to which the grid can be prefabricated outside the cells. It is estimated that for the GPC and for the PMC at least half of the construction effort will be in the cells. This is a very significant consideration, since much of the second tier will, therefore, be remotely assembled and positioned after the first tier contains waste canisters. A second tier, designed to withstand seismic loadings, and which is capable of remote assembly, will require a major design effort and may not be practically achievable.

It is noted that the entire first tier and half of the second tier can be assembled before any waste is introduced to the cells. The constructed half of the second tier could be stored over an empty half of the first tier until the other half of the first tier was entirely occupied with waste canisters. At this point, the assembled half of the second tier would be repositioned over the filled half of the first tier.

- (c) Operational - An examination of the head room in the three cells being examined and the crane hook upper limits points out the final and conclusive element which precludes use of the Process Mechanical Cell and the General Purpose Cell with more than one tier of canister storage. There is insufficient head room in these cells to permit one to lower a waste canister into a second tier. This applies to the 8-foot high canisters, as well as the 10-foot high canisters. As shall be seen later, the CPC has sufficient area to accommodate on one level the 224 canisters of waste that are expected. If it is desired to locate the waste solidification equipment in the CPC, and at the same time store the waste canisters in this cell, it is operationally feasible to use a two tier storage arrangement.

2.3 Cell Specific Evaluation

2.3.1 Process Mechanical Cell

Figures 2-2 and 2-3 show the proposed arrangement of waste canisters in the PMC. Storage space exists for 70 waste canisters. This assumes that the access hatch to the FRS is blocked and the hatch to the GPC is accessible. Since the overall height of this cell is 25 feet and the upper limit of the crane hook is 4 feet from the ceiling of the cell, only 21 feet of vertical clearance is available to maneuver waste canisters. Allowing 18 inches for the mechanism which will hang from the crane hook and grapple the waste canisters, one is left with 19-1/2 feet. There is, therefore, insufficient room to maneuver 10-foot long canisters within this cell, since a minimum clearance of 20 feet is required to move one canister over another. A loading sequence which does not require canisters to pass over each other, runs the risk of damaging canisters if the crane operator deviates from a planned route. When the space occupied by the grid structure base with air circulation paths (estimated at two feet) is

REVISION				DATE	BY	CHK	APPROVED	DRAWING RELEASE STATUS				ENGINEERING REVIEW				WESTERN NEW YORK NUCLEAR SERVICE CENTER			
																DOE - TASK 2A			
																INTERIM STORAGE OF SOLIDIFIED WASTE IN HOT CELLS			
																GENERAL PURPOSE CELL (G.P.C.)			
																PROCESS MECHANICAL CELL (P.M.C.)			
																PLANS & SECTIONS			
																BURNS AND ROE INDUSTRIAL SERVICES CORP.			
																Engineers and Constructors			
																Paramus, N.Y.			
																Stamford, Conn.			
																DRAWING NO.			
																M 002			
																REV			
																0			

TASK 2

APPROVED DATE WORK ORDER
4870-20

FIGURE 2-3

TASK 2:

DRAWING RELEASE STATUS					
☒ PRELIMINARY	☐ PARTIALLY APPROVED				
RELEASED FOR	BY	DATE	RELATED TO	AMEND	ADD
INFORMATION			PLS NO.		
COMMENT					
APPROVED FOR					
BY					
CONSTRUCTION					

ENGINEERING REVIEW			WESTERN NEW YORK NUCLEAR SERVICE CENTER			
DRW	ENGR	DATE	DOE-TASK 2A			
MECH			INTERIM STORAGE OF SOLIDIFIED WASTE IN HOT CELLS			
ELEC			GENERAL PURPOSE CELL (C.P.C.)			
CIVIL			PROCESS MECHANICAL CELL (P.M.C.)			
ARCH			ELEVATIONS			
PLC			BURNS AND ROE INDUSTRIAL SERVICES CORP.			
			Engineers and Constructors			
DESIGN	CHK	SL/DOE	APPROVED	DATE	WORK ORDER	DRAWING NO.
					4870-20	M 003
					SCALE	AS SHOWN

factored into this evaluation, it is apparent that 8-foot high canisters are an appropriate selection for the PMC.

The crane within the PMC is rated at 2 tons. A waste canister with an overall height of eight feet (Figure 2A-1) is estimated to weigh 5000 pounds when filled to a height of seven feet. Thus, the 8-foot canister exceeds the rated capacity of the PMC crane.

Canisters will be brought into the PMC through the GPC. Since, as is shown in Section 2.3.2, 8-foot canisters cannot be moved through the GPC after it is filled, the PMC must be filled first.

Reference 1 (Pg. 4-24) estimates that each of 224 waste canisters will liberate 600* watts, due to the decay of radio-nuclides in the wastes. This amounts to a total of 134.4 kw for all of the canisters. Since a smaller canister is being proposed for use in the PMC, the waste heat liberated by each smaller canister will be less by an amount proportional to the volume of waste in the canisters. Thus, about 470 watts will be released by each 8-foot high canister. One can, therefore, anticipate a heat load in the PMC of about 33 kw (approximately 110,000 Btu/hour). The PMC coolers can handle this load while maintaining a 36% design margin, however, as shall be seen in Section 2.3.4, a new ducted ventilation system is recommended.

2.3.2 General Purpose Cell

Figures 2-2 and 2-3 show a possible layout for waste canisters in the GPC. As is shown, space is available for 47 canisters, however, if canisters are stored under all access hatches, space is available for 58 canisters. Since movement of canisters through the GPC is impossible when canisters are stored there, there is no reason not to store canisters under access hatches.

The crane capacity within the GPC is rated at 2 tons. For the reasons delineated at the end of Section 2.3.1, the 8-foot high canister shown in Figure 2-1 exceeds by 25% the largest load that a crane rated at 2 tons can lift within code limitations.

*Work currently underway at PNL indicates this may increase to 700 watts.

The overall height within the GPC is 19 feet 4 inches. If 18 inches is allowed for the canister grapple which is hung from the crane hook and four inches of clearance is allowed above the canister support structure, the top of the canister support structure cannot be higher than 5 feet 6 inches off the GPC floor. If two feet of clearance is required under a stored canister to accommodate canister support structural members and ventilation requirements, stored canisters in the GPC could only be supported for 3-1/2 feet of their 8-foot height. Canisters cannot readily be supported under these conditions. See Figure 2-3 for a visual depiction of this argument.

It is noted that the path for waste canisters into the GPC will be from the west end of the cell. If the CPC is used for housing the waste encapsulation equipment, the CPC 16-ton crane will be used to lower canisters into the GPC via the access hatch connecting the cells.

Alternately, the waste canisters could be brought in from outside the facility via the "Scrap Removal" route, using the 7-1/2 ton scrap removal crane to lower canisters into the GPC via the hatch connecting these cells, or via the rail access to the CPC and then into the GPC using the 16-ton CPC crane.

The GPC is equipped with a cooling unit capable of rejecting 100,000 Btu/hr. This heat rejection capability is sufficient to handle the waste heat from the stored canisters; however, as discussed in Section 2.3.4, a cell cooler with a ducted discharge is recommended to replace existing cell coolers.

2.3.3 Chemical Processing Cell

The single tier arrangement of waste canisters in the CPC is shown on Figures 2-4 and 2-5. As can be seen, there is enough room to accommodate 224 storage locations for 10-foot high canisters. The head room in this cell is 43 feet. As is shown on Figure 2-4, there is sufficient vertical clearance to move 10-foot canisters into and out of storage positions. The 16-ton crane in the CPC will be used to move canisters into their storage position.

The heat rejected by the 224 canisters in this cell will amount to about 134.4 kw (460,000 Btu/hour) or 600 watts

FIGURE 2-4

REVISION				DATE	DWN	CHK	APPROVED	DRAWING RELEASE STATUS				ENGINEERING REVIEW				WESTERN NEW YORK NUCLEAR SERVICE CENTER			
																DOB-TASK 2A			
																INTERIM STORAGE OF SOLIDIFIED WASTE IN HOT CELLS			
																CHEMICAL PROCESS CELL (CRC)			
																PLAN & SECTION, ONE-TIER ARRANGEMENT			
																BURNS AND ROE INDUSTRIAL SERVICES CORP.			
																Engineers and Constructors			
																Permut, B.J.			
																Sawford, Cene.			
																APPROVED	DATE	WORK ORDER	DRAWING NO.
																SCALE	4870-20	M 004	REV
																AS SHOWN			0

FIGURE 2-5

REVISION		DATE	CHK	APPROVED	DRAWING RELEASE STATUS		ENGINEERING REVIEW		WESTERN NEW YORK NUCLEAR SERVICE CENTER	
NO.	DESCRIPTION				PRELIMINARY	PARTIALLY APPROVED	BY	DATE	BY	DATE
					RELEASED FOR	RELAYS TO	BY	DATE	BY	DATE
					INFORMATION	RECORD				
					COMMENT					
					APPROVED FOR					
					END					
					CONSTRUCTION					

TASK 2

ENGINEERING REVIEW		WESTERN NEW YORK NUCLEAR SERVICE CENTER	
BY	DATE	BY	DATE
MECH		MECH	
ELEC		ELEC	
CIVIL		CIVIL	
ARCH		ARCH	
MISC		MISC	
OSHA/		OSHA/	
DOEN		DOEN	

INTERIM STORAGE OF SOLIDIFIED WASTE IN HOT CELLS

CHEMICAL PROCESS CELL (C-C)

ELEVATION - ONE VIEW ARRANGEMENT

BURNS AND ROE INDUSTRIAL SERVICES CORP.

Engineers and Contractors

PLANNING, N.Y.

APPROVED

DATE

WORK ORDER

4870-20

M 003

10

per container. There are three cooling units in this cell. Each has a cooling capacity of 270,000 Btu/hour for a total of 810,000 Btu/hour. Relying on natural convection about the waste canisters will result in temperature differences between the canister surface and ambient temperatures around the canisters of 15° to 20° F. However, there is concern that ambient air temperatures around the canisters may be considerably higher than the ambient temperatures above the waste canisters. This concern is addressed in Section 2.3.4.

It may be desirable to minimize the number of canisters stored in the CPC to permit a waste solidification facility to share the cell. For this case, maximum use of the PMC and GPC permits storage for 70 and 58 canisters (8-foot high), respectively. This represents 44% of the total volume of anticipated waste. The remaining 56% of the waste can be stored in 10-foot canisters in the CPC. If this is done, space for 125 canisters will be required in the CPC. This is equivalent to 16 rows with 8 in a row, in lieu of the 28 rows required to store 224 10-foot canisters. Thus, 1000 square feet of CPC floor space would be available for solidification equipment and a 3-foot thick concrete shield wall between the canisters and equipment.

An additional option that appears feasible, pending definition of seismic criteria, is a two tier storage arrangement at the south end of the CPC, as shown on Figures 2-6 and 2-7. All HLW can be stored in the southern half of the cell. This leaves 950 square feet for a solidification system and 3-foot thick shield wall between the system and the canisters. To accommodate a more substantial grid structure, a 36-inch center to center canister spacing was assumed. As a result, only seven canisters are assumed for each row. This option will require that the lower tier be filled and the second tier be remotely positioned by the mechanical handling equipment in the cell.

If it is feasible, it is more desirable that both tiers be constructed and positioned prior to the introduction of waste canisters, and then, as the first tier is filled, a support plate remotely located on supports over each filled first tier storage position. This approach will significantly improve the constructibility concerns discussed in Section 2.2.2. In addition, large sections of the grid structure can be constructed outside the facility and moved into the CPC via the rail access. Personnel access to the north end of the CPC should be possible after waste has been stored in the CPC,

provided Solidification equipment is adequately shielded and provided that the three-foot thick shield wall dividing the cell is configured to limit scattering dose rates as much as possible.

2.3.4 Cell Ventilation and Cooling

The heat liberated by the waste canisters stored in the PMC, the GPC and the CPC was calculated and compared to the capacities of existing cell cooling units installed in these cells. The characteristics of these cooling units were then studied with respect to their ability to adequately establish air flow around the canisters in the proposed arrangements.

Each cell contained adequately-sized coolers to reject projected heat loads. The 70 eight-foot canisters in the PMC would liberate slightly over 110,000 Btu per hour. The cell cooler is rated at 150,000 Btu per hour. The GPC with 58 eight-foot canisters will have a heat load of 92,000 Btu per hour. Its cell cooler is rated at 100,000 Btu per hour. Finally, the 250 ten-foot canisters in the CPC will liberate the full 134.4 kw (460,000 Btu per hour) predicted in Reference 1. The CPC has three cell coolers, each rated at 270,000 Btu per hour, for a total heat rejection capacity of 810,000 Btu per hour.

The coolers are designed such that a propeller fan draws air through a water cooled coil and discharges the air vertically downward. Air is taken in through the top of the cooling unit which is located low enough to permit the cranes and power manipulators to clear the top of the units. The distribution of air, which these units are capable of establishing, is considered inadequate in promoting movement around the stored canisters. The propeller fan is expected to discharge cooled air in a concentrated stream that will not significantly diffuse among the canisters nor penetrate below the canisters. This will result in an inversion effect of cool air blocking flow of heated air back to the suction side of the coolers. The fan on these coolers is not capable of feeding a ducted distribution system.

As a consequence of the aforementioned considerations, a new cooling system would be required for each cell. The general design criteria applied to these units are:

- a) that they have adequate capacity to remove the maximum expected heat generation rate

FIGURE 2-7

REVISION				DATE	DES	CHK	APPROVED	DRAWING RELEASE STATUS				ENGINEERING REVIEW				WESTERN NEW YORK NUCLEAR SERVICE CENTER			
																DOE-TASK 2A			
																INTERIM STORAGE OF SOLIDIFIED WASTE IN HOT CELLS			
																CHEMICAL PROCESS CELL (C.P.C.)			
																ELEVATION - TWO TIER ARRANGEMENT			
																BURNS AND ROE INDUSTRIAL SERVICES CORP.			
																Engineers and Constructors			
																SIGNED, B. J.			
																APPROVED			
																DATE			
																WORK ORDER			
																4870-20			
																DRAWING NO.			
																M 007			
																REV			
																O			

TASK 2

- b) that they have a ducted discharge which distributes air below the canisters
- c) that two 100% capacity units be provided for each cell to be able to accommodate a single active component failure within the cooling system
- d) that the fan coil units be positioned to permit maintenance.

The CPC has a crane maintenance area located at the north end of the cell. As is shown on Figure 2-4, two fan coil units have been positioned in this area. A large shield door, the width of the cell, is raised to permit the crane and power manipulator to move into the maintenance cell. The crane, riding on the upper pair of rails, easily clears the proposed fan coil units. The power manipulator must be moved to the west end of its trolley to enter the crane room. Access through the hatch to the Scrap Removal Room is not impeded by the placement of the fan coil units. A supply and return duct is routed through a penetration in the lower east corner of the vertical sliding shield door. These ducts are routed past a six-inch thick steel shield which is provided to reduce radiation scattering through the duct penetration. The fan coil unit supply duct is routed down along the north wall of the CPC to the floor of the cell and then southward along most of the length of the cell. Side registers uniformly distribute cooled air under the waste canisters. Return air is drawn into a duct centrally located on the crane maintenance level over the point where the supply duct turned down. The return duct is routed over the supply duct through the shield door penetration and into the fan coil units. The fan coil units are maintainable with the crane shield door in a closed position.

The GPC also has a crane maintenance area which could be utilized in the manner just described for the CPC. However, the PMC has no clear shielded area such as this to locate fan coil units. As a result, providing a ducted supply and return cooling system for the PMC may require that the fan coil units be located in a corridor. Removal of a lead glass window and the addition of substantial shielding may also be part of the solution. If the PMC is used for storage in spite of this and other limitations, discussed elsewhere in the report, the design of this system will have to be pursued further.

2.4. Cost Estimate and Schedule

A baseline approach to waste canister storage was defined to establish a basis for preparing a cost estimate for storage of radioactive waste canisters at the WNYNSC. The approach selected is represented by Figures 2-4 and 2-5. All waste canisters are assumed to be stored in a one tier grid structure located in the CPC. The grid structure was assumed to be prefabricated outside the buildings to the maximum practical extent with a minimum amount of assembly inside the CPC. Large assembled sections can be brought into the CPC through the 11' x 14' equipment opening at the north end of the cell and positioned using the 16-ton CPC crane. An allocation was made for the two 100% capacity fan coil units and its associated ductwork, piping and electrical equipment. Task 1 work was reviewed to ensure that no costs were duplicated or omitted.

Given the aforementioned basis, it is estimated that it will cost \$1,400,000 to provide a one tier storage facility in the CPC. This estimate is in first-quarter 1980 dollars. It includes Engineering, Design and Construction management costs, and an appropriate contingency to reflect the uncertainties that exist at the conceptual design stage. There is no IDC allowance. It is estimated that the storage facility can be constructed and operable in ten months following the notice to proceed. This includes an estimate for mobilization and equipment procurement.

Alternately, an estimate was developed for the storage scheme which makes maximum use of the PMC and GPC and stores the balance of the waste in ten-foot canisters in the CPC. This scheme requires grid structures in the PMC and GPC and a grid structure occupying half of the CPC. It also requires a three-foot thick shield wall in the CPC. The assumptions for grid structure assembly in the CPC is unchanged from the base case; however, prefabrication of the grid structures for the PMC and GPC is severely limited by the 2' x 5' hatch between the CPC and GPC and the 3' x 4' hatch between the GPC and PMC. The greatly increased amount of equipment handling and fabrication largely in confined quarters results in a severe economic penalty. In addition, this scheme requires ducted cooling units in all three cells, one of which is not of a straight-forward nature as discussed in Section 2.3.4.

The estimated cost of this scheme is \$2,836.00. The principal causes of the significantly increased cost of this option over the base case is reduced productivity due to a

minimally prefabricated grid structure and due to higher H&V equipment and installation costs associated with cooling all three cells. The construction effort for this option is estimated to be on the order of 17 months from the notice to proceed.

A second option discussed in Section 2.3.3 proposed storing all waste canisters in a two-tier grid structure in the CPC. Although a formal cost estimate and schedule was not prepared for this option, it is expected that the costs and schedule will be comparable to the base case. Costs will be increased slightly due to the necessity for a three-foot thick solid block wall to shield the solidification area from the storage area and due to a greater engineering effort on the two-tier design, analysis and development. This design may, if unforeseen problems occur, extend the 10-month schedule, but this is not readily predictable.

2.5 Conclusions

The CPC has adequate space to store waste canisters produced during the solidification of HLW currently stored in the WYNSC underground tanks and processed using option 1. There is space to accommodate the estimated 224 waste containers (10-foot overall height). Although existing cell heat rejection coolers are adequately sized, new ducted discharge coolers are recommended. Crane capacity and cell vertical clearances are satisfactory. Access to and from the cell from outside the facility is straightforward via the "equipment removal" route. This option is the least expensive and can be constructed in the shortest time.

Conversely, the PMC has marginal headroom using the shorter (8-foot high) waste canister. In addition, the crane capacity in the PMC would have to be increased to handle the 8-foot waste container. Access to and from the cell is indirect and inefficient, that is, via the GPC, and requires transferring the waste using a minimum of three cranes.

The GPC has inadequate headroom to consider storage of waste containers of the sizes considered herein (8-foot and 10-foot overall height), unless a grid structure designed to be laterally-filled with waste canisters is developed. Crane capacity is 80% of the projected weight of an 8-foot canister. Cell heat rejection capability is adequate, although new fan coil units are recommended.

Two options for using the CPC for waste solidification equipment while storing waste canisters in the cells were discussed in Section 2.3.3:

- (a) store 8-foot canisters in the PMC and GPC, and the balance of the waste stored in 10-foot canisters in the CPC, or
- (b) store all waste in 10-foot canisters arranged in a two tier grid structure in the CPC.

Between them, Option (b) is viewed as preferable. Canister movement is more efficient. One crane is required to move filled canisters from the solidification equipment to the storage location. The cost and schedule of this option is similar to that for storage on one tier in the CPC. Option (a) is twice the cost of Option (b) and requires a much longer construction period.

A combination of options (a) and (b) is not desirable from the standpoint that one would be faced with perfecting a two tier storage grid structure for the CPC and a grid structure for the GPC that permits canisters to be laterally loaded into position and remotely locked in place. Both approaches require considerable design development and prototype experience.

Finally, the 33-inch center to center spacing of canisters in the single tier storage arrangement and the 36-inch spacing for canisters in the two tier storage arrangement are preliminary. It is possible that this may be modified at the detailed design stage.

3.0 SUBTASK 2B - INTERIM STORAGE OF WASTE CONTAINERS IN THE FUEL RECEIVING AND STORAGE POOL (FRS)

3.1 Introduction

A preliminary investigation with respect to the feasibility of temporary storage of solidified waste containers in the FRS shows that such an interim storage scheme is feasible. The FRS has sufficient space to accommodate the solidified waste containers in addition to the 617 spent fuel canisters presently stored in the pool. The cooling system, serving the FRS has ample capacity to remove the fission product decay heat generated within the solidified waste containers. The various changes and additions to buildings and equipment required for interim storage of the immobilized waste in the FRS are identified and discussed.

3.2 Description and Status of Facility

The FRS has dimensions of 75 feet by 40 feet by 29 feet deep and is normally filled with demineralized water to a level of 28 feet. The 75 foot length is oriented east-west. On the east end of the FRS is a Cask Unloading Pool (CUP), designed for the removal of spent fuel assemblies from the shipping cask and their placement in fuel storage canisters.

The fuel storage racks consist of an aluminum beam structure in the FRS, providing 42 storage rows oriented north-south. Each row can accommodate up to 22 canisters.

Presently, there are 750 assemblies stored in 617 fuel canisters in the pool. The decay heat generated by the spent fuel is minimal, since spent fuel was last received at the plant in 1975. The pool water temperature is controlled by a cooling system with a total cooling capacity of 12×10^6 Btu/hr (3.5 MW). The actual heat load from the spent fuel is estimated at less than one million Btu/hour (1×10^6 Btu/hour), or about 8.3% of the cooling system capacity.

3.3 Storage Scheme

If all the full fuel canisters are moved to the west end of the fuel storage pool and arranged in 29 rows of storage racks, an unoccupied space, approximately 23 feet by 40 feet by 29 feet deep, will be available at the east end of the storage pool. This space can be used for underwater storage of solidified waste. It is also important to note that along

the east wall of the storage pool there is a gate leading to the CUP. This opening, which is used for underwater transfer of canisters loaded with spent fuel from the CUP to the storage pool, could conceivably be used to introduce solidified waste containers into the storage pool. A barrier could be erected to physically separate the spent fuel storage area from the solid waste storage space in the pool, in order to protect the fuel from mechanical damage. This barrier would have to be designed not to interfere with pool coolant water flow.

3.4 Arrangement of Containers

Solidification option number 1 (section 4.4, Reference 1), is estimated to generate 224 waste containers shaped as right circular cylinders, each having a height of 10 feet and a diameter of two feet. One arrangement considered for storage of the solidified waste containers is one in which the cylinders stand on their base in one or more tiers in the pool. In the unoccupied space noted in Section 3.3, an array of 9 x 17, or 153 containers, can be accommodated in a single tier. This array of 9 x 17 is based on center to center spacing of approximately 28 inches, which allows a gap of about 4 inches between adjacent containers. The remaining 71 containers can possibly be stored on a second tier located above the bottom containers. Such a storage arrangement will yield a minimum water shielding height of 8 feet above the waste containers. In order to assure sufficient water shielding height during handling and movement of the second tier containers, a special storage rack arrangement and handling schedule can be established to maximize the water shielding height.

The above storage arrangement incorporates a space allowance for erecting a two (2) foot thick barrier between the stored fuel canisters and the space assigned for storage of vitrified waste. The purpose of such a physical barrier would be to protect the spent fuel from being contacted and damaged by the movement of waste containers or any of the gear used in association with the handling of these containers. This barrier would have to be designed not to interfere with pool coolant flow.

An alternative approach to the above storage scheme is to use containers with a height of approximately eight feet, (2.45 meter), instead of ten feet, (3 meter). Based on a total solid volume of 180 m³, 280 eight foot high containers would have to be used instead of 224 ten foot high containers. Containers having a height of about 8 feet are preferable for storage in

PLAN

FIGURE 3-1

REVISION				DATE	OWN	CHK	APPROVED	DRAWING RELEASE STATUS				ENGINEERING REVIEW				WESTERN NEW YORK NUCLEAR SERVICE CENTER			
																DUE-TASK-2B INTERIM STORAGE OF IMMOBILIZED WASTE IN FUEL STORAGE POOL - STUDY			
																BURNS AND ROE INDUSTRIAL SERVICES CORP.			
																Engineers and Constructors			
																Seymour, N.Y.			
																APPROVED			
																DATE 3-15-80			
																WORK ORDER 4870			
																DRAWING NO. M-001			
																REV 0			

TASK 2

the fuel storage pool, from a shielding aspect. Storage for the larger number of canisters can be achieved by arranging the containers in a manner similar to the previous layout, namely, in two tiers with each tier consisting of an array of 9 x 17 containers. This provides a storage capacity of 153 containers per tier, or a total capacity of up to 306 containers (only 280 are required). This storage arrangement will result in an improved water shielding height, (minimum of 12 feet), and will also provide increased water shielding during the handling of the containers.

In conclusion, the fuel storage pool can accommodate the solidified waste. Improved minimum water shielding height and increased water shielding during handling of the containers in the storage pool can be achieved by reducing the height of the waste containers. However, this will result in the requirement to form more containers. The economic implications of handling approximately 25% more waste containers of a smaller size will be considered in the cost analysis.

3.5 Storage Incorporating Compaction of Spent Fuel

Compact storage of spent fuel is a technique for increasing spent fuel storage by decreasing the spacing between the stored fuel assemblies to form a more compact array. Section 5.0 of Reference 1 presents several alternative concepts for increasing the storage capacity in the FRS. The most conservative of these alternatives is based on using the existing racks with modified canisters, (compacted canisters). This design would increase the number of storage spaces from 924 to 1848 spaces, (from 416 MTU to 832 MTU).

The employment of the above compacted storage arrangement over a limited portion of the pool, and the storage of the modified canisters (approximately 310 canisters), on west end of the storage pool along 15 rows of racks, will yield a larger unoccupied area approximately 49 feet by 40 feet by 29 feet deep on the east end of the storage pool.

Arrangement of the solidified waste containers so that the cylinders stand on their base on the pool floor, and form an array of 17 x 20 containers, will accommodate up to 340 containers in a single tier in this larger area. Such an arrangement can readily accommodate all the containers, whether the container height is 10 feet (3.0 meter, equivalent to 224 containers) or 8 feet (2.45 meter equivalent to 280 containers) in a single tier array. This storage arrangement will significantly increase the water shielding height, (minimum of 18 feet

with a 10 foot high container), and will also provide increased water shielding during the handling of the containers.

3.6 Cooling of Stored Waste

The total heat generation rate of the solidified waste is 134.4 KW. This is based on 224 containers with a heat generation rate of 0.6 KW for a container 10 feet in height. The FRS is served by a cooling system with a capacity of 12×10^6 Btu/hour, (3.5 MW). This indicates that storage of the solidified waste in the fuel storage pool will require no supplementary means for cooling the waste containers, as the pool cooling system has sufficient cooling capacity.

3.7 Accessibility and Transport

There is no direct access from the CPC to the FRS. However, the solidified waste can be transferred into the FRS using the cask unloading equipment. This will require shielded transfer casks for on-site transfer of the solidified vitrified containers from the location where the waste is sealed in stainless steel canisters, to the CUP. The shielded transfer casks must provide the necessary shielding and must ensure that the container integrity is maintained during on-site handling. Interim storage in the FRS will also require some form of conveyor or a track-mounted powered transfer cart for accepting the shielded casks and transferring it to the FRS facility. It is important to bear in mind that waste containers are to be generated at a rate of one per day. This implies that automated handling facilities are not essential, and conveying equipment capable of handling one waste container at a time will suffice.

The unloading of the shielded transport casks in the FRS facility, the removal of the containers from the cask and the transfer of the containers to the storage pool from the CUP, can all be performed using techniques similar to those already employed in receiving shipping casks used for shipment of spent fuel assemblies to the WNYNFC facility, offloading them and removing the fuel assemblies from the shipping cask. The 100-ton Cask Handling Crane with its two 5-ton auxiliary hoists could be utilized for unloading the shielded casks containing the waste containers and the placement of the containers in the CUP for subsequent transfer to the storage pool.

The fuel pool canister crane, a movable bridge with an attached crane of 2-ton capacity, is used to transfer fuel canisters between CUP and canister storage racks. The waste container, having a 10 foot (3.0 meter) height, will have an underwater

weight of slightly over 2 tons. It is thus possible that this crane can also be utilized in the handling of the waste containers.

The facilities available are also adequate to handle the removal of stored canisters from the storage pool and placement into a shielded shipping cask for removal to a Federal repository, once that facility becomes available. The cask for off-site shipment is presently considered to have the capacity to accommodate five waste containers and will weigh less than 100 tons.

3.8 Plant Changes and Additional Equipment Required for Interim Storage of Solidified Waste Containers in the FRS

This section of the analysis identifies the various changes and additions to plant structures and equipment that will be necessary in order to facilitate interim storage of waste containers in the FRS.

- (a) It will be necessary to remove a portion of the storage pool canister racks (remove 13 of 42 rows) and replace these with a rack arrangement appropriate for accepting the waste containers. The selected rack system must be designed: (1) to protect stored containers from mechanical damage, (2) to permit easy insertion and removal of containers during handling operation, (3) to meet Seismic Category 1 requirements, and (4) to ensure proper spacing between containers in order to allow for proper coolant flow as required for heat removal. Design must also preclude dropping of a container as a result of seismic forces or during crane handling. Materials used in construction of the storage racks must be compatible with the storage environment of the racks (demineralized water).
- (b) It will be necessary to erect a barrier-type structure inside the storage pool to physically separate the west end of the pool (area where spent fuel canisters would be stored) from the area marked for solidified waste storage. The barrier is to protect the spent fuel from potential mechanical damage that may be caused due to the handling or dropping of a waste container. The barrier should be designed in a manner that will allow coolant flow across the barrier face. Barrier thickness should not exceed two feet.
- (c) Shielded casks (at least two) must be provided for on-site transport of the waste containers. The casks should be of a design that provides the necessary shielding and will

also ensure that the container integrity is maintained during on-site handling.

- (d) Provisions must be made for the transfer of the cask shielded containers from the main process building to the FRS facility. This will require some form of conveyor, track-mounted transfer car, or truck. The transfer vehicle should be able to deliver the shielded containers to the FRS receiving area, where the shielded casks can be handled by the cask unloading crane.
- (e) The equipment serving the CUP must be modified. To accommodate the use of the shielded casks containing the waste containers during unloading into the CUP. The extent of these changes depends on the physical differences between the casks used for spent fuel shipments to WNYNSC, and the shielded casks to be selected for on-site container transfer.
- (f) Should the fuel pool canister crane be found adequate and of sufficient lifting capacity for underwater handling of waste containers, it will be necessary to provide the bridge crane with interlocks to prevent it from lifting waste containers above stored spent fuel containers, and also from raising waste containers above a level that will violate the minimum water shielding height requirements.
- (g) The design requirements indicated below must be examined to insure compliance with nuclear industry practice:
 - (1) Category I seismic design requirements for the spent fuel storage pool and surrounding structure (Reference 2).
 - (2) Facility tornado and missile design requirements to prevent or minimize loss of watertight integrity of the storage pool, or to protect either the fuel or the stored solidified waste from damage.
 - (3) Facility ventilation and filtration system effectiveness in controlling and limiting releases of radioactive materials.
- (h) Arrangement must be made in the waste processing cell to allow entry and removal of the loaded shielded transfer casks and to permit the loading of the waste containers into the transfer cask.

- (i) If the fuel compaction option is selected, it will be necessary to redesign the spent fuel storage canisters, and to construct approximately 310 new spent fuel storage canisters. For more details regarding the compacted canister, see Section 5.2 of Reference 1. A portion of the existing storage racks (15 rows) will be retained and utilized in conjunction with the new canisters.

3.9 Cost and Schedule

The cost and schedule requirements for subtask 2B, namely, interim storage of solidified waste in the FRS reflect the items identified in Section 3.8 of this study, namely: the various measures and modifications required in order to accommodate the waste containers in the FRS, access and interface requirements with the immobilization process area in the CPC, and the equipment required for transfer and handling the waste canisters from the waste solidification area to the FRS pool.

The total capital cost estimate for allowing interim storage of the solidified waste canisters in the FRS is approximately \$3.2 million. Included in this total are: design and engineering costs, capital cost of equipment and materials, construction labor costs, and construction management costs. The cost figure is in first quarter 1980 dollars, has no IDC allowance, and includes an appropriate contingency to reflect the conceptual nature of the design. No cost escalation was applied to bring the cost of equipment to the appropriate delivery date as the project authorization to proceed date has not been defined.

It is estimated that the above changes can be completed within an eighteen (18) month construction period that follows receipt of the Authorization to Proceed (ATP) notice. The above reflects the construction schedule only and does not account for schedule requirements in association with engineering, design, and licensing.

3.10 Conclusions

The FRS has adequate capacity to store the 617 spent fuel canisters currently stored in the pool and the estimated 224 waste containers (10 foot high) generated using option 1 (Reference 1) to solidify the HLW currently stored in the underground tanks. It was necessary to institute a two-tier storage arrangement for the waste containers to accommodate all 224. Alternately, storage of 280 eight-foot containers was considered. They, too, can be accommodated in a two-tier storage rack, but

with the advantage that the depth of water covering the containers increases from 8 feet (for the 10 foot containers) to 12 feet (for the 8 foot containers).

Reference 1 examined compact storage of fuel containers. If this is instituted, as many as 340 waste containers can be stored in a single tier in the remaining space in the FRS. This appears to be the most desirable of the options, since ten-foot waste containers can be stored with adequate shielding, the number of waste containers is limited to 224, and container shuffling can be carried out while maintaining seven feet of water between the container being moved and the water surface.

The cooling capacity of the FRS cooling water system is rated at 12 MBtu per hour and is satisfactory for the proposed service.

Accessibility to the FRS is straightforward via the current fuel assembly receiving and storage route. It is recommended that this route and its cask handling equipment be modified to accept and handle waste containers. It is noted that the rated capacity of the fuel pool canister crane (2 tons) is less than the projected submerged weight of a waste canister.

4.0 SUBTASK 2C - CONCEPTUAL PLAN FOR SEGREGATION OF THE FUEL RECEIVING AND STORAGE (FRS) OPERATION

4.1 Introduction

4.1.1 Task Outline

Consideration is being given to segregating the West Valley FRS operation from the waste solidification operation and relegating the FRS operations to a separate jurisdiction. It should be noted that the two operations are expected to proceed concurrently and the above emanates from site management considerations. The evaluation performed herewith is a conceptual examination of the measures required to segregate the FRS operation from the rest of the plant, and is based on the assumption that the FRS facility is not required for storage of immobilized waste, as analyzed under subtask 2B (part 3.0 of this study).

The study presented herewith is a conceptual outline of changes that the West Valley facilities will have to undergo in order to segregate the FRS facility from the balance of the reprocessing plant, and allow the solidification and FRS operations to be performed independent of one another.

The criteria followed in executing the above task are explained and outlined. The various changes to buildings and plant systems, required in order to achieve both physical and functional separation, are identified and discussed.

4.1.2 Codes and Standards

The work performed under this sub-task is based on compliance with the following guidelines and standards:

1. U.S.N.R.C. Code of Federal Regulations, Title 10, Chapter 1, Part 72, "Licensing Requirements for the Storage of Spent Fuel in an Independent Spent Fuel Storage Installation," Proposed Rule Making, November 10, 1978.
2. American National Standard, ANS-57.7, Draft, November, 1978, Design Criteria for An Independent Spent Fuel Storage Installation, (Water Pool Type).
3. U.S.N.R.C., Regulatory Guide 1.13, Spent Fuel Storage Facility Design Basis, Rev. 1, December, 1975.

4.1.3 Separation Criteria

Separation criteria is based on the assumption that the FRS will continue to be maintained under NRC license and

will be operated independently of the decommissioning of the reprocessing plant and associated facilities, and the sole function of the segregated facility is interim protective storage of spent fuel. The highlights of the separation criteria can be summarized as follows:

1. The segregated FRS facility will be maintained under NRC license, and is to conform to NRC design criteria and guidelines.
2. The FRS facility will function solely in a custodial capacity, providing safe storage conditions pending future disposition of the spent fuel.
3. With respect to certain systems, the spent fuel storage installation has to be completely independent from the reprocessing facility and the plant solidification operation. This requires that certain systems cannot be shared with the balance of plant. Examples of such systems are: pool water cooling system (primary loop) and pool water purification system.
4. Certain subsystems may be interconnected with, or use components of existing on-site systems associated with the processing plant, providing these systems are of sufficient capacity. Examples of such interconnections are:
 - (a) FRS Water Cooling System - The coolant heat sink for the secondary side of the evaporative coolers' heat exchangers may be provided by the existing facility system. This includes plant water circulated over the outside coils.
 - (b) Fire control and protection water system - The segregated FRS facility can be served by the existing fire control and protection water system.
 - (c) Transportation - Utilize existing railroad tracks with a separate projecting branch to the FRS building receiving bay.
5. The work performed is limited to spent fuel discharged from commercial light water reactors and aged a minimum of one (1) year from reactor shutdown. The spent fuel to be stored will be whole fuel assemblies or canned fuel assemblies, and is to be stored under water.

6. The storage pool is to be served by an independent cooling system of sufficient capacity to dissipate the decay heat of the stored fuel. The existing system has a total cooling capacity of 12×10^6 Btu/hr (3.5 MW). The amount of spent fuel to be stored in the pool should be in conformance with the capacity of the above cooling system, and the existing fuel storage racks.
7. Physical separation of the FRS building from the rest of the plant can be achieved by the closing or sealing of existing transfer ports/passageways shared by the FRS building and the main process building.
8. The separated fuel storage facility is to incorporate the following safety features: it will prevent a loss of water from the fuel pool, and thus prevent the fuel from being uncovered, it will protect the fuel from mechanical damage, and through its heating and ventilation system will provide the capability of limiting the potential off-site exposures in the event of a release of radioisotopes from the fuel.
9. The heat storage capability of the storage pool would allow sufficient time to take corrective action in case of a breakdown of the cooling system.
10. The segregated spent fuel storage facility will be provided with an independent spent fuel pool water treatment and makeup system. The system will include equipment for the removal of radioactive materials and particulates from the pool water by circulation through filters and ion exchangers.
11. In order to attain full independence from the balance of the reprocessing facility the FRS facility is to be provided with a separate electrical power supply via a new 34.5 KV/ 480V transformer and 480V switchgear, to be added adjacent to the FRS building. The separate electrical power supply will provide motive power to all pumps, electrically operated valves, and components of the segregated facility. It will also provide the necessary lighting, instrumentation, alarm functions, and security communications and interlocks.
12. The FRS facility will be provided with its own supply of on-site emergency electric power. The power source shall be designed to supply the essential emergency power needs

of the FRS facility. The above include: long term pool water cooling, pool water makeup, vital instrumentation, emergency lighting, communication equipment, and security systems.

13. The nature of an FRS facility is such that automatic action and immediate operator response are not required. This would imply that remote instrumentation and control equipment can remain located in the control room of the main reprocessing building. However, in order to make the FRS facility fully independent of the rest of the plant and its associated facilities, it is recommended that the existing control, instrumentation, and alarm functions in association with FRS operations be reconnected to a new console located in a new utility (auxiliary equipment) building. The new console will be arranged for control and monitoring of all equipment, both existing and new, associated with the fuel receiving and storage facility.
14. The segregated FRS facility is to be provided with an independent physical security system, designed in accordance with existing codes and standards. The protected area is shown in Figure 4-1, and includes the FRS building, on-site auxiliary power supply system, equipment used to transport and store fuel, and other vital equipment. The system is to protect vital materials and equipment against industrial sabotage and intrusion.

4.2 Discussion of FRS Separation

4.2.1 Separation Scheme

The point of entry for fuel assemblies to the reprocessing plant is through the FRS facility, located on the east side of the main process building. The FRS facility consists of a cask decontamination area, a cask unloading pool, an unloading crane, a fuel storage pool, storage racks and canisters, a fuel pool canister crane, and water cooling and purification equipment. The physical location of the FRS building relative to other buildings at the plant site is shown in Figure 4-1.

The utilization of the FRS facility for spent nuclear fuel storage only, will require that the existing FRS building be isolated physically, and separated both functionally and administratively, from the balance of the West Valley plant.

The approach adopted herewith is based on carving out of the existing reprocessing plant those structures, utilities, and ancillary equipment that serve in handling and storage of spent fuel. Figure 4-1 provides a schematic outline of the facilities to be isolated, they include: the FRS building, the existing FRS auxiliary equipment building (north of the FRS building), the evaporative coolers and additional components of the pool water cooling system located outside and north of the FRS building, railroad tracks and car pullers (north and south of the FRS building). The figure also shows the outline and location of an additional building, proposed for use to house various utilities and systems that are inseparable from the balance of the plant. All of the above are to be included in a protected area enclosed by a security barrier, with controlled access of personnel and vehicles, and is to be administrated independently from the rest of the West Valley facility.

4.2.2 Physical Separation

The physical segregation of the FRS building from the main process building can be accomplished without undue hardship. The separation requires the following:

1. Sealing of the underwater port that leads from the storage pool to the PMC. In the reprocessing mode of the plant, this port was used for underwater transfer of spent fuel canisters from the storage pool to the PMC.
2. Physical dismantling of the swing arm conveyor used for underwater transfer of spent fuel canisters from the storage pool to the PMC and its removal from the storage pool.
3. Sealing of the hallway leading from the main process building to the FRS building, and provision of a separate entrance to the FRS building from the outside.

4.2.3 Functional Separation

In order to fully segregate the FRS facility from the balance of the plant, it will be necessary to provide the segregated facility with utilities and auxiliary systems that are both separate and independent of the balance of the reprocessing plant. The above systems include:

1. FRS pool water cooling system.
2. FRS pool water treatment system.
3. Demineralized water system.
4. Plant water system.
5. Cooling water system.
6. Domestic and potable water.
7. Heating, Ventilation and Air-Conditioning System.
8. Compressed air Systems.
9. Electrical power and emergency electrical power.
10. Fuel and steam supplies.
11. Drains and sewage.
12. Facility Instrumentation and Control (I&C), and an independent control center.
13. Laundry.
14. Communications.
15. Plant Security.
16. Fire control and protection water system.
17. Radwaste treatment system.
18. Radiation protection system.

From the standpoint of segregating the FRS facility from the rest of the plant and converting it into an installation that is functionally self-sufficient, the above utilities and systems can be classified into two categories. These are:

1. Systems/Utilities that, based on the separation criteria, are not to be shared with the balance of plant, regardless of the ease or difficulty associated with their separation. The segregated FRS facility will require separate and independent systems to perform these functions. Examples are: an emergency on-site electric power supply, pool

water cooling system (primary loop), pool water cleanup system, and security systems to serve the segregated installation.

2. Systems/Utilities that serve both the FRS facility and the main process building that, based on the separation criteria, may be interconnected and shared with the main facility. Examples of such systems are: radwaste disposal, potable water, fire protection system, compressed air system, and communication equipment. It is important to note that, although the separation criteria allows the sharing of the above systems with the balance of the reprocessing facility, for some of these systems sharing of the system with the balance of plant is impractical or unfeasible due to system physical layout and/or capacity considerations. Examples of such systems are: compressed air system, off-site electric power system, potable water system, and demineralized water system.

4.2.4 Extent of Functional Separation

Certain systems/utilities are shared by the entire reprocessing plant complex, and their separation would be impractical. This was identified under 4.2.3 above. Some of these services are: certain water systems, compressed air systems, off-site electric power, auxiliary steam, etc. Two approaches appear feasible in order to overcome this hardship and achieve separation of the FRS facility. The approaches are:

- (a) Provide the utilities/services from the main facility by use of existing equipment and systems.
- (b) Install separate and independent systems to serve the fuel storage installation.

A brief discussion of the merits of the two approaches follows:

1. Provide Utilities from Facilities Associated with the Reprocessing Plant

Selecting this approach would result in a situation that the segregated fuel storage facility will depend for certain utilities/services on the balance of the reprocessing plant and the separated FRS will not be totally independent of the operability of the principal facilities

of the reprocessing plant. In other words, this approach will depend on continued use of the WNYNSC, and that certain systems and equipment, such as plant steam and electric power, be kept operational. This approach cannot be reconciled with certain plant decommissioning alternatives that follow high level waste solidification, such as protective storage or dismantlement, for which plant operation will cease.

It will also be necessary to establish a system to monitor the services provided to the spent fuel storage installation from the main facility for accounting purposes. This can be accomplished by the installation of flow volume and power metering devices, and/or institution of a charging system for services rendered.

2. Installation of Separate Systems/Utilities to Serve the Storage Installation

This approach appears more in conformance with the stated objective of identifying changes to the West Valley facility in order to allow the spent fuel pool to be operated independently of the waste solidification and plant decommissioning alternatives for the reprocessing plant and its associated facilities.

The above approach will require the installation of certain new systems/utilities and the modification of some of the existing systems to serve the spent fuel storage installation. These systems are:

- (a) Demineralized water system.
- (b) Plant water system, modification.
- (c) Cooling water system.
- (d) Domestic and potable water system.
- (e) Compressed air systems.
- (f) Off-site electric power system.
- (g) Fuel and auxiliary steam supplies.
- (h) Drains and sewage.
- (i) Fire control and protection water system, modification.

Installation of the above systems will require the addition of another building to house the additional auxiliary equipment. It can be erected on an area to the north-east of the FRS building which it will serve, see Figure 4-1. The additional building can also serve to provide space for other supplementary facilities required in association with an ISFSI, such as: an emergency source of on-site power and an independent facility control center.

4.3 Segregation Plan

The following is a detailed summary of the changes that will be necessary in order to segregate the fuel receiving and storage operation from the rest of the reprocessing facility. The plan presented herewith encompasses both physical and functional separation, and covers the entire scope of systems, auxiliary equipment, and utilities to be included in the separated fuel storage installation and specifies the changes/additions that will be required.

4.3.1 Physical Separation of Fuel Receiving and Storage operation

4.3.1.1 Separation of Existing FRS Building

Items to be addressed for physical separation of the FRS building from the main reprocessing building were provided under section 4.2.2 of this study.

4.3.1.2 New Auxiliary Building

A separate building to house the additional auxiliary equipment and systems will have to be constructed. Figure 4-1 shows the site location and outline of this building. It is to be added to the north-east of the FRS structure. The new building will be a steel frame structure with concrete masonry exterior walls, and supported on piles. The building is assumed to have a height of 20 feet, and a roof construction consisting of a concrete and steel deck. A portion of the building will include a ten (10) foot high mezzanine utilized as an office area.

4.3.2 Water Systems

4.3.2.1 FRS Cooling System

This system serves to dissipate the decay heat from the stored fuel. Heat is rejected through wetted surface

evaporative coolers located outside the FRS building, see Figure 4-1. The primary side of the system circulates pool water through the primary side of the evaporative coolers; the components of this system include: fuel pool circulating pumps, piping, and the evaporative coolers. The components of this portion of the system are located either in the FRS building or outdoors, and can be readily integrated into the separate fuel storage installation.

The secondary side of the system utilizes plant water, provided through the plant water system. The FRS cooling system also interfaces with the demineralized water system, auxiliary steam, utility air, electrical power and emergency power. The separability of these systems/utilities is to be discussed separately. In summary, the layout of the FRS pool water cooling system is such that it can be carved out of the existing reprocessing plant in its entirety, and no special changes to the system will be required.

4.3.2.2 FRS Pool Water Treatment System

The FRS water treatment system serves to maintain the purity of the water in the pools. It consists of a 500 gpm filter, a 100 gpm non-regenerable ion-exchanger, a precoat mixing tank, and a piping system, all used to remove particulate and dissolved impurities. The equipment is housed in the water treatment area inside the FRS building, (adjacent to the cask unloading pool), see Figure IV-2-1 of Reference 3. No changes will be necessary in order to incorporate this system in the separated facility. However, it is important to note that the radioactive filter precoat and spent bead resin of the purification equipment are presently pumped to the plant's Intermediate Level Waste Facility (ILWF), for processing and concentration. The intermediate level waste treatment facility can be characterized as inseparable from the balance of plant, and the separation approach is to be discussed under item 4.3.10.

4.3.2.3 Demineralized Water

A Segregated FRS facility will require demineralized water for storage pool water make-up. The existing FRS facility receives demineralized water from the demineralized water system. The major components of the system are housed in the Utility Room and the system can be classed as inseparable.

The above dictates that a separate demineralized water system will have to be installed. The system will incor-

porate the following components: ion exchangers, a 300 gallon storage tank and a stainless steel piping system. System capacity is estimated as 3 gpm. The system can be housed in the new auxiliary systems building.

4.3.2.4 Plant Water

A segregated FRS facility will require plant water to supply systems such as: make-up water for losses from the secondary side of the wetted surface evaporative coolers serving the FRS pool water cooling system, demineralized water system, domestic water, process cooling water losses make-up, and fire control and protection water system. If it is proposed that the segregated FRS facility be provided with plant water from the existing plant water system. This will require continued operation of the present raw water treating system. The present plant water system encompasses the following:

- a. Two (2) artificial lakes as the water source.
- b. Pumps and pump house at lake No. 2, and an underground pipeline in which water is flowing to the utility building.
- c. A raw water clarifier located outdoors south of the utility building.
- d. A chlorinator, lime feed equipment, two plant water filters and two (2) clarified water pumps, all located in the utility building.
- e. A 475,000 gallon filtered water storage tank located outdoors south of the utility building.
- f. Two plant water booster pumps that feed the plant water header.

In order to interconnect the segregated FRS facility to the existing plant water system, it is required that a separate piping system be installed from the existing plant water header to plant water users in the FRS installation (both existing and new users).

It is important to note that should the main facility be dismantled subsequent to completion of HLW solidification, new arrangements for plant water supply will be required to support the FRS operation.

4.3.2.5 Cooling Water

A segregated FRS facility will require a cooling system to remove heat from equipment such as air compressors, aftercoolers, air conditioners, fuel pool cooler, and various service equipment.

With the exception of a forced ventilation cooling tower located outdoors, the major components and piping of the cooling water system are located in the main process building and are inseparable.

The above requires that a separate cooling water system be installed to serve the fuel storage facility; this can be accomplished as follows:

- a. Installation of a new cooling water system in the auxiliary systems building. The system will include: two (2) circulation pumps rated at 180 gpm each, supply and return headers, a piping distribution system to cooling water users in the auxiliary buildings and the FRS building and filters.
- b. A new roof mounted cooling tower package for heat rejection.

4.3.2.6 Domestic and Potable Water

The existing potable water system is inseparable from the balance of plant and a new potable water system will have to be installed to serve the segregated FRS operation.

The new system is to prepare domestic and potable water by the additional chlorination of plant water. It will require: chlorinators, a 300 gallon storage tank to be pressurized with plant air, a booster pump, and a distribution piping system. Hot water can be furnished by use of individual electric heaters. The new system will be installed in the auxiliary systems building. It is estimated that the system will require a water makeup rate of 15 gpm.

4.3.2.7 Fire Control and Protection Water System

The segregated fuel storage installation can be provided with an adequate water fire protection system, by utilizing portions of the existing fire protection system. This can be accomplished as follows:

- a. Retain use of existing fire pump shelter south of the utility building, and existing fire pumps, one (1) electric motor driven and one (1) diesel driven.
- b. Retain use of existing plant water (filtered water) storage tank serving the plant water system of item 4.3.2.4.
- c. Utilize portions of existing fire loop and add connection as and where required for fire protection of FRS installation. This applies to sprinkler system and fire hydrants.

Decommissioning of the reprocessing plant and the associated facilities subsequent to solidification of the high level waste (HWL), will require an alternate approach for providing the FRS installation with water for fire protection.

The independent fuel storage installation will also require additional fire detectors and alarms; also, new portable fire extinguishers and stations.

4.3.3 Compressed Air Systems

4.3.3.1 Plant Air

Presently, plant (process) air is supplied by compressors located in the plant Utility Room. The existing system is inseparable from the main facility, and the separate FRS installation will require its own source of plant air. A compressed air system is required in order to provide the following process air needs:

- (a) Utility Stations in the FRS building and the auxiliary buildings, (air tools).
- (b) Pool water treatment system, and cask decontamination room requirements.
- (c) Air motors serving air operated valves.
- (d) Air for priming of certain components.
- (e) Instrument air.

The new system will require the following components: two (2) 75 scfm, 100 psig compressors, air receiver tanks, intake filters, air aftercoolers, and a piping system to supply both existing and new air users in the FRS building and the auxiliary buildings. The system will also require a supply of cooling water. The new equipment is to be housed in the new auxiliary equipment building.

4.3.3.2 Instrument Air

The FRS facility will require its own supply of instrument air. This can be accomplished by piping a portion of the plant air through a 50 scfm electric heated regeneration dryer, filters and pressure regulators. The new hardware is to be installed in the new auxiliary equipment building.

4.3.4 Steam and Fuel

4.3.4.1 Steam

The existing reprocessing plant is served by two auxiliary steam boilers located at the Utility Room with steam being distributed throughout the plant. The existing steam system is inseparable from the balance of plant, and a separate auxiliary boiler, to serve the segregated FRS operation, will have to be installed.

It is proposed that a steam generation unit (package-type), with a rated capacity of 6900 lbm/hour and 150 psig be installed in the new auxiliary systems building to serve steam to the following users:

- (a) Utility Stations in FRS building
- (b) Cask Decontamination Room, FRS building
- (c) Fuel Pool Cooling System - Steam jets serving the water cooling units outdoors
- (d) Building Ventilation Heating
- (e) Trace Heating
- (f) Heating outdoor water storage tanks, such as de-mineralized water

It is assumed that only one auxiliary steam boiler will suffice in meeting the various steam consumption modes, and the facility will be able to accommodate a situation where the boiler is down.

The auxiliary steam system also requires the installation of certain ancillary equipment, such as: feed and condensate systems, feedwater makeup, and a condensate storage tank.

4.3.4.2 Fuel

The auxiliary steam boiler can be run on natural gas, supplied to the West Valley site by the Iroquois Gas Corporation. Certain FRS facility buildings can be directly heated by gas-fired heaters.

Oil is to be used for the emergency diesel generator, and an ample supply of diesel fuel will have to be stored on site, (approximately four days of emergency diesel operation).

This system will require the installation of a 2,000 gallon diesel oil storage tank, located outdoors, two (2) electric driven transfer pumps, and an indoor day tank adjacent to the emergency diesel generator containing sufficient fuel for several hours of operation.

4.3.5 Drains and Sewage System

4.3.5.1 Radioactive Drains

Certain FRS building drains can be characterized as radioactive drains and will require special collection and processing. These include: the drain from the cask decontamination pit room, railroad car spot drains, and certain FRS building floor drains.

In the existing plant, the above FRS building drains are collected in storage and settling tanks and are subsequently transferred by steam jet to the Intermediate Level Waste Treatment (ILWT) facility for concentration and storage.

The segregated FRS facility can no longer be served by the existing waste tanks and ILWT facility and will have its own equipment for handling radioactive liquid drains and floor sumps. The drain system has a minimal radioactive inventory and the installation of a small size radwaste system to collect, monitor, and process the liquid from the various drains for subsequent release to the environment will suffice.

The new system will require the installation of a drain settling tank, two (2) transfer pumps, a cartridge type filter, sample monitoring equipment, a drain water demineralizer (ion exchanger), and a suitable piping system for recirculating the processed liquid to the drain settling tank or releasing it to the environment. The added equipment can be housed in a new pit adjacent to the FRS building.

The spent bead resin from the drain water demineralizer is to be transferred to a new backwash settling tank as discussed under item 4.3.10.

4.3.5.2 Sanitary Sewage

Sanitary waste from the segregated FRS installation and office building is to be connected to the existing sewage system.

4.3.5.3 Chemical Process Drains

Chemical waste streams such as water treatment waste streams, demineralizer regeneration waste streams and auxiliary boiler blowdown are diverted to an existing sludge pond via an auxiliary building sump. The system requires the installation of two (2) sump pumps.

4.3.6 Heating and Ventilation System

The heating and ventilation (H&V) equipment serving the FRS building is housed in a separate equipment building located north of the FRS structure. The major components of this system include a HEPA filter, two (2) recirculation fans, also heating and cooling coils. The above H&V equipment building can be readily incorporated into the separated FRS installation as shown in Figure (4-1). In light of the above, the heating and ventilation work within the existing reprocessing plant complex affected by separating the FRS operation is considered minimal, the presumption being made on the basis of lack of detailed layout drawings and plans of building services.

The only recognizable addition would be the connection of the existing steam coils of the FRS makeup air system to the new steam system originating in the new auxiliary systems building.

The separation of the FRS building exhaust from the plant exhaust train requires that a new prefilter, HEPA filters, air washers, exhaust fan and stack be provided for the segregated FRS building.

The added auxiliary systems building requires its own components of building services, consisting of a new heating and ventilation supply system, duct work, air outlets, insulation, steam connections, automatic temperature control system, unit heaters, plumbing, and venting.

4.3.7 Electrical

4.3.7.1 Electric Power

The existing NFS reprocessing facility is provided with electric power from a 34.5 kV Niagara Mohawk Corporation loop system. From the 34.5 V loop bus electric power is

carried through a fused horn gap switch to the process building via aerial open pole line construction. An outdoor 2500 kVA transformer steps voltage down to 480 V. Power is delivered from the transformer terminals to indoor 480 volt switchgear via cable bus. The 480 V switchgear contains Niagara Mohawk revenue metering and low voltage circuit breakers for control of power. From a switchgear room in the reprocessing building electric power is supplied throughout the facility.

In order to separate the FRS operation from the balance of plant, a new 750 kVA, 34.5 kV/480 V transformer and a 480 V switchgear lineup will have to be added. Power for the transformer primary could most economically be obtained by tapping the existing aerial pole line in close proximity to the FRS building, and extending to transformer bushings via open line. Transformer disconnect, fuses, and surge protection devices would be mounted on a deadend structure adjacent to the new transformer. The new transformer is located outdoors adjacent to the new FRS auxiliary systems building. The new 34.5 kV/480 V transformer and the deadend structure for terminating aerial lines will be situated in a fence-enclosed area, as shown in Figure (4-1). Underground conduits will carry power from transformer bushings to switchgear terminals indoors. Niagara Mohawk metering will be included in the switchgear lineup. The new switchgear will be installed inside the added auxiliary equipment building. The separated FRS installation is to be served by a total of five (5) motor control centers (MCC's), situated in the various buildings and structures that form the segregated spent fuel storage installation. Figure 4-2 is a one line diagram of the new electrical system.

Existing power equipment in the FRS building will be reconnected by running new power feeders to the new switchgear as required. Utilization equipment such as motors, outlets, etc., located in the FRS building and fed from motor control centers outside the FRS area will receive new branch wiring from motor control centers located in the new auxiliary systems building. Existing wiring between equipment in the FRS area will remain unchanged where practicable. Where modifications are necessary, new wiring will be arranged to utilize the existing raceway and wiring system as much as is practically possible. The wiring method and type of materials selected will conform with those existing in the FRS area.

A new 480/120 volt transformer will be required to serve miscellaneous lighting and receptable outlets, and provide instrument and control power requirement. This transformer can be installed inside the added auxiliary systems

building. The off-site electric power system interfaces with on-site electric power system, see section 4.3.8.

4.3.7.2 Instrumentation and Control

The segregated FRS facility is to be provided with a separate installation monitoring area. The new monitoring and control center is to be located in the added auxiliary systems building. The above will require the reconnection of all existing monitoring, control and alarm functions of FRS equipment to a new console in the auxiliary systems building. Selected instrumentation and control functions, in association with FRS ancillary equipment in the auxiliary building and other locations, will also be connected to the above console. The extent to which control is to be carried out from the above monitoring/control area, or by use of local controls, will require further investigation.

4.3.8 On-Site Electric Power

The segregated FRS facility will be provided with an on-site electric power system consisting of an emergency 480 volt, 230 kVA diesel-driven generator. The system will be designed to provide an emergency supply of electric power to vital instrumentation, air compressors, emergency lighting, minimum communication and security systems, and diesel oil transfer pumps. The on-site standby power generation unit will also encompass the capability of providing the long-term pool water cooling/makeup requirements.

4.3.9 Physical Security

The FRS building and associated service buildings will be provided with a physical security system to protect the facility against industrial sabotage, to detect unauthorized access, and to have provisions for controlled access.

The various buildings and structures that make up the FRS installation are to be located within a protected area surrounded by a security fence, as shown in Figure (4-1). Access of personnel is to be controlled and is to be administered through a security station at the north end of the installation.

The security fence is to be provided with an intrusion detection system and sufficient illumination. The security system will include remote control of all gates, closed circuit

TV, an intrusion alarm system, surveillance and communication equipment, and an independent backup power supply.

4.3.10 Radwaste Treatment

The segregated FRS facility will require its own equipment for processing the collected radioactive waste into a solid nondispersible form prior to shipment off-site.

The radioactive waste that can be expected from the segregated spent fuel storage installation consists of: the replaceable filter media and spent bead resin from the ion exchanger serving the radioactive drain system. All of the above can be collected in a backwash settling tank to be installed in a pit adjacent to the FRS building.

From the above backwash settling tank the waste can be immobilized and packaged for off-site disposal using truck-mounted solidification equipment. An example would be the portable system operated by Chem-Nuclear Systems, Inc., which utilizes Dow binder for solidification.

4.4 Cost and Schedule

The cost and schedule requirement for subtask-2C reflects the changes/additions identified under section 4.3 of the study. The cost estimate covers the full scope of modifications and additions, in both structures and equipment, necessary to effect separation of the FRS operation from the rest of the plant.

The total capital cost estimate for the above effort is \$4.15 million. The cost figure is in first-quarter 1980 dollars. Escalation and interest during construction costs were not included.

Included in the above total are: site improvement costs, costs of added equipment, structural and mechanical modification costs, costs of new building and structures, construction materials, construction-installation labor costs, design and engineering costs, and construction management costs. The cost estimate includes an appropriate contingency to reflect the conceptual nature of the design.

It is estimated that the effort of segregating the FRS operation from the rest of the plant, following the plan outlined under section 4.3, will require eighteen (18) months following the authorization to proceed notice. The above

schedule reflects the construction phase of the operation, and does not account for design and engineering licensing, or equipment test and start-up requirements.

4.5 Conclusions

The operation at the spent fuel pool as a separate entity to minimize interfaces with the solidification project was examined. It was determined that the pool and its existing cooling water system can be isolated from the reprocessing facility. In addition, the water treatment system can be retained; however, a new waste processing facility must be provided to dispose of the solid wastes generated by the water treatment equipment. Significant elements of the existing demineralized water system, plant water system, cooling water system, domestic and potable water system, fire protection system, compressed air system, instrument air system, steam system, and fuel system must be provided new to isolate the FRS facility from the balance of the reprocessing facility. This is especially true for the dismantlement option for decommissioning the reprocessing facility. Existing H&V equipment can be retained essentially in its entirety. A new electrical supply system, including a transformer and switchgear will be required to satisfy the electrical demands and design criteria of the segregated FRS facility.

The estimated cost of the aforementioned modifications and plant security system is \$4.15 million and the construction schedule is 18 months.

An additional option for future consideration was identified during the review of this task. This option is to install high density fuel storage racks in the Cask Unloading Pool and moving all spent fuel into these racks. All space in the main pool would be available for waste storage.

References

1. U.S. Department of Energy, Washington, D.C. 20545, TID-28905-2, Western New York Nuclear Service Center Study, Companion Report.
2. U.S. - N.R.C., Regulatory Guide 1.13, Spent Fuel Storage Facility Design Basis.

TASK 3 - SEISMIC STUDY

for

WESTERN NEW YORK NUCLEAR SERVICE CENTER

WEST VALLEY, N.Y.

TABLE OF CONTENTS

	<u>PAGE</u>
1.0 <u>INTRODUCTION</u>	1
1.1 Scope	1
1.2 Description of Facility	1
1.3 History of Seismic Analyses	3
2.0 <u>REPORTS AND DOCUMENTS</u>	4
2.1 General	4
2.2 Data Sources	4
3.0 <u>DESIGN REVIEW CONSIDERATIONS</u>	5
3.1 General	5
3.2 Design Options	6
3.2.1 Option 1	6
3.2.2 Option 2	7
3.3 Technical Assumptions	7
4.0 <u>TECHNICAL DISCUSSION</u>	8
4.1 General	8
4.2 Analytical Conservatism	9
4.3 Evaluation of Options	9
4.3.1 Option 1	9
4.3.2 Option 2	11
4.4 Remedial Work	12
5.0 <u>CONCLUSIONS & RECOMMENDATIONS</u>	13

LIST OF TABLES

	<u>Page</u>
I - Summary of Results	15
II - Cost Breakdown for Option 1	16
III - Cost Breakdown for Option 2	17

LIST OF FIGURES

- 1 - NFS Process Building and Adjacent Structures
- 2 - Schedule for Option 1
- 3a - Schedule for Option 2 Without Fall-Back Measures
- 3b - Schedule for Option 2 With Fall-Back Measures
- 4 - Detail of Remedial Work for MCR Section Work

TASK 3 - SEISMIC STUDY

1.0 INTRODUCTION

1.1 Scope

This report is based on a review of seismic analyses done to date for the Western New York Nuclear Service Center at West Valley, N.Y. and recommends appropriate measures to be implemented for the facility which are consistent with the intended future usage, viz. solidification of high level waste. Based on the requirements listed in the request for proposal by the Department of Energy, the following documents were reviewed,

- (1) "Seismic Analysis of the Nuclear Fuel Services Reprocessing Plant at West Valley, N.Y.," UCRL-52266, R.C. Murray, T.A. Nelson, and A.M. Davito, May 24, 1977..
- (2) "Seismic Investigation of Nuclear Fuel Services, Inc. Reprocessing Plant at West Valley, New York," LA-7087-MS, E.G. Endebrock, et al, March 1978.
- (3) "Summary of the Seismic Analysis of the Nuclear Fuel Services Reprocessing Plant at West Valley, New York," LA-7185-MS, E.G. Endebrock, March 1978.

Based upon review of the above material, various approaches were examined to accommodate a seismic event. As a part of this effort, an estimate was made regarding the degree of seismic resistance which may be contained in the plant analyses to date and facility and system design features were identified, which could be incorporated to increase the seismic resistance of the plant or to mitigate consequences of a seismic event. Since the degree of seismic resistance estimated by any analytical method is related to the conservatism provided in analytical procedures, the areas of design conservatism must be clearly identified in order that further seismic resistance could be developed against depletion of available design margins. This report identifies available analytical conservatism and discusses retrofit measures and necessary further analyses to reduce design margins. Cost and scheduler data are also developed for available options.

1.2 Description of Facility

The facility at the Western New York Nuclear Service Center consists of a fuel reprocessing plant as shown in Figure 1. The facility is owned by Nuclear Fuel Services, Inc. (NFS) and was constructed in 1964. Reprocessing of

spent fuel was carried out from 1966-1972. The facility was shutdown in 1972 to carry out modifications necessary to increase the plant capacity. Since NFS subsequently decided to withdraw from the fuel reprocessing business, modifications were not completed, and the facility has been in a shutdown condition since 1972.

The principal part of the facility consists of a Process Building, which is constructed of reinforced concrete cells and perimeter block walls, and measures 250 ft. wide by 200 ft. long by 85 ft. high. The main reprocessing operations were performed inside the Process Building and included shearing of fuel, separation of reusable materials, and handling of waste products. Buildings adjacent to the Process Building are the Fuel Receiving Station, Utility Building, Manipulator Service Module Repair Shop, and Iodine and Acid Recovery Cell.

The Process Building is a very complex structure composed of many individual cells. These cells are of reinforced concrete construction with the floors, walls and ceilings ranging from 1 to 6 ft. in thickness. These cells are inter-connected with each other to form an integral structure. Some of the inter-connections are monolithic while others provide vertical supports and allow relative lateral motion on steel bearing plates.

Surrounding heavily reinforced concrete cells is a lighter construction consisting of masonry walls and metal deck flooring supported on steel beams or masonry walls. This construction houses the control room and other less critical parts of the structure.

The massive cell structure is supported by a pile foundation. This was required due to inadequate bearing capacity of surface layers at the site. The foundation consists of approximately 500 H-bearing piles located in staggered rows under the cell walls.

Some high level waste has been collected from earlier reprocessing operations and is currently stored at the site. It is stored in suitable tanks which are housed in underground concrete vaults outside the Process Building. One option relative to the future use of the facility envisions using existing cells for waste solidification and solidified waste storage. To assure that operations in the existing structures can be carried out safely, an estimation of the seismic capability of the Process Building is made in this report.

FIG. 1. NFS PROCESS BUILDING AND ADJACENT STRUCTURES

TASK 3

BURNS AND ROE INDUSTRIAL SERVICES CORP.
Engineers and Constructors
Paramus, N.J.

1.3 History of Seismic Analyses

NFS submitted a construction and operating license application to the Nuclear Regulatory Commission (NRC) for modification and expansion of their reprocessing plant at West Valley, New York in 1973. The original license, issued in 1966, did not require consideration of acceleration levels (other than the level inherent in provisions of the Uniform Building Code) in the design for seismic events. However, the current NRC seismic requirements as, codified in 10CFR50 and 100, became a consideration for the facility modification. NFS retained the Chemical Plants Division (CPD) of Dravo as a consultant to determine the seismic competence of the existing facility and to recommend methods to upgrade the facility to satisfy updated NRC seismic requirements.

To aid NRC in the license review, Los Alamos Scientific Laboratory (LASL) and Lawrence Livermore Laboratory (LLL) were asked to provide seismic analyses of the existing facility. The principal objective was to identify the level of ground motion at which particular structural elements could first experience mechanical distress. LASL and LLL were to conduct independent analyses but were allowed to exchange information.

A summary of the earthquake levels and the general location at which impending structural distress was predicted by various organizations are noted in Table I. The earthquake level mandated by NRC for the proposed modification so that spent fuel reprocessing could be continued at the facility, was 0.2g.

NRC also retained Nathan M. Newmark (NMN) Consulting Engineering Services to provide review comments concerning the results of above analyses. Drs. Newmark and Hall of NMN concluded the following:

"After considerable study and assessment of the assumptions and techniques of analysis used by both groups (*), as reported in their studies, it is our belief that resistance levels that can be associated with reasonable levels of localized cracking in the reinforced concrete cell walls and/or tension in the pile foundations without excessive deformation and cracking of the cells would be on the order of 0.15 to 0.2g, except for the concrete block walls, as discussed above. This opinion is based upon many factors, including a realization of the fact that the effective damping in structures is undoubtedly much higher than has been accounted for in the analysis, and the stress limit on the average may be as much as 50 to 100 per-

cent higher than those used conservatively in assessing the resistance in the studies. At the excitation level noted, we do not see any likelihood of gross collapse of the process building as a whole. We would expect localized cracking at or near penetrations, at re-entrant corners and near discontinuities generally."

(*) These groups are LASL and LLL.

2.0 REPORTS AND DOCUMENTS

2.1 General

Burns and Roe's work in this report is based upon the data sources noted in this section. In some instances, appropriate detailed data were not available. Suitable assumptions have been made in these instances to bridge the deficient information and such assumptions are properly identified in the body of this report. Furthermore, Burns and Roe has not attempted to verify accuracy of the data contained in the material referenced in this section. It is probable that, as detailed design of the facility for waste solidification progresses and more accurate data are generated, some of the supporting information used in this report may require updating. To this extent, results of this report are also subject to appropriate updating.

2.2 Data Sources

- 2.2.1 TID-28905-1, Western New York Nuclear Service Center Study, Vol. 1 of 2, Summary Report, U.S. DOE.
- 2.2.2 TID-28905-2, Western New York Nuclear Service Center Study, Companion Report, U.S. DOE.
- 2.2.3 See reports noted in Sections 1.1 and 1.3 of this report.
- 2.2.4 UCRL-52600, Seismic Analysis of the Acid Liquid Waste Tanks at the Western New York Nuclear Service Center, West Valley, New York by C.Y. Liaw, A.M. Davito, R.C. Murray of Lawrence Livermore Laboratory
- 2.2.5 Nathan M. Newmark Consulting Engineering Services' review comments dated May 25, 1979 on UCRL-52600.
- 2.2.6 Nuclear Regulatory Staff, Interim Safety Evaluation 1, August 1977, Docket No. 50-201.
- 2.2.7 Report No. 0476.015, Seismic Competence of the Existing Process Building at the West Valley

Reprocessing Plant by Chemical Plants Division,
Dravo Corporation, June 1976.

- 2.2.8 Safety Analysis Report, NFS Reprocessing Plant,
West Valley, N.Y., Docket No. 50-201, 1973 (LLL).
- 2.2.9 Arthur, Dong, Murray, Nelson, Smith & Wight,
Evaluation of Methods for Seismic Analysis of
Nuclear Fuel Reprocessing Plants and Fabrication
Facilities, Report UCRL-52159 (to be published)
(LLL).
- 2.2.10 Tokarz, Murray, Arthur, Ferg, Wight, Zeslewsky,
Evaluation of Methods for Seismic Analysis of
Nuclear Fuel Reprocessing Plants, Part 1, Report
UCRL-51802 (Pt. 1, Tab 75) (LLL).
- 2.2.11 Tereskiewincz, Seismic Dynamic Parameter Study on
Finite Element Model of Nuclear Power Plant
Facility, International Symposium on Earthquake
Structural Engineering, St. Louis, Missouri,
August 1976 (LASL).
- 2.2.12 Process Building, Preliminary Pile Competence
Study Report 0975.012, CPD-2401-47, September 1975
(Dravo).
- 2.2.13 Report of Consultation, Pile Load Tests, Pile
Driving Criteria, Report 3945-002-10, Dames &
Moore, July 1963 (Dravo).
- 2.2.14 NRC, LLL, LASL Meeting, August 24, 1976.
- 2.2.15 Report of Consulation, Static, Vertical and Cyclic
Lateral and Vertical Pile Load Tests - July 1976,
Dames & Moore Report No. 3905-026-10.

3.0 DESIGN REVIEW CONSIDERATIONS

3.1 General

In reviewing the analytical studies completed to date, it is apparent that a number of options may be selected in evaluating the structural integrity and seismic capability of the West Valley facility during the period when solidification of the nuclear waste will be conducted. The original seismic design was based on the Uniform Building Code approach which corresponds to an effective and equivalent horizontal ground acceleration of 0.04g based upon Chemical Plants Division (CPD) analysis. Consequently, to retain a comparable design margin, any increase in the level of excitation will require some degree of remedial treatment.

Alternatively, more rigorous structural analyses, taking into consideration the inherent conservatism incorporated in the previous structural design and analyses, may demonstrate that the seismic capability of the facility can be increased significantly. Summarizing the results of the comprehensive analytical work done to date, it appears that minimum treatment will be required for a mandated seismic ground acceleration up to 0.1g, while significant expenditure of money and recourse to a high risk design may be necessary to demonstrate that the upgraded facility can withstand a seismic ground acceleration of 0.2g considered by NRC to be appropriate for a spent nuclear fuel reprocessing facility in the West Valley region of New York State.

During this review phase, the evaluation of structures was restricted to two principal seismic design options -- viz. options 1 and 2 --, which would set seismic capability requirements at 0.1g and 0.2g ground acceleration levels. A brief summary follows which justifies selection of 0.1g and 0.2g values and further outlines potential problems and resolutions, if the 0.2g value is mandated by the controlling regulatory agency. A number of technical assumptions have been made to evaluate design options 1 and 2. These assumptions are listed in Section 3.3 of this report.

3.2 Design Options

3.2.1 Option 1 - Design for horizontal seismic ground acceleration up to 0.1g:

There is considerable uncertainty on the appropriate seismic ground acceleration which should be used in the design of a facility which will be used only for waste solidification and only for a short time period (3-4 years). Nuclear production and utilization facilities are governed by the legislative requirements of 10CFR50 and 100 and consequently, NRC had mandated during modification application that the facility should be upgraded to withstand a seismic ground acceleration of 0.2g which is equivalent to the Safe Shutdown Earthquake (SSE). The non-production aspects of the facility (for High Level Waste Immobilization), i.e., absence of fissionable material production, short operational life, lack of volatile radionuclides and appropriate recognition of potential source terms, would indicate that the seismic requirements for the proposed utilization can be comparable to those for the radwaste facilities within the jurisdiction of 10CFR50 and 100. It is, therefore, deemed appropriate to check the facility to determine the degree of compliance with Regulatory Guide 1.143 which controls the structural design of radwaste facilities. This guide stipulates that the seismic capabil-

ity must be equivalent to that required for the Operating Basis Earthquake (OBE). Criterion V (2) of Appendix A to 10CFR100 specifies that the OBE must be at least 50% of the SSE. It is considered, therefore, that it will only be necessary to demonstrate that the structures can withstand a horizontal ground acceleration of 0.1g. This design option was selected for detailed review and the additional analytical and geotechnical work required to prove capability at 0.1g is covered in this report.

3.2.2 Option 2 - Design for horizontal seismic ground acceleration up to 0.2g:

If the radwaste approach is not acceptable, alternate design routes are available to cover three specific aspects of Option 2 as discussed below:

(a) Attempt to demonstrate that the existing design is capable for 0.2g by more detailed rigorous analytical studies, incorporating, where feasible, allowances for the inherent conservatism in previous analyses, as discussed by Dr. Newmark.

(b) Additional geotechnical studies to determine if the site seismicity may be reduced or if probabilistic seismological considerations might result in an effective lowering of the horizontal ground acceleration. The development of site dependent spectra using the approach suggested by Weston Geophysical (See Attachment A) may also result in a lower response.

(c) Evaluation of the appropriate remedial treatment to permit acceptance of either 0.2g design, reduced acceleration level, or reduced responses.

Viewed in the above context, items (b) and (c) may be considered as fallback measures in case attempts under (a) were not successful.

3.3 Technical Assumptions

- (1) Current evaluations are based upon past analyses which considered fuel reprocessing equipment for seismic models. It is assumed that equipment mass disposition does not contribute significantly to the seismic model. Consequently, the waste solidification equipment will not cause major perturbation to the previous seismic models; nevertheless, the final facility design should verify this.
- (2) Because of lack of field test data and mill certificates, full credit for higher in-place strengths are

not considered in this report. However, some allowance is implicitly provided in previous analyses by assuming, (1) the capacity reduction factor at unity and (b) a strength level higher than the specified nominal.

- (3) This report assumes that containment of only fluid waste is required. Therefore, structural cracking of confinement cells is acceptable so long as a gross failure is prevented.
- (4) Previous analyses do not discuss in detail potential missiles resulting from failure of adjacent non-critical structures. It is consequently implicitly assumed that potential failure missiles will not impair the functional performance of cell structures. This assumption should be confirmed in the detailed design phase.
- (5) The waste solidification process criteria, as they would impact civil/structural design, are not defined at this time. As these criteria develop during the course of detailed design, appropriate changes to this report will be necessary.
- (6) This report assumes that the existing stack will be dismantled or retained depending upon the result of follow-on seismic analysis. The stack is not modeled in previous analyses.
- (7) For remedial work, it is assumed that the facility is adequately decontaminated to permit a reasonable access.
- (8) Foundation pile criteria, as provided in previous analyses, are assumed valid.
- (9) The data for cost and schedule in this report are for conceptual planning and would require updating as the detailed design is developed. Since more accurate data would demand significant design development and a considerable amount of engineering and design effort, Burns and Roe believes that the information provided in this report would be adequate for conceptual purposes.

4.0 TECHNICAL DISCUSSION

4.1 General

It is planned to develop the probable cost, schedule and risk factors associated with pursuing each option. The ability to meet respective design requirements is noted in

the context of previous analyses, available design conservatism, and potential remedial measures. Fallback positions are also defined in case currently projected seismic capabilities are not confirmed by follow-on detailed design work. In order to reduce expensive retrofit work, an attempt was made to account for the inherent conservatism in previous analyses. See discussion in Section 4.2 of this report.

4.2 Analytical Conservatism

- (1) All analyses are based upon Regulatory Guide 1.60 spectra. Since consideration of site specific spectra offers potential for a lower response, further geotechnical work in this area could be successful in demonstrating the higher seismic capability of West Valley structures.
- (2) Because of shorter operating life of the facility for waste immobilization, probabilistic studies may result in lower intensity of ground acceleration and consequently lower response.
- (3) The past analyses determine onset of structural distress based upon linear behavior. However, a non-linear approach that would factor redistribution of stresses could result in a higher estimate of the seismic resistance of the facility.
- (4) The credit available due to radiation damping and structural cracking of stressed areas may be evaluated and higher damping resulting from these effects could reduce seismic response of the facility.
- (5) Since field test data are not available, an evaluation of core samples from existing structures is expected to result in higher strength of concrete than that provided in previous analyses. The strength margin above nominal may provide a higher estimate of the seismic resistance.

4.3 Evaluation of Options

4.3.1 Option 1

Design Requirement: Comparable to those applied to radwaste facilities. See discussion in Section 3.2.1.

Seismic Capability: Of the three analyses noted in Section 1.3, the LASL analysis establishes highest seismic resistance of the facility. On a general facility basis, the structural features exhibiting minimum seismic capabil-

ity are the foundation piles subjected to dynamic loading conditions. These are rated to experience distress at 0.14g. Therefore, the safety factor for an OBE event, based upon linear interpolation is estimated at $0.14g/0.1g = 1.4$. No generic requirements for an acceptable safety factor for the intended application are available. However, based upon NRC deliberations on Bailey Plant (Docket No. 50-367), a safety factor of 2.0 is considered appropriate for safety-related Category I structures subjected to severe environmental loads. Since Regulatory Guide 1.143 permits a one-third increase in allowable stress under an OBE event -- such allowance being denied for safety related Category I structures --, the desirable safety factor for radwaste facilities could be set at $2/1.33 = 1.5$. Thus, a deficiency

of 7 percent ($= \frac{1.5-1.4}{1.4} \times 100$) in the safety factor for the

facility is noted. However, this is not considered unreasonable in the context of the discussion noted in Section 4.2 of this report. It is further noted that the linear interpolation presupposes an OBE damping comparable to that provided in the LASL analysis. On the surface, this may appear inconsistent with Regulatory Guide 1.61, since it provides for a lower damping due to an OBE event. However, for the West Valley facility, the lower OBE damping is not justified because of potentially favorable structural behavior. Since the facility is designed for seismic loads based upon Uniform Building Code (UBC), reasonable cracking of structural elements can be expected due to OBE loads that are substantially in excess of those defined by the UBC. This cracking should impart higher damping to the structure and therefore the linear interpolation is well within the intent of Regulatory Guide 1.61.

Cost: The cost for this option essentially includes the engineering effort required to perform an updated seismic analysis for an OBE event. The analysis through improved modeling techniques and up-to-date programs will attempt to demonstrate a higher safety factor than previous analyses. The cost breakdown is shown in TABLE II.

No construction costs are developed for this option since no remedial treatment is necessary. Several concrete block walls may show lower seismic resistance. However, LASL analyses does not identify such walls. It is probable that these walls may be located in non-critical areas where potential seismic failures would not impair the plant safety. Dr. Newmark's review comments appear to confirm this view. It should be further noted that all confinement walls except the localized area in Mechanical Crane Room (MCR) section are rated for better than 0.2g capability. The MCR section is rated at 0.14g.

Schedule: The schedule for this option is shown in Figure 2.

Fall-back Measures: Since the option indicates reasonable design margins and a lower level of design requirements, no fall-back measures are considered.

Risk Factors: No appreciable risk factors are envisioned for this option.

4.3.2 Option 2

Design Requirements: Comparable to those applied to production and utilization facilities. See Section 3.2.2.

Seismic Capability: As discussed previously under Option 1, the LASL analysis rates the weakest link (foundation piles) at 0.14g. Therefore, the design requirement for this option (i.e. 0.2g acceleration level) exceeds the available capability. The only precedent for pile supported structures in recent nuclear power plant design is the Bailey Plant referenced earlier. Based upon the criteria established by NRC on Bailey Plant, it is apparent that a safety factor of 1.5 may be desirable in the context of extreme environmental loads. The analyses to date fall short of this requirement. However, as discussed in Section 1.3, Dr. Newmark estimates that if all design conservatisms are considered, the facility may be able to withstand acceleration levels of 0.15g to 0.2g. Pending conformation by a detailed analysis, it is uncertain that the facility could meet design requirements for this option.

Cost: Total cost for this option is determined in two parts, viz. (a) engineering cost and (b) construction cost.

The engineering cost includes the following:

- (1) Seismic analysis for a 0.2g event: The analysis through improved modeling techniques and up-to-date programs will attempt to demonstrate higher seismic resistance than previous analyses.
- (2) Extensive geotechnical studies would be conducted in parallel with the above to determine if the site seismicity can be reduced or horizontal ground acceleration lowered, based on probabilistic seismologic considerations. This effort will require consultation with leading experts to determine the optimum and most defensible seismological approach. The geotechnical effort is proposed to be carried out in parallel with the seismic analysis since this strategy will offer significant schedular benefits. Should the seismic analysis fail to confirm a capability at 0.2g, poten-

tial benefits of a reduced ground acceleration offer the necessary protection against scheduler delays.

- (3) Design and engineering effort for remedial work in the MCR section. See Section 4.4 of this report.

The details of engineering costs are shown in Table III.

The construction costs associated with the remedial work in the MCR section are included in Table III.

Schedule: The schedules for Option 2 are shown in Figure 3. The schedules are developed on two bases, viz. (a) assuming that seismic analysis will yield expected results (i.e., no fall-back measures are to be applied), and (b) assuming that the seismic analysis results are not satisfactory (i.e., fall-back provisions are to be applied).

Fall-back Measures: This option utilizes every conceivable design conservatism. Consequently, it is a high risk option. Since foundation piles have the lowest seismic capability, the viable fall-back measures will have to upgrade the foundation region. Based upon Burns and Roe's informal discussion with geotechnical consultants and potential foundation contractors in low permeability soils, the appropriate treatment to improve the foundation medium is to grout the substrata. The cost and scheduler data for fall-back measures are respectively shown in Table III and Figure 3. This data is based upon discussions with the above personnel. Grout mix, penetration, and maximum pressure stipulation would be established in a test program on driven piles to demonstrate increased lateral capability.

Risk Factors: This option has significant risk factors as noted below:

- (1) Since all design margins are eliminated, a considerable risk is introduced in the design insofar as accommodation of potential ratcheting is concerned.
- (2) The available fall-back measures are also very costly and will require a significant effort to permit evaluation of in situ treatment.

4.4 Remedial Work

The remedial work for Option 2 consists of adding a wall between existing Mechanical Crane Room (MCR) columns. The LASL analysis shows that untreated columns cannot accommodate a seismic event larger than 0.14g. The added wall will provide the necessary shear stiffness and also prevent

FIG. 2

TASK 3

BURNS AND ROE INDUSTRIAL SERVICES CORP.
Engineers and Constructors
Paramus, N. J.

FIG. 3a

SCHEDULE FOR OPTION-2 WITHOUT FALL-BACK MEASURES

FIG. 3b

SCHEDULE FOR OPTION-2 WITH FALL-BACK MEASURES

TASK 3

BURNS AND ROE INDUSTRIAL SERVICES CORP.
Engineers and Constructors
Paramus, N. J.

flexural failures of cross walls in the upper area. The details of the remedial work are shown in Figure 4.

5.0 CONCLUSIONS AND RECOMMENDATIONS

This study was directed at outlining an approach for providing increased protection from a seismic event through facility design. Before extensive effort is expended on pursuing the recommended approach, or any other, it is recommended that the impact of a seismic event on the solidification process system and the resultant public risk be determined. The impact and risk information can be used to determine if seismic design in excess of the existing UBC is necessary. If a general hazards analysis indicates seismic design is required, the analysis may also indicate that the seismic design requirement is limited to a specific part(s) of the process line or facility.

Design to a SSE is appropriate when the risk to the public is unacceptable; if the risk is acceptable, no seismic design requirement is needed. The specific magnitude of the SSE and OBE for a given area is based on earthquake magnitude versus probability of occurrence. If a seismic design is required, a lower level for the solidification project than that used for nuclear reactor plants may be justified since the operating time is short (i.e., the probability of a large earthquake during operation is reduced).

The studies conducted in this report evaluate cost, schedule, and feasibility aspects for two options which are based upon differing levels of design requirements. If seismic protection in excess of UBC is required, Burns and Roe recommends that Option 1 be applied for the intended facility usage because of the following:

- (1) The design requirements for this option are commensurate with the safety considerations that should be applied for the intended facility usage, viz. solidification of liquid waste.
- (2) This option results in minimum cost and schedule.
- (3) The option does not rely upon unconventional and complex design approaches. Consequently, the risk factors are minimal.
- (4) An SSE level of 0.2g considered for earlier studies would be inappropriate for the intended application since the possibility for the release of volatile radioactive nuclides and the development of critical masses does not exist. Therefore, an earthquake level of 0.1g provided in Option 1 adequately addresses the safety concerns.

- (5) The option also eliminates extensive retrofit work and does not have to depend upon complex engineering and in situ foundation treatment which has not been applied to the U.S. nuclear industry.

FIG. 4
DETAIL OF REMEDIAL WORK FOR MCR SECTION

TABLE I

SUMMARY OF RESULTS

Substructure or Structural Member	Earthquake Levels at Impending Structural Distress and Locations					
	A		B			
	Chemical Plants Division of Dravo		Lawrence Livermore Laboratory		Los Alamos Scientific Laboratory	
	Acceleration (g's)	Location	Acceleration (g's)	Location	Acceleration (g's)	Location
Shear Wall (Reinforced Concrete)	0.04*	CPC**	0.09 0.15 0.17	GPC CPC LWC	0.20	N.R.
Shear Wall (Concrete Block)	N.R.	-	0.03 0.07	TOP AOC	N.C.	
Pile Distress (Combined Loading)	0.08	N.R.	0.11	***	0.14	N.R.
Pile Distress (Tension)	0.05	EPC	0.17	***	0.16	EPC
MCR Section (Flexure or Shear)	N.C.		> 0.20		0.14	MCR
Intersection of GPC & PMC	N.R.		> 0.20		> 0.20	
Joint Pounding	N.C.		N.C.		> 0.20	EPC, CPC

N.R. - Not Reported
N.C. - Not Considered

EPC - Extraction & Product Purification Cell
CPC - Chemical Process Cell
GPC - General Purpose Cell
PMC - Process Mechanical Cell
MCR - Mechanical Crane Room
AOC - Acid and Off-Gas Recovery Cell
LWC - Liquid Waste Cell
TOP - Concrete Block Structures on top of CPC

* Using different assumptions, a 0.12g competence level was once reported.

** Based upon CPD's interpretation of steel splice integrity in the CPC south wall.

*** Perimeter of building, the level at which 10% of piles would be in tension.

TABLE II
(COST BREAKDOWN FOR OPTION 1)

(1)	Engineering Effort to Include Seismic Analysis & Supporting Geotechnical Work (Lump Sum):	= \$ 177,000
(2)	Computer Costs (Lump Sum):	= \$ 50,000
(3)	Consultation (Lump Sum):	= \$ <u>3,000</u>
	Total Cost for Option 1	= \$ 230,000

TABLE III

(COST BREAKDOWN FOR OPTION 2)

(A) Engineering Effort:Engineering Costs

(1) Engineering Effort to Include Seismic Analysis and Geotechnical Work (Lump Sum):	= \$ 254,000
(2) Computer Costs (Lump Sum):	= \$ 50,000
(3) Consultation (Lump Sum):	= \$ 53,000
Total Engineering Cost:	\$ 357,000

(B) Construction:

<u>Item</u>	<u>Quantity</u>
(1) MCR Wall Concrete:	50 C yds

Construction Cost:

(1) MCR Wall Concrete: 50 C. yds. @ \$1,240/cu. yd.: (Cost to include rebars, formwork, surface preparation, contractor's overhead & profits, productivity factor and contingencies):	= \$ 62,000
--	-------------

(C) Fall-Back Measures:Cost of Fall-back Measures:

(1) Engineering Effort to Include Geotechnical Work (Lump Sum):	= \$ 86,000
(2) External Consultg. Service (Lump Sum):	= \$ 300,000
(3) Grouting (Lump Sum):	= \$ 3 x 10 ⁶
Total Cost:	\$ 3.39 x 10 ⁶

Cost for Option 2

(1) Cost for Option 2 Without Fall-back Measures = (A) + (B)	= \$ 419,000
(2) Cost for Option 2 With Fall-back Measures = (A) + (B) + (C)	= \$ 3.8 x 10 ⁶

ATTACHMENT A

Weston Geophysical
CORPORATION

March 7, 1980

Burns & Roe, Inc.
305 Route 17 South
Paramus, New Jersey 07652

Attention: Mr. Walter Brusey
Supervising Civil Engineer
Engineering Department

Gentlemen:

Subject: Methods for Constructing Ground Motion
Response Spectra with Reference to
the West Valley Nuclear Facility

This letter will appraise you of some recent developments in the determination of design response spectra as it applies to nuclear power plants especially to those plants which are operational or under construction. As you are aware, several methodologies are presently used to determine motions resulting from earthquakes; these range from equivalent static methods to dynamic methods using either response spectra or time history data.

For new nuclear power plants, conventional practice has been to define the earthquake threat(s), characterize the earthquake(s) by intensity, and correlate this intensity to a "peak" ground acceleration value using a relationship developed by Trifunac & Brady (1973). This peak acceleration value is then used as a zero period anchoring point for a standard response spectra curve, such as the one used in the U.S. Nuclear Regulatory Commission Regulatory Guide 1.60. This approach results in a response spectral shape which generally envelopes all site conditions and very conservatively accounts for all sizes of earthquakes principally because of the "scaling" of large earthquakes. This method is basically site independent.

For some time, we have sought a more realistic estimate of eastern United States ground response spectra. A new method for defining eastern United States ground motion was first submitted to the Nuclear Regulatory Commission on the Pilgrim Docket No. 50-471 in 1976 and on the Sequoyah Docket Nos. 50-327 and 50-328 in 1978. This method is based

Burns & Roe, Inc.
Attention: Mr. Walter Brusey

March 7, 1980

on eastern United States attenuation data and on a magnitude (m_b) determination which describes eastern United States earthquakes. Generally, the maximum motion from an eastern United States earthquake occurs in a frequency band around (one) 1 hz; this amplitude is used to determine the magnitude m_b .

The spectral shape and level (displacement) for eastern United States earthquakes are well-behaved and related to the magnitude through the seismic moment. Using these data, a methodology was developed to estimate site specific response spectra (Yankee Rowe Docket No. 50-29, 1980).

A second method is based on the recently available, large, strong motion data base and the definition of eastern United States earthquakes by their characteristic magnitude (m_b); this method results in a direct development of site dependent response spectra. These spectra are developed by selecting only those earthquakes from the worldwide data base within the correct magnitude range, at the appropriate distances recorded at sites with conditions similar to the site conditions for which the design ground motions will be used. This approach was used by the applicant and the Nuclear Regulatory Commission to establish spectral shape for the Tennessee Valley Authority Sequoyah Plant (Docket No. 50-327 and 50-328).

Either of these site dependent response spectral methods used in conjunction with a seismicity model will produce more realistic spectra than those which result from the scaling of large magnitude earthquakes. It is also possible to produce a "uniform hazard spectra" using different seismicity models (earthquake sources). This is accomplished by a probabilistic analysis of the earthquake sources, the seismic wave transmission characteristics, and site conditions. The result of such an analysis is that each spectral ordinate from combined sources, transmission characteristics, and various site conditions, has an equal probability of occurrence. This spectral level and shape is expressed as a mean annual probability of occurrence (or its reciprocal return period). It should be cautioned that the results of a uniform hazard

Burns & Roe, Inc.
Attention: Mr. Walter Brusey

March 7, 1980

analysis should be used in a relative sense for comparison purposes; this is especially true when the length of the data base time period is exceeded by the return period.

This letter has outlined in the briefest form the recent methods used to obtain ground motion predictions for eastern United States earthquakes. Typically, such studies have taken two to three months to complete; the cost involved for a particular site depends on a number of factors which cannot be estimated at this time. Should you have any questions or desire further information, please call.

Sincerely,

Richard J. Holt

RJH:jb

TASK 4

LOW LEVEL WASTE MANAGEMENT

TASK 4

LOW LEVEL WASTE MANAGEMENT

Table of Contents

	<u>Page</u>
1.0 <u>INTRODUCTION</u>	4-1
2.0 <u>WASTE SOURCES</u>	4-2
2.1 <u>Liquid Waste</u>	4-2
2.1.1 Presolidification Phase Wastes	4-2
2.1.2 HLW Solidification Phase Wastes	4-5
2.1.3 Post-Solidification Phase Wastes	4-5
2.2 <u>Dry Active Waste</u>	4-5
2.2.1 Presolidification Phase Wastes	4-5
2.2.2 HLW Solidification Phase Wastes	4-7
2.2.3 Post-Solidification Phase Wastes	4-7
3.0 <u>LOW LEVEL LIQUID WASTE TREATMENT</u>	4-9
3.1 <u>High Conductivity Wastes</u>	4-9
3.1.1 Standard High Conductivity Waste Treatment System	4-9
3.1.2 Acid Recovery System	4-11
3.1.3 Cost/Benefit of Acid Recovery System	4-12
3.1.4 Reference High Conductivity Waste and Acid Recovery System	4-13
3.2 <u>Low Conductivity Wastes</u>	4-14
3.3 <u>Low Level Waste Solidification System</u>	4-15
3.3.1 Direct Addition of Binder	4-16
3.3.2 Volume Reduction Systems	4-17
3.3.3 Conclusion	4-18
4.0 <u>DRY ACTIVE WASTE TREATMENT</u>	4-20
4.1 <u>Metallic Wastes</u>	4-20
4.2 <u>Dry Contaminated Trash</u>	4-20
4.3 <u>Combustible and Non-Combustible Trash</u>	4-24

Table of Contents (cont.)

	<u>Page</u>
5.0 <u>WASTE DISPOSAL COSTS</u>	4-25
5.1 <u>Solidification Costs</u>	4-25
5.1.1 Direct Addition of Binder	4-25
5.1.2 Volume Reduction Systems	4-25
5.2 <u>Transportation Costs</u>	4-25
5.3 <u>Burial Costs</u>	4-28
5.4 <u>Conclusion</u>	4-28
6.0 <u>POTENTIAL FOR USE OF EXISTING FACILITIES</u>	4-33
7.0 <u>REFERENCE LOW LEVEL LIQUID WASTE TREATMENT STRUCTURE</u>	4-35
7.1 <u>Layout of the Reference LLWT Facility Process Area</u>	4-35
8.0 <u>RADIATION EXPOSURE FOR LOW LEVEL WASTE MANAGEMENT</u>	4-38
9.0 <u>SUMMARY AND RECOMMENDATIONS</u>	4-40
10.0 <u>REFERENCES</u>	4-41

LIST OF FIGURES

<u>Figure No.</u>	<u>Title</u>
3.1	"Standard" High Conductivity Waste Treatment
3.2	High Conductivity Acid Recovery System
3.3	Spent Fuel Processing Plant Process Enclosure Layout
3.4	Off Gas Treatment and Acid Recovery Building Layout
3.5	Low Conductivity Waste Treatment System
3.6	Reference Low Level Liquid Waste Treatment System
3.7	Werner and Pfleiderer Corp. Volume Reduction System
3.8	Fluid Bed Dryer Volume Reduction Systems
3.9	VR System Capacity
7.1	Low Level Waste Treatment Facility - Plan at El. 100'
7.2	Low Level Waste Treatment Facility - Plan at El. 115'
7.3	Low Level Waste Treatment Facility - Plan at El. 157'
7.4	Low Level Waste Treatment Facility - Sections A-A and C-C
7.5	Low Level Waste Treatment Facility - Section B-B

TASK 4

LOW LEVEL WASTE MANAGEMENT

1.0 INTRODUCTION

The solidification of the liquid High Level Waste (HLW) present at the Western New York Nuclear Service Center (WNYNSC) and the decontamination of the equipment and cells for functional use or for decommissioning will result in the production of a large volume of Low Level Waste (LLW). This waste will be in both aqueous and solid forms. All aqueous LLW will require solidification before storage on-site or off-site can be instituted.

For this task, LLW is considered to be any solid or solidified waste suitable for burial in licensed shallow burial sites. This waste must, therefore, be nontransuranic (NON-TRU) in nature. That is, the solidified waste contains less than 10 nanocuries of TRU isotopes per gram.

Decontamination solutions that contain quantities of TRU waste such that the solidified product is anticipated to exceed the 10 nanocurie per gram limit will be diverted to the HLW processing system.

In the process of decontaminating the piping and equipment at the WNYNSC, the initial rinses of decontamination solutions are expected to be highest in activity, while later rinses will be lower in activity. Provisions have therefore been made to divert excessively high activity waste to the existing HLW tanks or to some other HLW storage tank to await processing by the HLW solidification system. In the event that an occasional batch of processed decontamination solutions produces TRU sludges, the waste will be diverted to the HLW solidification system or, alternately, be solidified with the LLW binder within a canister having an integrity equivalent to that of canisters which are used to store vitrified waste produced in the reference solidification process.

2.0 WASTE SOURCES

2.1 Liquid Waste

There are three phases of low level liquid waste generation associated with the decommissioning of the West Valley Facility. Wastes are generated before, during and after the solidification of the high level wastes currently stored in buried tanks at the fuel reprocessing facility. The nature of the wastes is described in studies by Nuclear Energy Services (NES) (Ref. 12, 13 - Task 1).

2.1.1 Presolidification Phase Wastes

The presolidification wastes are generated when the facility is initially decontaminated to permit the installation of the High Level Waste solidification equipment. This waste results from external flushes of equipment surfaces and surfaces of processing cells as well as from flushes of internal surfaces of equipment and piping. Waste quantities, their composition and expected activity levels are listed on TABLE 2.1. Waste quantities are based on the option in Ref. 12 in which all equipment and cell surfaces are decontaminated and which generates the greatest quantity of waste.

The largest batch of waste occurs during the internal flush of the Chemical Processing Cell (CPC). This batch is 159,000 gallons within an eight-hour period and is the determining factor in establishing vessel capacities.

One of the constituents comprising the suspended solids present in the waste listed on TABLE 2.1 is called "black metal." This is a particulate of unknown composition found in the CPC and extraction cells. Analyses on this material should be performed. Due to the unknown nature of the "black metal" and lack of information on the external and internal contamination at West Valley, data on the final solution conditions were predicted based on information from Savannah River.

A list of the isotopes present in the decontamination solutions are listed on TABLE 2.2. The weight of the radioisotopes is not known. Their presence is assumed because they were present in the fuel which was processed and the relative concentration should be proportional to their concentration in the fuel when decay time since removal from reactor is considered. It is noted that the quantities of transuranics are generally expected to be low enough to be considered low level waste when diluted with the massive decontamination chemicals.

TABLE 2.1
PRESOLIDIFICATION LIQUID WASTES

External Flush

<u>Flushing Agent</u>	<u>Quantity</u>	<u>Dissolved Solids</u>	<u>Suspended Solids</u>
Water at 80°C	300,000 gal	1 wt %	1 wt %

Internal Flush

<u>Flushing Agent</u>	<u>Quantity</u>	<u>Neutralized Salts</u>	<u>Contaminated Dissolved Solids</u>	<u>Contaminated Suspended Solids</u>
*0.1M KMnO ₄ - 10M HNO ₃ , at 80°C	58,000 gal	50 wt %	1 wt %	2 wt %
Water at 80°C	175,000 gal		1 wt %	2 wt %
**6M NaOH - 0.1M tartaric acid at 80°C	58,000 gal	20 wt %	1 wt %	2 wt %
***1M HF - 3.5M HNO ₃ at 80°C	58,000 gal	25 wt %	1 wt %	2 wt %
External-Internal Total	349,000 gal			

Expected Activities (dpm/ml)

	<u>High</u>	<u>Normal</u>
Alpha	10 ⁶	10 ⁵
Beta/gamma	10 ⁷	10 ⁶

* Hot Potassium permanganate/nitric acid mixture

** Hot sodium hydroxide/tartaric acid mixture

*** Hot hydrofluoric acid/nitric acid mixture

TABLE 2.2
PRESOLIDIFICATION LIQUID WASTE
EXPECTED ISOTOPE CONSTITUENTS

<u>Fission Products</u>	<u>Actinides</u>
Se-79	Np-237
Sr-90	Np-239
Zr-93	Pu-238
Nb-93m	Pu-239
Tc-99	Pu-240
Ru-106	Pu-241
Pd-107	Pu-242
Sb-125	Am-241
Sn-126	Am-242m
Cs-134	Am-243
Cs-135	Cm-244
Cs-137	Cm-245
Ce-144	Cm-246
Pm-147	
Sm-151	
Eu-152	
Eu-154	

TABLE 2.3 *
SALT CAKE COMPOSITION

<u>Component</u>	<u>Wt %</u>
(Na,K)SO ₄	6.79
(Na,K)NO ₃ /NO ₂	83.29
(Na,K)OH	3.47
Na, K	0.04
FePO ₄	0.09
Cr(OH) ₃	0.16
Ni(OH) ₂	0.05
Na ₂ CO ₃	5.96
AlF ₃	0.12

* Private Communication, D. Knowlton, Pacific Northwest Laboratory

2.1.2 HLW Solidification Phase Wastes

The LLW waste generated during HLW solidification is the supernatant liquid from tank 8D2. This liquid has been clarified by centrifugation and filtration and processed in ion exchangers to remove dissolved strontium and cesium. For this assessment it is assumed that the solution is concentrated in a process evaporator to a 26 percent salt slurry before treatment in the LLWTF. The salt composition is listed on TABLE* 2.3.

2.1.3 Post-Solidification Phase Wastes

The waste, generated after the solidification process during decontamination and decommissioning, consists of the internal and external flushes of the cells in preparation for final decommissioning of the facility and is based on the NES Study (Ref. 13). This includes the decontamination of the HLW solidification equipment, the off gas treatment system and the low level liquid waste treatment facility (LLWTF). The expected waste quantities and composition are listed on TABLE 2.4. Since there is very little difference between the volume of liquid waste generated in the decommissioning options considered (see TABLE 6.1, Ref. 13), the dismantlement option was chosen as the basis for establishing decommissioning waste volumes. As was the case for the option selected in Section 2.1.1, this option also generates the greatest volume of waste.

2.2 Dry Active Waste

During the three phases of operation described in Section 2.0, radioactive waste will be generated which is dry. This waste will include materials such as paper, used to wipe up contamination, and plastic, used to isolate or cover surfaces which is compactable. It will also include non-compactable waste, consisting of non-operative or non-usable metallic equipment and piping. Compactable waste is generated during cleanup operations throughout all phases of decontamination, solidification operation and decommissioning. Compactable wastes such as towels, plastic shoes, and cloth swipes are fed into a compactor or baler and reduced in volume before removal to storage as low level waste.

Non-compactable solid wastes will result mostly from equipment which is removed for disposal during the three phases of operation. This waste is packaged in steel or wood containers for storage before burial as low level waste.

2.2.1 Presolidification Phase Waste

The waste generated during this phase is discussed in Ref. 12 Section 6.6. The bulk of the waste is the fuel processing equipment that is removed from the facility. The balance of the dry waste is that associated with the decontamination operation.

* Private Communication, D. Knowlton, Pacific Northwest Laboratory

TABLE 2.4
POST-SOLIDIFICATION LIQUID WASTE

<u>External Flush</u>				
<u>Flushing Agent</u>	<u>Quantity</u>	<u>Dissolved Solids</u>	<u>Suspended Solids</u>	
Water at 80°C	1,000,000 gal	1 wt %	1 wt %	
<u>Internal Flush</u>				
<u>Flushing Agent</u>	<u>Quantity</u>	<u>Neutralized Salts</u>	<u>Contaminated Dissolved Solids</u>	<u>Contaminated Suspended Solids</u>
*0.1M KMnO ₄ - 10M HNO ₃ , at 80°C	150,000 gal	50 wt %	1 wt %	2 wt %
Water at 80°C	440,000 gal		1 wt %	2 wt %
**6M NaOH - 0.1M tartaric acid at 80°C	150,000 gal	20 wt %	1 wt %	2 wt %
***1M HF - 3.5M HNO ₃ at 80°C	<u>150,000 gal</u>	25 wt %	1 wt %	2 wt %
External-Internal Total	890,000 gal			

Expected Activities (dpm/ml)

	<u>High</u>	<u>Normal</u>
Alpha	10 ⁶	10 ⁵
Beta/gamm	10 ⁷	10 ⁶

- * Hot Potassium permanganate/nitric acid mixture
- ** Hot sodium hydroxide/tartaric acid mixture
- *** Hot hydrofluoric acid/nitric acid mixture

It will consist of air filters, paper and other contaminated trash as discussed above and later in Sections 4.2 and 4.3.

2.2.2 Solidification Operation Phase

The dry solid wastes in this phase will consist mostly of materials used and contaminated during operation. This will include paper and cloth used to wipe contaminated surfaces clean, non-recoverable plastic shoe covers and air filters used to clean exhaust air from contaminated areas. Malfunctioning equipment that cannot be repaired and replacement pipes will make up the balance of the dry waste generated during this phase.

2.2.3 Decommissioning Phase

The dry solid wastes in this phase will be similar to that generated during the initial decontamination phase. The bulk of the metal waste will be the equipment used for waste solidification which will be removed from the operating cells.

In addition, there will be concrete, chipped from cell surfaces to remove contamination. The paper, cloth, air filters and other wastes resulting from post operation decontamination will make up the balance of the dry waste generated during this phase.

Projected dry waste volumes are listed in Table 2.5. The volume of non-compactable metallic waste will vary, depending on which decommissioning option is selected. For entombment, none of the solidification equipment is removed. For protective storage, where facility areas are decontaminated to radiation levels that existed before solidification equipment was installed, only the equipment is considered to be removed. For dismantlement, additional equipment is considered for removal.

TABLE 2.5
DRY ACTIVE WASTE VOLUMES

<u>Waste Type</u>	<u>Volume</u>
Compacted Trash:	3000 - 55 gallon drums
Metallic Waste:	
Pre-HLW Solidification:	38,000 ft ³
Post-HLW Solidification	
Entombment (limited decon)*	0
Protective Storage (decon to previous levels)**	23,000 ft ³
Dismantlement (thorough decon)***	32,000 ft ³
Decommissioning of LLWTF	20,000 ft ³

* Removal of loose surface contamination only, equipment remains in cells

** Cell radiation level ~ 12mr/hr

*** Unlimited entry after decon

3.0 LOW LEVEL LIQUID WASTE TREATMENT

As described in Section 2.0 and listed in TABLE 2.1, various chemical flushes are expected to be used to decontaminate the internals of the equipment within the cells of the West Valley facility. These chemical flushes include:

- (a) Hot potassium permanganate/nitric acid mixture
- (b) Hot sodium hydroxide/tartaric acid mixture
- (c) Hot hydrofluoric acid/nitric acid mixture.

Large quantities of demineralized water will be used for flushing these chemicals from the internals and for cleaning surfaces of equipment and cell walls with water lances. In addition to these decontamination wastes, a large volume of salt solution is expected from the solidification of HLW (option 1 Ref. 14 pp 4-17). Since these solutions are radioactive, they must be treated to remove radioisotopic contamination sufficiently to permit reuse for subsequent decontamination operations or for release to the environment. The laundry waste from decon and solidification operations will also potentially be contaminated and must therefore undergo treatment.

The waste types identified in the preceeding paragraphs can be categorized into two general types of waste:

- (a) Waste with a high dissolved and a high suspended solid content (High Conductivity Waste); and
- (b) Waste with a low dissolved solid but a high suspended solid content (Low Conductivity Waste).

In the category of High Conductivity Wastes (HCW) are: Chemical flushes (acidic and basic); initial water rinse of equipment internals; the salt solution from HLW solidification operations; and laundry detergents. Two options for treatment of high conductivity waste have been considered. One is a treatment system with no acid recovery ("Standard HCW"). The second has the capability to recover nitric acid ("Acid Recovery System").

Any laundry waste with an average activity less than 1×10^{-3} microcuries per milliliter will be sent to the existing Low Level Waste Treatment (LLWT) plant, which is operational. Higher activity laundry wastes will be directed to HCW. This action will reduce or eliminate the problem of adding a defoamer to the HCW process train.

3.1 High Conductivity Wastes

3.1.1 Standard High Conductivity Waste Treatment System

A system for treating high conductivity wastes without recovering acid is shown in Figure 3.1. The system consists of multiple collection tanks and a chemical neutralization tank which

is used to add chemicals to the waste solution to bring the pH level within the range of 7 to 9. The pH adjustment is provided to protect downstream components, particularly evaporators, from chemical attack by highly acidic liquids.

The collection tanks have a total capacity of 200,000 gallons and permit the segregation of chemically different waste streams. At least two tanks are provided for each process train to permit filling, sampling and chemical adjustment of the contents on one tank, while the other is feeding the process train. The tanks are equipped with mixing jets located near the tank bottoms for the purpose of suspending settled solids, and an internal spray system to wash down tank walls facilitating decontamination. Each tank has its own pump, which can (a) recycle tank contents through mixing jets suspending settled solids, (b) transfer waste between the tanks, and (c) pump waste through the process train. The HCW treatment system consists of two process trains each with a 20 gpm throughput. Each train will have one filter and one evaporator. The distillate from both evaporators will be fed to two polishing demineralizers in series. Concentrates will be sent to a concentrate storage tank awaiting batch delivery to the low level waste solidification system.

Filters are provided to remove particulate matter from the waste stream. Remotely operated, backwashable filters are proposed to reduce radiation exposure of personnel. Two types of backflushable filters are considered acceptable for use in the High and Low Conductivity Waste treatment trains. One is a horizontal leaf precoat filter and the other is an etched disc filter. The backwash from both filters are sent directly to the solidification system. The waste volume produced by the etched disc filter is about one order of magnitude less than that for the precoat filter due to the absence of filter cake. For this reason etched disc filters are recommended for use in the HCW and LCW treatment systems.

Since waste processing is a batch type operation and there are redundant process trains, only one filter is required in each train. Filters can be backflushed and placed back in service in several minutes thereby having a minimal impact on processing times.

Due to scaling and plating characteristic of evaporator operation, excess evaporative capacity is provided. Shielding and maintenance requirements for the evaporators were considered in developing the general arrangements drawings. Provision is made to permit antifoam addition to the waste so that the evaporators can process detergents, if required.

The concentrate lines from the evaporators are heat traced to prevent salt precipitation. As a result of this consideration and the higher activities associated with these lines, the evaporators, concentrate hold tank, and the solidification system are physically grouped.

FIG. 3.1
'STANDARD' HIGH CONDUCTIVITY WASTE TREATMENT SYSTEM

The distillate from the evaporators flows to the polishing demineralizers for further treatment. The demineralizers provide a final "polishing" of the waste stream prior to sampling. The two polishing demineralizers are run in series until the lead demineralizer is exhausted. Flushing of exhausted resin from this unit is accomplished while the second unit processes the waste. Since the operation at West Valley is short term, bead resin is used with no resin regeneration and recovery. The spent resin is sent to a hold tank and then to the waste solidification system. New resin is loaded into the demineralizer, and it is restored to service.

The process stream from the demineralizer is discharged to the sampling tanks before final discharge or recycle. These tanks have the same capacity as the collection tanks feeding the process train, and their pumps perform analogous functions. Multiple sample tanks allow additional batch operations to commence prior to disposition of the waste in the sampling tank just filled. Processed liquid which is off-standard can be recycled to the High Conductivity Collection tanks or sent to the Low Conductivity Collection tanks, depending upon sample results. Processed waste which meets 10CFR20 discharge standards for radiation and chemical contents can be sent to Decontamination Water Storage in WNY NSC Lagoon No. 5 (200,000 gal capacity) for further use or be discharged to the environment.

3.1.2 Acid Recovery System

A system for treating high conductivity waste with recovery of nitric acid is shown on Fig. 3.2. There is no neutralization of the nitric acid waste in the collection tanks in the Acid Recovery System. Aside from this, the treatment of the waste stream is the same as in the high conductivity system; namely, filtration, evaporation, and demineralization. The acid recovery elements are in the special treatment of the distillate from the evaporator.

The distillate from the evaporator contains acid and water. The acid recovery system contains a fractionator which produces concentrated acid and weak acid. Concentrated acid is discharged from the bottom of the fractionator, further concentrated in a reboiler and sent to the acid surge tank. Weak acid is the effluent from the top of the fractionator. This weak acid is condensed and fed to a holdup tank. The contents of this tank can be recycled as reflux or sent to the polishing demineralizers. The discharge stream from the demineralizers is fed to the sampling tanks as before. It is in these tanks where the weak acid is collected and neutralized. Off standard treated liquid can be recycled to the collection tanks. Processed wastes which meet 10CFR20 standards can be stored for future decon work or discharged.

Presently at the West Valley site there is an Acid Recovery system in the Off Gas Treatment/Acid Recovery building, adjacent to the main process building, see Figures 3.4 and 3.5. The Acid

Recovery system contains the following equipment: a vaporizer, fractionator, reboiler, condenser, 100-gallon weak acid hold tank and a 3,000-gallon recovered acid surge tank. Although the equipment was never licensed or operated, it is assumed that since the equipment is new it can be made operational with minimal effort. The throughput of this system is about 13 gpm due to refluxing. Therefore, a large holdup capacity must be provided for the acid in the collection tanks.

The Acid Recovery system is designed to receive condensed distillate from an evaporator and produce contaminated 6M acid (vaporizer bottoms), clean 10M acid, and 0.002M weak acid. The solutions used to decontaminate the West Valley facility require 10M and 3.5M acid. The 3.5M acid can be obtained by dilution of the recovered 10M acid or possibly any low activity 6M acid.

3.1.3 Cost/Benefit of Acid Recovery System

The cost/benefit of providing an acid recovery system was evaluated. For this evaluation it was assumed that contaminated waste streams containing caustic and acidic solutions could not be mixed together to promote neutralization since the content of these streams is uncertain and reactions cannot be satisfactorily predicted. The cost of chemicals to neutralize the waste solutions and the cost of nitric acid were both significant cost factors.

Specific data were lacking on the existing (never operated or licensed) Acid Recovery System present at West Valley. It was, therefore, necessary to assume that the acid recovery system could operate or be modified to operate with an 80% recovery of acid.

Much of the acid used in decontamination cannot be recovered because it is consumed. For example, none of the nitric acid in the hydrofluoric/nitric acid flush will be recovered because of the difficult separation process. It was also assumed that the 6M acid recovered by the vaporizer is too contaminated to be used and has to be neutralized and treated by the HCW system. It is also noted that acid cannot be recovered once decontamination of the acid recovery system is initiated.

The total volume of flushes from which acid can be recovered is estimated to be about 98,000 gallons. This includes flush volumes from pre-solidification decontamination, decontamination of the HCW solidification equipment and cubicles, and the off gas treatment system equipment. All other acid solutions require neutralization whether there is an acid recovery system or not.

For a once through system (no acid recovery) new acid must be used for each flush. Caustic solutions will have to be purchased to neutralize all of the acid. The cost for non-recoverable 10M nitric acid (98,000 gallons) and its subsequent neutralization is \$3,100,000.

FIG. 3.2
HIGH CONDUCTIVITY ACID RECOVERY SYSTEM

TASK 4

FIGURE 3.3

TASK 4

				DESIGNED			TITLE			
				DRAWN	BROADUS	11-5-74	SPENT FUEL PROCESSING PLANT			
				CHECKED			PROCESS ENCLOSURE			
				APPROVED			LAYOUT			
				APPROVED			SECTION D			
				APPROVED			FOR			
				APPROVED			NUCLEAR FUEL SERVICE INC.			
				APPROVED			WEST VALLEY, N.Y.			
				APPROVED			SCALE	1/8"=1'-0"	DRAWING NUMBER	REV.
				APPROVED					2401-30-230-108	

DO NOT SCALE THIS DRAWING.
IT MAY BE REPRODUCED FROM ORIGINAL SIZE.

PORTS OF THIS DRAWING OR FROM PAPER ARE "UNRELIABLE" AND SHALL
NOT BE USED FOR CONSTRUCTION PURPOSES.

THIS DRAWING AND THE INFORMATION IT CONTAINS ARE THE PROPERTY OF DRAVO CORPORATION.
IT IS NOT TO BE COPIED OR REPRODUCED AND IS TO BE KEPT IN A SAFE PLACE.

Dravo CORPORATION
Steel-Knox Chemical Plants Division - Pittsburgh, Pennsylvania

TASK 4

The estimated cost to make the acid recovery system operational is \$2,300,000. This includes costs for an additional evaporator, new tanks, nitric acid dilution station, piping to and from the LLLWT facility, and a three year operating period but excludes cost of the acid. This results in a \$800,000 cost savings. The acid recovery system then, is economically beneficial.

Since this cost saving with limited added capital expense is significant, the cost/benefit of furnishing a new acid recovery system was evaluated. This option is applicable if it is determined that the existing acid recovery system is unrecoverable. The cost for all equipment which could recover 80% of the acid treated in a new system was \$1,100,000. The incremental cost of the rad-waste building which would house the additional equipment is \$1,400,000. Thus, even a new system is cost effective.

3.1.4 Reference High Conductivity Waste and Acid Recovery System

Based on the evaluation and findings contained in the preceding section, the HCW system, recommended for the decontamination of the West Valley Facility, is as follows.

Since decontamination chemical rinses and water flushes are significantly different, provisions for segregating waste streams are provided. Two decontamination flushes of equipment internals will contain nitric acid. Both acidic flushes will be cooled from an initial temperature of 80°C to 35°C by a heat exchanger. This temperature reduction will reduce acidic attack on the collection tanks. The cooling water system is operated at a pressure greater than the process stream to avoid contaminating the cooling water system in the event a leak develops.

Decontamination of equipment internals is typically accomplished by two acid flushes and a caustic flush each followed by a water flush. Collection tank sizes and processing rates are based upon the highest expected waste generation rate. Two 18,000 gallon 316 stainless steel collection tanks are provided for the first nitric acid flush, two are provided for the caustic flush, and two to collect the second nitric acid flush (containing hydrofluoric acid). These last two tanks are Kynar lined fiberglass which are resistant to acidic attack from hydrofluoric acid. Four 18,000 gallon 304 stainless steel collection tanks are provided for the three internal water flushes. These four tanks will collect salt solution generated during the HLW solidification operation. The contents of these collection tanks can be transferred to either the HCW or the LCW treatment systems. This allows waste to be redirected to another process train depending on the actual nature of the waste collected.

Wastes are processed by filtration, evaporation, and demineralization. One backwashable filter is provided before each evaporator. Typically, two types of waste streams will be eva-

porated in the HCW system. One is the nitric acid flush and the others are the neutralized caustic, hydrofluoric and an occasional water flush.

The acid stream is processed through a 15 gpm process train which has one filter and one evaporator. This evaporator/crystallizer is constructed of Incalloy 625. The distillate from this evaporator is condensed and double piped to two new 2,000 gallon 316 stainless steel tanks which are housed in a new concrete structure next to the Off Gas Treatment/Acid Recovery building. Two 316 stainless steel acid tanks, 3,200 gallons and 1,800 gallons, are also located in this building.

The contents of one of these tanks will be sent to a Kynar lined collection tank in the LLLWT facility to be neutralized and treated. These tanks are necessary for a functional acid recovery system. Recovered acid is stored in tanks for clean decontamination solutions. Acidic concentrates at 50 weight percent solids are sent in heat traced lines to the concentrate storage tank.

Neutralized waste streams are treated in two 20 gpm process trains. Each train has one filter and an evaporator. The distillate from both evaporators is fed to two polishing demineralizers operated in series. Processed waste from the demineralizers is sent to two 18,000 gallon stainless steel sampling tanks. Tank contents are recycled to the HCW collection tanks or sent to the LCW collection tanks when samples are off-standard. Processed waste which meets acceptance standards can be sent to the decon storage tank for reuse or discharge. Concentrates from the evaporators are sent in heat traced lines to the concentrate storage tank.

Waste storage tanks are provided for filter sludge, evaporator concentrates, and spent resin. The filter sludge tank has a 1,500 gallon capacity. The concentrate storage tank has a capacity of 4,000 gallons. The spent resin tank is a 1,500 gallon stainless steel tank. The contents of these three tanks feed the solidification system.

3.2 Low Conductivity Wastes

Low Conductivity Wastes (LCW) are expected to be products of the "wet vacuuming" of cells after decontamination with water lances, and off-standard processed HCW. It may also be possible to run all or portions of the internal water rinse solutions through the LCW system, depending on the sampled content. The "wet vacuum" system will filter out any large particles or scrap which might foul pumps. This waste is expected to contain a high concentration of suspended solids and a low concentration of dissolved solids.

The system as shown on Figure 3.5 has four 18,000 gallon collection tanks and four pumps. These tanks are the same as the

FIG. 3.5
LOW CONDUCTIVITY WASTE TREATMENT SYSTEM

TASK 4

HCW collection tanks. The tanks have mixing jets located above the tank bottoms to suspend any settled solids and an internal spray system to wash down tank walls. The pumps serve to recycle tank contents, transfer waste between tanks, and to pump waste through the process train.

The process train is capable of a 150 gpm throughput. Two 75 gpm etched disc filters remove suspended solids from the process fluid. Filter sludges, generated therein, are sent to the filter sludge tank for solidification.

Two 150 gpm LCW demineralizers are provided to remove ionic impurities from the process stream. These demineralizers are protected from any high conductivity feed by a diversion valve and associated instrumentation up-stream of the filters and demineralizers. The demineralizers are run in series and are operated as were the evaporator distillate demineralizers discussed in Section 3.1. Spent resin will be sent to the spent resin storage tank.

The filtered and demineralized waste is sent to the LCW sampling tanks. The two sampling tanks and their pumps are identical to the collection tank system. The volume of each of these tanks is 18,000 gallons. If processed liquid is off-standard, it is recycled to the LCW collection tank. Demineralized waste which meets discharge standards can either be stored for reuse in decontamination activities or discharged. An integrated flow of the reference HCW and LCW treatment system is contained on Figure 3.6.

3.3 Low Level Waste Solidification System

All low level liquid waste produced during the West Valley project will be solidified. The low level solidification system is expected to receive waste from the following sources: evaporator bottoms (which may be acidic), demineralizer spent resins, filter backwash sludges, and salts. There are four possible media or binders in which these wastes can be solidified. They are cement, asphalt, urea-formaldehyde (UF), and Dow vinylester. Due to persistent free standing water problems with UF, it is not considered herein.

There are two approaches that can be taken to solidify the filter sludges, concentrates, and resin generated by the LLWT facility. They are volume reduction of waste and the addition of binder to the waste or the direct addition of binder to the wastes without volume reduction. The volume reduction systems (VR) which were considered are the Werner and Pfleiderer Corporation (WPC) extruder/evaporator which uses asphalt as the binder and the Aerojet Energy Conversion Company's (AECC) fluid bed dryer which can use cement or the Dow binder.

The amount and type of waste to be solidified will determine the solidification option that is preferable. The total amount of Low Level Waste to be solidified is dependent upon the decom-

missioning option selected (i.e. protective storage, entombment, or dismantlement, listed in order of increasing waste production). Since equipment will be decontaminated for all options, the amount of liquid waste will not vary much. The greater the amount of waste to be solidified, the more desirable the VR option becomes. Although a VR system represents a large initial cost and more equipment to be decontaminated, the savings in transportation and burial cost associated with fewer LLW drums can compensate for the expenditure.

The most firmly identified waste stream at this time is the salt solution and resins from solidification of HLW (option A-1). These wastes will be solidified regardless of where the HLW solidification is performed or what decommissioning option is chosen. The volume of waste from pre-HLW and post-HLW solidification decontamination operations in the main process building has been identified. Estimates have been made for the amount of liquid waste generated in clean up of the LLWT system. The total amount of decontamination waste to be solidified dependent upon where the HLW solidification is performed and on the decommissioning option chosen.

For cases studies where the salt solution represents the major amount of waste to be solidified, a direct addition of binder solidification system is cost effective. For cases where the decontamination wastes to be solidified were more than twice the amount of salt solution, a VR system is optimal.

A general discussion of some VR and solidification options are discussed below.

3.3.1 Direct Addition of Binder

Dow has developed a binder which will immobilize filter sludges, salt concentrates and resin while limiting the amount of free water present after solidification and demonstrating good leach rate characteristics.

Dow binder can accommodate wastes with pH levels from 2.5 to 11. Chemical adjustment is needed for any waste outside of this pH range. The system employs an in-container mixer with a small disposable mixing blade, which is left in the waste container (assumed to be 55 gallon drums for this study). The drums are initially charged with Dow binder. The waste is then added to the drum from a small Waste Drum Filling Tank. After the promoter and catalyst are added, the waste/binder mixture is emulsified.

Within 5 to 10 minutes the drum contents turn to a gel, and within an hour the mixture is solidified. The packaging efficiency (PE) of Dow Binder (waste to binder ratio) is 1.5 for liquid waste slurries and 2.0 for ion exchanger resins in 55-gallon drums. The cost of Dow Binder is \$1/lb. A complete, remotely operated Dow Binder system has been installed at 9 Mile Point, and one is planned for Dresden I.

W.O. No. _____ Date _____ Book No. _____ Page No. _____
 Drawing No. _____ Catc. No. _____ Sheet _____ of _____
 By _____ Checked _____ Approved _____
 Title REFERENCE LOW LEVEL LIQUID WASTE TREATMENT SYSTEM

FIG. 3.6

TASK 4

FIGURE 3.7
WERNER AND PFLEIDERER CORP. - VOLUME REDUCTION SYSTEM

TASK 4

Little equipment is needed for this system, and the only contaminated equipment is the waste storage tank and the drum filling tank.

A cement binder requires more hardware than the Dow system and product leach rates and packaging efficiencies are not as good.

The packaging efficiency of wastes in cement is approximately 1.33. Although the equipment costs for a cement system are larger than the Dow system, the low cost of cement (\$.03/lb) makes cement economically preferable for solidification of large amounts of waste.

3.3.2 Volume Reduction Systems

If large amounts of waste are generated by the LLWT system, one of the following volume reduction systems may be employed.

3.3.2.1 Werner and Pfleiderer Corporation (WPC)

The WPC system can solidify filter sludges, concentrates, and bead resin; however, acidic wastes are first neutralized to moderate pH level for compatibility with the binder and protection of the carbon steel extruder-evaporator. The extruder-evaporator consists of two co-rotating screws. These are assembled by placing kneading and conveying elements on a keyed shaft (See Figure 3.7). These screws rotate within a barrel which is heated and cooled at specific points along its length. A motor and gear box arrangement turns the screws.

Asphalt is fed into the extruder-evaporator at the head end. The waste feed from the waste solidification hold tanks enters slightly downstream. As the mixture is conveyed along the screws, the waste and hot asphalt are intimately mixed, and water (comprising the bulk of the waste) is evaporated. Water vapor exits the extruder-evaporator through steam domes located along the top of the machine. This vapor is condensed, filtered, and collected for recycle to the waste collection tanks. The radsalt/asphalt mixture exits at the end of the extruder-evaporator and falls into 55-gallons drums.

A volume reduction of as high as 8 can be achieved for evaporator bottoms and possibly more for sludges, with water removal exceeding 99 percent. The PE of asphalt is 1.0 and it costs \$.08/lb.

Werner and Pfleiderer furnishes a complete radwaste VR and solidification system with all required controls, waste feed components, container handling equipment, and asphalt storage and feed components. With the exception of the extruder-evaporator and associated gear box (approximately 10 percent of the total cost), all components are manufactured in the United States. The extruder-evaporator and gearbox are manufactured in Stuttgart, West Germany by Werner and Pfleiderer Corporation.

3.3.2.2 Aerojet Energy Conversion Corporation (AECC)

The AECC system makes use of a fluid bed dryer (See Figures 3.8 and 3.9). This device treats only radwaste concentrates producing a dry anhydrous salt product. The VR system does not process filter sludges or spent resins although these can be processed in the AECC fluid bed incinerator which was not studied here. Acidic concentrates are neutralized before being fed to the fluid bed dryer. The system can accept from 7 to 28 wt% dissolved solids in the feed. A VR of 8 can be achieved, with 100 percent removal of water from concentrates.

Radsalts exit near the bottom of the dryer and are conveyed to a hopper which feeds the salts to the solidification system. Either Dow Binder or cement can be used for solidification. See Table 3.1 for the qualities of various binders.

In conclusion, the selection of a volume reduction solidification system is basically a choice between binders. The equipment costs are similar whereas binder costs are quite different.

3.3.3 Conclusion

The AECC system with Dow Binder was found to be the most cost effective system if the waste is to be buried off site (see Table 5.6). This system produces the fewest solidified drums of all systems studied and uses a versatile low leach rate binder. If waste is to be buried on site the direct addition of binder systems are cost effective. The Dow system is recommended due to the favorable characteristics of the binder.

Fluid Bed Dryer Volume Reduction System Schematic

FIGURE 2.9

VR System Capacity

FIGURE 3.9

TABLE 3.1 Comparison of Available Immobilization Technologies

COMPARISON FACTOR	DOW VINYLESTER ^(a)	UREA-FORMALDEHYDE	PORTLAND CEMENT ^(b)	BITUMEN
SHELF LIFE OF IMMOBILIZING AGENT:	BINDER SHORT (MONTHS)	SHORT (MONTHS)	LONG	LONG
MIX FLUIDITY	GOOD	GOOD	POOR	FAIR
MIXER CLEANABILITY	GOOD	GOOD	POOR	FAIR
CHEMICAL TOLERANCES				
BORIC ACID SOLUTION	GOOD	GOOD	POOR	GOOD
Na_2SO_4	GOOD	REDUCED EFFICIENCY	FAIR	GOOD
NaNO_3	GOOD	FAIR	GOOD	NOT RECOMMENDED
ALKALINE	GOOD (pH 12-13)	REDUCED EFFICIENCY	GOOD	GOOD
LAUNDRY DET	POOR TO FAIR	POOR	POOR	FAIR
ORGANIC LIQUIDS	POOR TO FAIR	POOR	POOR	FAIR
ION EXCH RESINS	GOOD	GOOD	FAIR	FAIR
SLUDGES	GOOD	GOOD, MAY REQUIRE pH ADJUSTMENT	GOOD	GOOD; HAZARDOUS WITH MnO_2 SLUDGE
VOLUMETRIC EFFICIENCY ^(d)	HIGH (1-2)	MODERATE (0.6-1.0)	LOW (0.5)	HIGH (> 2)
PRODUCT FORM	MONOLITH	MONOLITH	MONOLITH	MONOLITH
PRODUCT DENSITY, kg/m^3	1020	1000-1300	1500-2000	1000-1300
WATER BINDING STRENGTH	EXCELLENT	FAIR	GOOD	WATER EVAP
RESIDUAL FREE WATER	NEVER	OCCASIONALLY	SCARCELY	NEVER
MECHANICAL STRENGTH	GOOD	FAIR	GOOD	GOOD
PRODUCT STABILITY	GOOD	FAIR (LOSES WATER AND STRENGTH IN OPEN SYSTEM)	VERY GOOD	GOOD
COMBUSTIBILITY	YES	YES	NO	YES
FREEZE/THAW RESISTANCE	GOOD	POOR	FAIR TO GOOD	GOOD
LEACH RESISTANCE	HIGH	MODERATE	MODERATE TO HIGH	HIGH

(a) DOW REPORTS

(b) WITHOUT ADDITIVES

(c) THE ABILITY TO SETUP AS AN ACCEPTABLE SOLID IN THE PRESENCE OF THE STATED CHEMICALS

(d) RATIO OF THE AS-GENERATED WASTE VOLUME TO THE SOLIDIFIED VOLUME

4.0 DRY ACTIVE WASTE TREATMENT

The quantity of dry active waste generated during the decontamination of the West Valley facility is dependent on the decommissioning option which is chosen (Protective Storage, Entombment, Dismantlement). These wastes are discussed in Task 1 and they must be packaged and disposed of on-site or shipped off-site for ultimate disposal. Dry active waste consists of two general types: (1) Metallic wastes (process cell equipment and pipes, stainless steel liners, storage racks, contaminated tools, metal scrap, etc.; (2) Dry contaminated trash including dry vacuum and HEPA filters, zeolite clay, and NO_x destructive material, protective clothing, paper, plastic, glass, and floor sweepings. Treatment, packaging, storage, and shipment of these wastes are discussed in the following sections.

4.1 Metallic Wastes

Metallic waste is expected to be produced during pre- and post-HLW solidification activities. All metallic waste is packaged and stored in a specially constructed vault. For further details of this waste and treatment see Task 1 (NES). It is assumed for this study that the equipment is decontaminated to exposure levels which allow shipping to a burial site in the storage packages. Packages which need shielding will be penalized in transportation and burial costs.

It is noted that in practice the metal may receive additional decontamination. Chemical solutions and emerging technologies in the area of vibratory finishing and electropolishing could be used for additional decontamination of the metallic waste. In the case of vibratory finishing and electropolishing the metal may be cleaned to background radiation levels. This would eliminate the need for burial of this material and allow the metal to be reused for nuclear or non-nuclear purposes. Mobile and/or centralized large scale metallic treatment facilities may be operational in the coming decade. Small scale electropolishing for maintenance tools and equipment has already been used at Three Mile Island. These types of facilities should be considered for the management of metallic wastes.

Fifty-one containers of metallic waste are expected from pre-solidification activities. Post decontamination metallic waste will result in 107 containers for "Cleaning to previous dose levels", 158 containers for the "dismantlement" option, and no additional containers if "entombment" is chosen. Details of the number and size of these waste containers are contained in Tables 4.1, 4.2, and 4.3.

4.2 Dry Contaminated Trash

Dry contaminated filters are expected to come from vacuum decontamination of the cells and the off-gas system. These filters

TABLE 4.1

Metallic Waste Packages
Pre-HLW Solidification

<u>No. of Containers</u>	<u>Size (ft)</u>	<u>Total Volume (ft³)</u>
11	4x4x8	1408
12	6x8x12	6912
6	8x8x12	4608
1	6x8x12	576
5	8x8x24	7680
8	17.1x8x8	8755
2	6x4.2x4.9	247
2	9x9x16.5	2673
1	44x3x3	396
1	50x6x6	1800
1	48x6x6	1728
<u>1</u>	<u>28x6x6</u>	<u>1008</u>
51		37791

Activity of Containers

<u>Decon</u>	<u>No. of Containers</u>	<u>Activity</u>
Thorough	51	less than 200 mrem/hr
Gross	33	less than 75 R/hr
	3	5.7 R/hr
	15	10 mrem/hr

TABLE 4.2

Metallic Waste Packages
Post-HLW Solidification
Decon to Previous Levels

<u>No. of Containers</u>	<u>Size (ft)</u>	<u>Volume (ft³)</u>
20	10x10x12	20,000
11	4x4x8	3,168
33	7x3x3	2,205
5	6x6x10	1,800
4	6x6x8	1,152
3	4x4x16	768
3	12x12x24	10,368
20	4x4x8	2,560
6	4x4x12	1,152
<u>107</u>		<u>43,168</u>

Activity of Containers

<u>Decon</u>	<u>No. of Containers</u>	<u>Activity</u>
Thorough	107	less than 200 mrem/hr
Gross	20	less than 75 R/hr
	87	less than 200 mrem/hr

TABLE 4.3
Metallic Waste Packages
Post-HLW Solidification
Dismantlement

<u>No. of Containers</u>	<u>Size (ft)</u>	<u>Volume (ft³)</u>
20	10x10x12	20,000
19	4x4x8	2,432
9	4x4x8	1,152
2	5x5x10	500
2	8x8x16	2,048
1	2x3x10	60
11	4x4x18	3,168
16	4x4x8	2,048
2	4x4x8	236
33	7x3x3	2,205
5	6x6x10	1,800
4	6x6x8	1,152
3	12x12x24	10,368
20	4x4x8	2,560
6	4x4x12	1,152
158		51,664

Activity of Containers

<u>Decon</u>	<u>No. of Containers</u>	<u>Activity</u>
Thorough	158	less than 200 mrem/hr
Gross	53	less than 75 R/hr
	108	less than 200 mrem/hr

should include prefilters, HEPA filters, and zeolite clay. Non-TRU waste filters can be removed using normal maintenance procedures and compacted in 55 gallon drums. The zeolite clay can either be packaged in plastic or loaded in drums. If shielding is necessary, zeolite can be loaded in 30-gallon drums inside of 55-gallon drums lined with cement.

A sulfate sludge (option A-3) is expected to be non-TRU waste and could be loaded into 55-gallon drums. All non-TRU waste should be properly stored on-site until transported to a LLW burial ground.

Any TRU waste will have to be reduced in size to fit into HLW canisters for geological burial. These canisters may be the same as those used for vitrification. These canisters can be stored with the HLW vitrified canisters until transported to a Federal Repository.

4.3 Combustible and Non-Combustible Trash

The relatively short duration of the decontamination and decommissioning operation at West Valley will not justify the installation of an incinerator. In addition, LLW burial facilities are considering providing incinerators at the burial ground to limit trench development. Therefore, all non-TRU trash will be compacted in 55 gallon drums. The drum must be stored while awaiting transportation to a burial ground.

Compactors typically consist of a vertical hydraulic ram, frame and safety enclosure with loading table, and a vent and filter system with fan, gages and controls. A full 60 inches of stacked waste can be compacted, permitting paper rolls to be loaded endwise. Both the hinged loading table and enclosure door for the extension space above the drum must be closed before compacting. The extension space is evacuated by the built-in fan, which draws air through a roughing and HEPA filter. Filters can be remotely dropped into the drum, avoiding handling. The cost of a compactor is approximately \$50,000.

All TRU trash should be cut down and/or sized to fit into a HLW canister. These canisters can be the same as the vitrified glass canisters.

5.0 WASTE DISPOSAL COSTS

5.1 Solidification Costs

5.1.1 Direct Addition of Binder

The two binders considered were cement and Dow binder. As previously mentioned the cost of cement is \$.03/lb. and the cost of Dow is \$1/lb. A complete, remotely operated Dow system as was furnished at Nine Mile Point was \$300,000, while a cement system will cost approximately \$600,000.

5.1.2 Volume Reduction Systems

Three binders were considered with VR systems. The cost of cement and Dow are listed above while unit asphalt costs are \$.08/lb. The price of the WPC extruder-evaporator system with catch tanks drumming station and instrumentation is estimated at approximately 2.6×10^6 . The cost of the AECC fluid bed dryer with complete instrumentation and feed tanks is about 2×10^6 . In addition the cost of either the cement or Dow binder solidification system must be added to the cost of the AECC system. To be conservative, all liquid waste volumes were taken from the Dismantlement option (Ref. 13).

The costs of solidifying and packaging the waste for various systems are listed on Table 5.1.

5.2 Transportation Costs

A parametric analysis of transportation costs was made using generic disposal sites; on site and site numbers 1, 2, 3, and 4 corresponding to distances of 500, 1000, 2000, and 3000 miles respectively from West Valley. Fifty five gallon drums of solidified filter sludges, evaporator bottoms (concentrates), and spent resins are shipped in shielded casks on flat bed trucks. Casks of one and two inch lead shielding are used to account for shielded transport costs. One third of the solidified spent resins, concentrates and filter sludge drums will be shipped in two inch lead shielded casks. The remaining two thirds of the drums are shipped in the one inch lead shield casks.

For VR systems and direct addition of binder systems, solidified drums of the HLW salt solution will be shipped in one inch lead shield casks. Drums of compacted trash will not require shielding. On site transportation is assumed to be carried out on unshielded flat bed trailers at a cost of \$400/trip.

Shielding casks can be rented, however, it is cost effective to purchase casks solely for this operation. These casks could then be sold when no longer required. The number of casks to be purchased was determined by the requirements dictated by a shipping schedule of shipping all waste to the burial site in one year. The

TABLE 5.1

Solidification and Packaging Costs

<u>Solidification Method</u>	<u>Number of Drums</u>	<u>Cost [\$]</u>
Werner-Pfleiderer Corp. (WPC) Extruder Evaporator with Asphalt	26,100	4.17×10^6
Aerojet Energy Conversion Comp. (AECC) Fluid Bed Dryer with Dow Binder	11,400	4.75×10^6
AECC Fluid Bed Dryer with Cement	14,000	3.22×10^6
Dow Binder Alone	31,600	7.09×10^6
Cement Alone	37,000	2.26×10^6
<u>Waste Type</u>	<u># Packages</u>	<u>Cost [\$]</u>
Trash	3,000 (drums)	$.12 \times 10^6$
Metallic		
Pre-Solidification	51	3.9×10^4
Post-Solidification		
Decon to Previous Levels	107	4.0×10^4
Dismantlement	158	5.2×10^4

TABLE 5.2
SUMMARY OF LOW LEVEL WASTE (LLW)
SOLIDIFIED AND DRY WASTE (1)

Source of Waste	Isotopic Content	Activity	Physical & Chemical Description	Packaging	Transportation	Volume																				
Pre-HLW Solidification Decon Solutions	Fission Products and Actinides	0.3 Ci/Drum	NaNO ₃ , NaF	Salt Solidified in Dow Binder in 55 gallon drums	Drums in 1- and 2-in. lead shielded casks on flat bed trailers	1375 drums																				
Post-HLW Solidification Decon Solutions	Fission Products and Actinides	to 9.7 Ci/Drum	NaOH, Tartaric Acid KMnO ₄ , NaN ₃			3625 drums																				
HLW Solidification Salt Solutions	Fission Products and Actinides	1.8 Ci/Drum	<table><tr><th>Component</th><th>Wt%</th></tr><tr><td>(Na,K)SO₄</td><td>6.79</td></tr><tr><td>(Na,K)NO₃/NO₂</td><td>83.29</td></tr><tr><td>(Na,K)OH</td><td>3.47</td></tr><tr><td>Na,K</td><td>0.04</td></tr><tr><td>FePO₄</td><td>0.09</td></tr><tr><td>Cr(OH)₃</td><td>0.16</td></tr><tr><td>Ni(OH)₂</td><td>0.05</td></tr><tr><td>Na₂CO₃</td><td>5.96</td></tr><tr><td>AlF₃</td><td>0.12</td></tr></table>	Component	Wt%	(Na,K)SO ₄	6.79	(Na,K)NO ₃ /NO ₂	83.29	(Na,K)OH	3.47	Na,K	0.04	FePO ₄	0.09	Cr(OH) ₃	0.16	Ni(OH) ₂	0.05	Na ₂ CO ₃	5.96	AlF ₃	0.12	Salt Solidified in Dow Binder in 55 gallon drums	Drums in 1- and 2-inch lead shielded casks on flat bed trailers	6100 drums
Component	Wt%																									
(Na,K)SO ₄	6.79																									
(Na,K)NO ₃ /NO ₂	83.29																									
(Na,K)OH	3.47																									
Na,K	0.04																									
FePO ₄	0.09																									
Cr(OH) ₃	0.16																									
Ni(OH) ₂	0.05																									
Na ₂ CO ₃	5.96																									
AlF ₃	0.12																									
Operational Resin from HLW and LLW Treatment Systems	Fission Products and Actinides	0.4 Ci/Drum	Spent Resins	Resin Solidified in Dow Binder	Drums in shielded casks on flat bed trailers	300 drums																				
Operational Waste Trash	Fission Products and Actinides	< 50 mR/hr	Clothing, Filters, Wipe Cloths, Tools, Paper, Coatings	Compacted in 55 gallon drums	Drums in unshielded trailers	300 drums																				
Process Equipment	Fission Products and Actinides	Low <200mR/hr High <75R/hr	Metal Components and Piping	Wooden and Metal Containers of various sizes	Packages on shielded & unshielded trailers	Low Decon 38,00 ft ³ Previous level Decon, 81,000 ft ³ ; Dismantlement, 89,000 ft ³																				

(1) Based on VR using the Aerojet Energy Conversion Comp. Fluid Bed Dryer and Dow Binder

price of a two inch lead cask (14D-2L) is \$65,000. A one inch lead shield cask (14D-1L) is \$45,000. Both casks can hold 14 drums of radioactive waste. Two one inch lead casks can be carried on one truck while only one two inch lead cask can be carried on a truck. Neither loading violates the 45,000 lb. max load per truck.

The rental cost for trucks to carry shield casks is 2\$/mile-truck, round trip. The rental cost for unshielded trucks is 1.37 \$/mile-truck for the east coast and 1.47 \$/mile truck west of the Mississippi, one way. The two shorter distances, 500 and 1000 miles, were considered east coast trips. The two larger trips of 2000 and 3000 miles were considered to cross the Mississippi.

Transportation costs are summarized on TABLES 5.3 and 5.4

5.3 Burial Costs

The burial costs calculated for this study were based on the rate schedule for the burial ground in Hanford, Washington operated by Nuclear Engineering Company. These costs are listed on TABLE 5.5.

5.4 Conclusion

With the estimated volumes of waste to be solidified in the West Valley project a volume reduction system was found to be warranted. The AECC system is considered to be the best system if the waste is to be buried off site. If waste is to be buried on site a direct addition of binder system is optimal. For either case the choice of binder is between Dow and cement. Although Dow costs more it is generally considered a better binder than cement. The isotopic leach rates for Dow are lower than cement and the waste is concentrated into fewer drums. For these two reasons the Dow system is recommended as a reference solidification system over cement. Cost figures on TABLE 5.6 show that from a waste management standpoint it is desirable to decontaminate metallic waste as much as possible before shipment and burial.

TABLE 5.3

Waste Transportation Costs [\$]Solidified Waste

<u>System</u>	<u>On-Site</u>	<u>Site #1</u>	<u>Site #2</u>	<u>Site #3</u>	<u>Site #4</u>
WPC	500,000	2,620,000	5,750,000	10,700,000	1,570,000
AECC+ DOW	220,000	1,140,000	2,510,000	4,680,000	6,860,000
AECC+ CEMENT	270,000	1,410,000	3,110,000	5,780,000	8,440,000
DOW	630,000	3,160,000	6,900,000	12,900,000	18,900,000
CEMENT	740,000	3,720,000	8,150,000	15,200,000	22,200,000

Compacted Waste and Filter

	<u>On-Site</u>	<u>Site #1</u>	<u>Site #2</u>	<u>Site #3</u>	<u>Site #4</u>
<u>Compacted</u>	5,200	8,900	17,800	38,200	57,300

Metallic Waste Packages

<u>Pre-HLW</u>	<u>On-Site</u>	<u>Site #1</u>	<u>Site #2</u>	<u>Site #3</u>	<u>Site #4</u>
Unshielded	12,000	20,600	41,100	88,200	132,000
Shielded	12,000	60,000	120,000	240,000	360,000

Post-HLW

Previous Level Decon

Unshielded	42,000	72,000	144,000	309,000	463,000
Shielded	42,000	210,000	420,000	840,000	1,260,000

Dismantlement

Unshielded	53,600	91,800	184,000	394,000	59,000
Shielded	53,600	268,000	536,000	1,070,000	1,610,000

TABLE 5.4
Transportation Costs [\$]
Dry Active Waste

<u>Waste</u>	<u>On-site</u>	<u>Site #1</u>	<u>Site #2</u>	<u>Site #3</u>	<u>Site #4</u>
Trash	259,000	266,000	283,000	323,000	359,000
<u>Pre-HLWS</u>					
Unshielded	345,000	353,000	374,000	421,000	465,000
Shielded	993,000	1,040,000	1,100,000	1,220,904	1,340,000
<u>Post-HLW</u>					
Previous Level Decon To					
Unshielded	457,000	486,000	558,000	723,000	878,000
Shielded	1,190,000	1,360,000	1,570,000	1,990,000	2,410,000
Dismantlement					
Unshielded	545,000	583,000	675,000	884,000	1,080,000
Shielded	1,510,000	1,730,000	1,990,000	2,530,000	3,070,000

TABLE 5.5

Burial Costs

<u>Liquid Wastes</u>		
<u>Solidification</u>		
<u>Option</u>	<u>No. of Drums</u>	<u>Cost [\$]</u>
WPC - Extruder Evap. Asphalt	26,100	2,640,000
AECC - Fluid Bed Dryer/Dow Binder	11,400	1,150,000
AECC - Fluid Bed Dryer/Cement	14,000	1,420,000
Dow Binder Alone	31,600	3,200,000
Cement Alone	37,000	3,750,000
Compacted Trash	3,000	190,000
<u>Metallic Wastes</u>		
	<u>Unshielded</u>	<u>Shielded</u>
Pre-HLW	290,000	940,000
Post-HLW (Decon to Previous Levels)	330,000	1,100,000
Post-HLW (Dismantlement)	400,000	1,400,000

TABLE 5.6
TOTAL COST OF WASTE MANAGEMENT*
(SOLIDIFIED WASTE)

VR System/ Binder	Number of Drums	Cost in Millions of \$				
		On-Site	Site #1	Site #2	Site #3	Site #4
WPC - Extruder Evaporator + Ashpalt	26,000	7.30	10.1	12.6	17.5	22.5
AECC - Fluid Bed Dryer + Dow	11,400	6.12	7.31	8.41	10.6	12.8
AECC - Fluid Bed Dryer + Cement	14,000	4.91	6.40	7.75	10.4	13.1
Dow Alone	31,000	10.9	14.2	17.2	23.2	29.2
Cement Alone	37,000	6.71	10.7	14.2	21.2	28.3

* Includes solidification, transportation, and burial costs.

6.0 POTENTIAL FOR USE OF EXISTING FACILITIES

An examination of existing radwaste treatment facilities and available storage tanks was carried out in order to determine if the existing facilities can be utilized in association with the proposed LLLW treatment system. Existing radwaste facilities were identified, their operability and space capacity investigated, and their suitability for the proposed LLW treatment system examined. The findings can be summarized as follows:

As discussed under Section 3.1.2. (Acid Recovery System), it was assumed feasible to utilize the acid recovery equipment in the Off-Gas Treatment/Acid Recovery Building. There are several tanks located inside the Main Process Building which will not be removed during pre-HLW solidification decontamination work. Existing storage tanks located in the Acid Recovery Room (ARR) are not functional and are highly contaminated and cannot be used in association with the acid recovery effort.

Each of the existing full HLW tanks is provided with an empty tank that serves as a spare. These empty tanks serve as a safety reserve storage capacity for the full HLW tanks and can, therefore, not be used for HLW storage during the pre-HLW solidification.

The existing Low Level Waste Treatment (LLWT) facility can accept waste with an average activity less than 1×10^{-3} micro-curies per milliliter. Although the facility is not operated at full capacity, it makes use of open lagoons as decay pools and external water treatment equipment. For these reasons, it was not considered for use as a LCW treatment system. As previously mentioned, the facility could be used to handle laundry waste which meet activity requirements. Presently, the facility is used to treat water from the spent fuel storage pool and water drainage from the burial trenches.

Some use may be made of the large lagoons which surround the LLWT site. One lagoon (Lagoon No. 3) is an environmental discharge lagoon. Treated water can be released to the surrounding creeks from this lagoon. All environmental releases should be routed through this 3.3×10^6 gallon clay-lined lagoon. It is considered feasible to isolate Lagoon No. 5 from the LLWT facility and use this lagoon for decon water storage. The lagoon is rubber-lined and has a capacity of 200,000 gallons. Its present use is as one of two sample lagoons (Nos. 4 and 5) for the LLWT facility. Since the facility is not used to full capacity, it may be able to function with only one sample lagoon, or perhaps Lagoon No. 4 could be divided in half to provide two 100,000 gallon sample lagoons.

There are presently on-site unused natural circulation-type evaporators which are the property of NFS. If these evaporators were used for a LLLW treatment system, a larger collection tank capacity would be needed as these evaporators have a lower throughput than the forced circulation units proposed.

Overall, the extent to which existing facilities can be utilized as part of the low level liquid waste treatment system appears limited. Added capacity for waste solutions will have to be provided. It will also be necessary to house the low level liquid waste treatment system in a new structure since existing space is limited. New storage tanks for the acid recovery system will also be necessary.

7.0 REFERENCE LOW LEVEL LIQUID WASTE TREATMENT STRUCTURE

The reference LLLWT structure is designed to house all process equipment excluding the acid recovery system. Approximately two thirds of the facility contains liquid storage, filtration, evaporation and demineralization equipment. The remaining third of the building contains solidification equipment, drum storage, and a truck bay. The majority of the structure is concrete with two metal roof structures to house heating and ventilation equipment and the control room, see Figure 7.1.

The structure includes design features which facilitate decontamination. All process and storage tank cells will be equipped with floor drains and water lance connections. Walls and floors will be coated with strippable vinyl to prevent contamination of the concrete. Roof plugs are provided above all major process equipment items that may require removal.

If equipment should fail, a plastic tent is constructed on the roof of the building over the appropriate roof plug. The plug is removed by an exterior crane which operates through a sleeve in the top of the tent. The failed unit is lifted out of the building and packaged.

Decontamination of equipment will occur while equipment is in place. Clean decon solutions can be fed into the process train through the chemical addition tanks or through an extra connection provided for decontamination. The decontamination of the LLLWT facility equipment internals will consist of running decon solutions through the process train tanks, filters and evaporators to the solidification system. Space for clean decon solution tanks is provided in the maintenance aisle.

7.1 Layout of the Reference LLWT Facility Process Area

The proposed site of the structure for this task is taken to be to the north of the Main Process Building. The structure is 165 ft x 162 ft with a maximum height of 155 ft. The floor mat is 5 foot of concrete and shield walls and ceilings are two to three feet thick.

The process train is U shaped around a central access aisle, see Fig. 7.2. The collection tank cells are located along the south wall of the facility. Four cells contain all of the collection tanks. The cells are arranged from east to west. Three cells contain four collection tanks and one cell contains only two tanks. The three large cells are 40 ft x 40 ft x 30 ft in height. The smaller cell is 20 ft x 40 ft x 30 ft. in height.

To the east of all the collection tank cells is a cell which contains a heat exchanger. This heat exchanger cools the acidic solutions. All waste solutions enter the building through this cell. The cell is 9 ft x 30 ft x 30 ft in height. To the east and

adjacent to the heat exchanger cell is the caustic collection tank cell. Further east is the acidic collection tank cell, the Internal Rinse/Salt Solution collection tank cell, and finally the External Rinse collection tank cell.

Each collection tank cell has an associated pump room and valve room. The valve room is located above the pump room, see Fig. 7.1. A ladder connects the pump room (ground level) with the valve room. The valve room has a passage to a platform in the collection tank cell allowing access to tank instrumentation located at the top of the tanks. Access to these areas should only rarely be necessary as the system is completely automated with active components located outside equipment rooms. Though no ground level access exists to the collection tank cells a knockout passage is located in the pump room through a common wall. This wall is to be knocked out during decommissioning.

Waste streams, which enter the southwest corner of the building, pass through piping supported along the walls of the tank cells. Waste to be processed is pumped from the tanks through pipes which are supported off the northern collection tank cell walls to the filters.

The filter gallery contains both high and low conductivity filters and is located on the upper level of the west wall, see Fig. 7.2. Five filter cubicles (9 ft x 9 ft x 15 ft in height) contain one filter each. The walls, floors and ceilings are 3 foot thick concrete and roof plugs are located over each filter. The pressurized air backflush tanks are located in the metal structure on the roof. Beneath the filter gallery level is the filtrate pipe chase. The chase contains the lines to the filter sludge solidification tank. After filtration, waste is sent to either the evaporators (HCW) or to demineralizers (LCW). Both lines enter on the south wall of the first evaporation cell in the center of the building, see Fig. 7.1.

The evaporator cells are located in the center of the building. These cells are 30 ft x 30 ft by 52 ft in height. The walls and ceiling are 3 foot thick concrete. These cells contain all the equipment necessary for evaporation. Roof plugs are provided for the vapor body unit and the heat exchanger. The two western evaporator cells contain the 20 gpm evaporators and the remaining cell contains the 15 gpm acidic evaporator. Heat traced lines at the lower level will run west along the northern evaporator cell walls and north along the facility's outer wall carrying concentrates to the concentrate collection tank, see Fig. 7.1. Distillate lines run along the northern evaporator cell walls on the upper level to the polishing demineralizer. Low conductivity waste lines will run along the southern evaporator cell walls at the upper level to the demineralizers.

The four demineralizer cells are located on the upper level adjacent to the acid evaporator cell, see Fig. 7.2. The cells are

11 10 9 8 7 6 5 4 3 2 1

PLAN AT EL. 100.0'

TASK 4

FIGURE 7.1

REVISION				DATE	BY	CHK	APPROVED	DRAWING RELEASE STATUS				ENGINEERING REVIEW				WESTERN NEW YORK NUCLEAR SERVICE CENTER			
								☒ PRELIMINARY	☐ PARTIALLY APPROVED			BY	DATE	BY	DATE	LOW LEVEL LIQUID WASTE TREATMENT FACILITY			
								RELEASED FOR	BY	DATE	RELATES TO	AMEND	ADD			PLAN AT EL. 100.0'			
								FOR INFORMATION								BURNS AND ROE INDUSTRIAL SERVICES CORP.			
								FOR CONSTRUCTION								Engineers and Constructors			
								APPROVED FOR								DESIGNED BY			
								CONSTRUCTION								CHECKED BY			
																DRAWING NO.			
																4870			
																C-001			
																0

PLAN AT EL. 115'-0"

TASK 4

FIGURE 7.2

[illegible]

9 ft x 11 ft x 15 ft in height and contain one demineralizer each. The walls and ceiling are 3 feet of concrete and a roof plug is above each unit. Above the demineralizer on the roof and to the south is the resin feed system. This is housed in a metal structure, see Fig. 7.3. A resin feed tank on wheels is positioned over a floor valve and resin is emptied from the feed tank through the fill pipe into the demineralizer. Spent resin is slurried out the bottom of the demineralizer and piped along the same route as the concentrate to the spent resin collection tank. The sumps for the facility are located in the cell below the demineralizer cells.

Acidic distillate is condensed in the cell to the north of the demineralizer cells. Acid distillate and demineralized fluid lines cross over the access aisle into the sampling tank cell. The sampling tank cell is a long cell which is located along the east wall. Both HCW sampling tanks (2), and LCW sampling tanks (2), are located in this cell. The associated pump room and valve room can be seen in Fig. 7.1. The system for these tanks is the same as for the collection tanks. Recycle lines are sent through the valve room to the Internal and External collection tank cells.

Demineralized water and acid distillate exit the building to the east. The water line runs to the decon waste storage lagoon. Acid is sent to the acid recovery system via a system in which the transfer pipe is located within a protective out pipe.

The solidification area is located in the northern third of the building. Solidification system feed tanks are located along the west wall. The filter sludge and spent resin tanks are situated on an upper level with their pumps below them. The larger concentrate tank is on grade elevation. Two foot shield walls are provided around the concentrate, filter sludge, and spent resin fuel pumps and access for this repair and maintenance is provided.

Along the south wall of the solidification area space is provided for waste solidification and drum storage. Storage space for 792 drums is provided.

In the northern part of the solidification area is an entrance, aisle, new drum storage and truck bay, see Fig. 7.1. The entrance allows access to the ground floor aisles throughout the building and to the stairs which lead to the control room on the roof of the solidification area, see Fig. 7.3. One 10 ton crane services the solidification area including the truck bay. The bay is sloped down to a depth of 4 feet to facilitate loading of drums.

The metal roof structure to the south houses the heating and ventilation equipment. The northern metal structure encloses the control room and cable spreading room.

The cost of this facility including upgrading of the existing acid recovery system is approximately \$37,000,000.

8.0 RADIATION EXPOSURE FOR LOW LEVEL WASTE (LLW) MANAGEMENT

Management of LLW associated with the solidification of high level liquid wastes will result in radiation exposure of operating personnel. This exposure will take place during all phases of operation in which LLW is generated and includes initial decontamination, solidification operation, and final decontamination and decommissioning.

Personnel exposure (Man-Rem) has been calculated for the LLW Management Operations and is shown in TABLE 8.1. For purposes of calculation, it is assumed that operators are generally located in areas shielded from radiation and designed for maximum levels of 0.1 mr/hr. Higher levels of radiation are assumed for activities performed outside the shielded areas or performed infrequently. These levels are shown in the table together with the crew size expected to perform the activity. It is also assumed the LLW management activities are required for six years to span the three phases of operation mentioned above.

FIGURE 7.3

						REVISION		DATE		DOW		CHK		APPROVED (NAME)		DRAWING RELEASE STATUS							END USER'S REVIEW NEW			WESTERN NEW YORK NUCLEAR SERVICE CENTER LOW LEVEL LIQUID WASTE TREATMENT FACILITY	
																☐ PRELIMINARY ☐ PARTIALLY APPROVED RELEASED FOR BY DATE RELATED TO SPEC NO. AISC NO. ADD. INFORMATION COMMENTS APPROVED FOR END CONSTRUCTION							DIV ENG DATE CIVIL MECHANICAL ELECTRICAL PLUMBING HVAC STRUCTURAL OTHER				
																								ROOF FRAMING PLAN AT EL. 157'-0"			
																								BURNS AND ROE INDUSTRIAL SERVICES CORP. Engineers and Constructors			
																								DRAWING NO. 4870 WORK ORDER C-003 REVISED BY 0			

11 10 9 8 7 6 5 4 3 2 1

SECTION B-B

TASK 4

FIGURE 7.5

REVISION				DATE	CHK	APP	DRAWING RELEASE STATUS			ENGINEERING REVIEW			WESTERN NEW YORK NUCLEAR SERVICE CENTER LOW LEVEL LIQUID WASTE TREATMENT FACILITY			
							☐ PRELIMINARY ☐ PARTIALLY APPROVED			CHK	DATE	DATE	SECTION			
							RELEASED FOR			DATE	DATE	DATE	BURNS AND ROE INDUSTRIAL SERVICES CORP.			
							REVISION						Engineers and Constructors			
							APPROVED FOR						PROJECT NO.			
							BY						DRAWING NO.			
							CONSTRUCTION						SHEET NO.			
													C-005			

TABLE 8.1

LLW MANAGEMENT RADIATION EXPOSURE

<u>Activity -</u>	<u>Crew</u>	<u>Exposure Rate</u>	<u>Frequency</u>	<u>Time Exposed</u>	<u>Total Exposure (Man-Rem)</u>
1. Concentration	3	0.1 mr/hr	Continuous	(2920 hrs/yr)	5.3
2. Solidification	3	0.1 mr/hr	Continuous	(2920 hrs/yr)	5.3
3. Drumming	3	0.1 mr/hr	2 drums/hr	14,400 drums	2.2
4. Drum Removal from Process	4	2 mr/hr	10 drums/hr	14,400 drums	11.5
5. Drum Loading for Off-Site Shipment	4	5 mr/hr	10 drums/hr	14,400 drums	28.8
6. LLW Equipment Repair	3	100 mr/hr	10 events/yr	3 hr/event	54.0
7. Existing Equipment removal for storage	3	10 mr/hr	1 time	40 hr	1.2
8. Existing Equipment loading for off-site shipment	3	10 mr/hr	1 time	40 hr	1.2
9. Solid Equipment removal	3	5 mr/hr	1 time	120 hr	1.8
10. Solid Equipment loading for off-site shipment	3	10 mr/hr	1 time	120 hr	<u>3.6</u>
					114.9

9.0 SUMMARY AND RECOMMENDATIONS

In summary, it is recommended that a low level waste treatment system include an evaporative process train with acid recovery capability, a high capacity filter/demineralizer process train, and a radwaste solidification system.

If low level waste is buried on site, solidification with cement is the least costly option. For disposal at any off site burial ground at distances ranging from 500 to 3000 miles, it is less costly to volume reduce waste prior to disposal. For the case of the burial ground, 3000 miles distant, four million dollars can be saved over the least expensive direct solidification option (i.e. no volume reduction).

Finally, solidified waste product criteria are being developed and it is anticipated that some solidification agents that are currently acceptable may no longer be permitted at burial grounds. In light of the uncertainties associated with the pending solidified waste product criteria, it is recommended that a Dow binder product be tentatively considered as the reference solidification agent.

10.0 REFERENCES

1. "Vinyl Ester Solidification of Low-Level Radioactive Waste," H.E. Filter, Dow Chemical Company, Midland, Mich., November 1979.
2. "Study of the Thermal and Mechanical Sensitivity of Bitumen/oxygen salt Mixtures," E. Backof and W. Drepold, Institute für Chemieder Treib-Und Expolisvstoffe, Berghausen, Karlsruhe, Technical Communication No. 9/70, July 1975.
3. "The Bituminization of Radioactive Waste Solutions at Eurochemic," H. Eschrich, Eurochemic, Mol, Belgium, May 1976.
4. "Backwashing A Stacked Disc Filter," T. van den Berg and T. V. Lancey, presented at ANS Winter Meeting, November, 1973, San Francisco, California.
5. Oyster Creek Nuclear Generating Station Radwaste Modification Conformance to 10CFR20, Appendix I (FSAR Amendment).
6. Safety Analysis Report, Nuclear Fuel Services, Inc. Reprocessing Plant, West Valley, NY, Vol I, II, and III.
7. Topical Report, Fluid Bed Dryer," Report No. AECC-1-A, February 21, 1975 by Aerojet Energy Conversion Company.
8. "Radwaste Disposal System,": A. J. Stock, Stock Equipment Company, Chagrin Falls, Ohio, September 1975.
9. "Radwaste Volume Reduction and Solidification System," Report No. WPC-VRS-001, November 1976, Revision May 1978.
10. Electropolishing as a Decontamination Process: Progress and Applications," R. P. Allen, H. W. Arrow Smith, L. A. Charlot, J. L. Hooper, Battelle, PNL-SA-6858, April 1978.
11. Schedule of Charges/Radioactive Waste, Nuclear Engineering Company, Inc., March 1, 1980.
12. Decontamination Study for Preimmobilization Operation, Nuclear Energy Services, July 1980.
13. Study of Postimmobilization Disposition, Nuclear Energy Services, August 1980.
14. Western New York Nuclear Service Study - U.S. Department of Energy TID-28905-2.

TASK 5

**REMOTE INSTALLATION AND REMOVAL
OF SOLIDIFICATION EQUIPMENT**

TABLE OF CONTENTS

1.0	INTRODUCTION
2.0	DESCRIPTION OF CHEMICAL PROCESSING CELL
3.0	INITIAL EQUIPMENT REMOVAL
4.0	REMOTE INSTALLATION OF SOLIDIFICATION EQUIPMENT
4.1	General Requirements
4.2	Skid Layout
4.3	Installation of Skids
4.3.1	Mock-Up
4.3.2	Installation in CPC
5.0	REMOTE REMOVAL, DECONTAMINATION AND PACKAGING OF EQUIPMENT
6.0	RADIATION EXPOSURE
7.0	ESTIMATION OF COSTS
8.0	REFERENCES
APPENDIX A	EQUIPMENT LIST
APPENDIX B	SKID DESIGN DRAWINGS

TASK 5

REMOTE INSTALLATION & REMOVAL OF SOLIDIFICATION EQUIPMENT

1.0 INTRODUCTION

The overall objective of this task was to establish the feasibility and costs involved in the utilization of the Chemical Processing Cell (CPC) for the immobilization of the high level wastes at the Western New York Nuclear Service Center (WNYNSC) by completely remote techniques. The solidification process to be used was calcination and subsequent vitrification of waste in in-can melters as developed by Pacific Northwest Laboratories (PNL).

The basic philosophy governing the employment of completely remote installation, operation and maintenance of the waste solidification process equipment is to minimize the radiation exposure of personnel and to satisfy the concept and requirements of achieving exposures As Low As Reasonably Achievable (ALARA). However, the remote installation, operation, and maintenance of equipment results in an increased monetary cost against which the differential saving in man-rem of radiation exposure must be balanced. There may be additional benefits with this alternative, such as reduction in volumes of LLW generated, however, these were not evaluated in this task report.

2.0 DESCRIPTION OF CHEMICAL PROCESSING CELL (CPC)

The Chemical Processing Cell at WNYNSC measuring 6.7m x 28m x 13.1m high (22 ft. wide x 92 ft. long x 43 ft. high) was previously selected as the cell to be used for waste solidification operations. The selection of the cell was based on:

- a) Convenience of size to accommodate required equipment.
- b) Size of cell door (11 ft. wide x 14 ft. high).
- c) Availability of shielded viewing windows; cell penetrations; air, water, steam and electrical services; manipulators, and cranes.

3.0 INITIAL EQUIPMENT REMOVAL

This sub-task was based on remote removal of the existing CPC equipment without decontamination after which the new waste solidification system equipment will be remotely installed in the cell without requiring the remote or manual decontamination of the cell walls and floors. Equipment removed will be remotely packaged and stored on site for eventual decontamination and disposal.

The equipment to be removed includes all piping and equipment used to dissolve fuel from the hulls, adjust feed, evaporate and condense liquid waste, transfer baskets (except cranes and manipulators), storage baskets, and jumpers. This includes such components as dissolver tanks, accountability and feed adjustment tank, evaporators, neutralizers, condensers, jumper storage rack, basket rack, dissolver pickup device, and spare pickup and storage devices.

Remote removal of the CPC equipment will be accomplished via the cell cranes and manipulators with air impact wrenches, tools and plasma torches as described in Section 3.1 of the NES Decontamination Study (Task 1) (Ref. 5).

Equipment will be remotely packaged in the Equipment Decontamination Room (EDR) for transfer to a previously selected on-site storage facility.

4.0 REMOTE INSTALLATION

4.1 General Requirements

Remote installation and operation of in-can melting vitrification equipment in the CPC requires a fully integrated design concept and sequenced loading scheme in order to meet the requirements of this task. The design concept mandates the placement of all required equipment on a number of movable skids or equipment carts which then can be lifted or rolled into the cell in a logical order and properly located with respect to one another. The process to be utilized as the basis of this study is that developed by PNL (Ref. 7) utilizing the flow diagram developed by Vitro Engineering Corporation (Ref. 8).

Additional criteria governing the organization of equipment on the carts were: (1) limiting dimensions to those of the access door size (11 ft. x 14 ft.), (2) maintaining equipment weights within the limitations of remote handling cranes and manipulators, (3) minimizing piping complexity, (4) maximizing ease of maintenance and (5) providing for ready removal of solid product.

4.2 Skid Layout

A total of twenty (20) equipment skids were designed in this assessment. Table 4-1 lists the equipment designated for each skid and the total estimated weight. Calculations of equipment weights were based on approximate sizes and assumed wall thickness. The skid weights range from 1000 pounds to 12,000 pounds and are well within the capacity of the 15-ton cranes. (See Appendix A for equipment description and size.)

The positioning of the skids with relation to one another and the general location of equipment on each skid may be seen on Figures 4.1 and 4.2.

Major piping connections to equipment are also noted on Figure 4.1.

4.3 Installation of Skids

4.3.1 Mock-Up

In order to successfully accomplish the remote installation and subsequent removal of the skids and to design and fabricate the piping required for inter-connecting all the equipment, a mock-up installation of the actual skids will be necessary. This procedure will also permit the skid interlocking and leveling methods to be tested. Trial runs using non-radioactive simulated wastes will also be necessary to "de-bug" the equipment and all the process controls. These can be performed more easily in the mock cell.

An exact duplicate of the CPC will be constructed in a separate building using steel frame construction, a 4-inch concrete floor slab and 3/4 inch plywood cell walls. All required service and electrical supply lines will be provided. Duplicate 15-ton and 2-ton cranes and a 2-ton bridge mounted manipulator will be installed. Duplicate viewing windows will be simulated.

If necessary, master slave manipulators will be installed to simulate remote operations.

4.3.2 Installation

After eliminating all problems involved with the installation, the inter-connection of equipment and the

process operations, the skids may be installed within the cell in the prescribed order. Viewing within the cell may be accomplished by existing shielded viewing windows and additional closed circuit TV cameras (CCTV). Hanford-type piping and electrical connectors will be used for most process and service connections. Hanford-type remote tank flanges will be used for pump installation, agitators and filter assemblies. Vee flanges and other quick-connective devices will be used where Hanford-type connectors are inappropriate. Mechanical operations will be accomplished by use of master slave manipulators and the two cranes.

Skid alignment procedures will utilize a system of indexing dowels and fixed mounting trunions.

Process piping is sloped to assure gravity drainage to or from the point of origin to eliminate unwanted liquid hold-ups or settling areas.

Removable jumpers are used to make all process and service connections to cell equipment.

Equipment will be arranged in a manner that will optimize operations, remote maintenance, solids flow, system hydraulics and connecting piping routings. Operations considerations involve the convenient handling of waste canisters, the assurance of adequate viewing of equipment, and the provision of required in-cell crane and manipulator access.

The installations required for remote maintenance and operation of process equipment are similar. Both involve direct overhead access via the crane and crane manipulator to operate the equipment, service it in place or disconnect and remove equipment for service outside the cell.

Prior to the operation of the solidification equipment, all connections and instrumentation will be tested and a trial run made to prevent unnecessary spills of radioactive waste solutions and to insure the integrity of the remotely installed equipment.

5.0 REMOTE REMOVAL, DECONTAMINATION AND PACKAGING OF EQUIPMENT

Removal of solidification equipment from the CPC is basically the reverse of installation procedures without the time consuming requirement of skid and piping alignment. After insuring the removal of all liquids and solids inside

REV. NO.		ISSUE PURPOSE		DATE		BY	
UNITED STATES DEPARTMENT OF ENERGY BURNS AND ROE INDUSTRIAL SERVICES CORP. PROJECT NO. 4870 DRAWING TITLE WASTE SOLIDIFICATION SKID ASSEMBLY SUBMITTED - DATE APPROVAL RECOMMENDED - DATE DRAWING APPROVED - DATE ARCHITECT - ENGINEER OPERATOR DOE ENGINEER DRAWN - J. H. D. J. DATE CHECKED DATE SCALE PROJECT 4870 DRAWING NUMBER REV. NO.

SECT. "A-A"

FIG. 4.2

TASK 5

UNITED STATES DEPARTMENT OF ENERGY				
WASTE SOLIDIFICATION SKID LAYOUT IN C.P.C.				
BURNS AND ROE, INC. Engineers and Constructors Headquarters Office - Oradell, N. J.				
Approved for Construction	Date	Work Order	Drawing No	Rev
Chief	Engineer	Scale 3/32" = 1'-0"		

TABLE 4-1

SOLIDIFICATION EQUIPMENT AND SKID WEIGHTS

<u>Skid No. 1 and No. 3</u>	<u>Wt.</u>	<u>Skid No. 7</u>	<u>Wt.</u>
CE-A-1/2	5484#	TK-C-2	339
		CR-C-1	2000
<u>Skid No. 2</u>		S-C-1	450
TK-A-7	1150	C-C-1	110
TK-A-1	2155	C-C-2	271
TK-A-2	765	Total Wt.	3170#
TK-A-3	765		
TK-A-4	1150	<u>Skid No. 8</u>	
TK-A-5	339	TK-C-2	339
TK-A-6	1150	TK-C-4	480
TK-A-8	339	TK-C-9	339
Total Wt.	7813#	TK-C-8	1150
		F-C-1	1150
<u>Skid No. 4</u>		Total Wt.	3458#
TK-B-1	1150		
TK-B-2	339	<u>Skid No. 9</u>	
TK-B-3	339	TK-C-5	480
AGS-B-1	1150	TK-C-6	339
TK-B-4	339	TK-C-7	339
Total Wt.	3317#	IEX-C-1	271
		IEX-C-2	271
<u>Skid No. 5</u>		Total Wt.	1700#
F-B-1	575		
TK-B-5	480	<u>Skid No. 10</u>	
TK-B-6	339	TK-D-4	339
F-B-2	575	TK-D-3	339
Total Wt.	1969#	TK-D-5	339
		TK-D-1	1150
<u>Skid No. 6</u>		TK-D-2	339
TK-B-7	480	IEX-D-1	271
TK-C-1	1150	Total Wt.	2777#
TK-C-3	670		
Total Wt.	2300#	<u>Skid No. 11</u>	
		TK-H-1	2155
		TK-H-2	765
		E-H-1	1473
		GH-1	420
		GH-2	420
		E-H-2	450
		TK-H-4	765
		Total Wt.	6448#

TABLE 4-1 (continued)

<u>Skid No. 12</u>	<u>Wt.</u>	<u>Skid No. 18</u>	<u>Wt.</u>
TK-E-1	4600	TK-F-4	2155
TK-E-2	<u>4600</u>	TK-F-6	<u>480</u>
Total Wt.	9200#	Total Wt.	2635#
<u>Skid No. 13</u>		<u>Skid No. 19</u>	
CA-E-1	3474	CS-G-1	227
TK-E-3	<u>1150</u>	TK-G-1	1150
Total Wt.	4624#	TK-G-2	1150
		D-G-1	<u>112</u>
<u>Skid No. 14</u>		Total Wt.	2639#
ICM-E-1	2276	<u>Skid No. 20</u>	
ICM-E-2	<u>2276</u>	C-G-1	135
Total Wt.	4552#	H-G-2	112
		NOX	175
<u>Skid No. 15</u>		FG-1B	142
Canister Cooling Sta.)		FG-1A	142
Leak Test Sta.)	3166	HG-1	112
Decontamination Sta.)		FISS	<u>175</u>
Lid Welder	<u>575</u>	Total Wt.	993#
Total Wt.	3741#		
<u>Skid No. 16</u>			
TK-F-1	2155		
TK-F-5	2155		
TK-F-2	<u>2155</u>		
Total Wt.	6465#		
<u>Skid No. 17</u>			
E-F-1	2680		
E-F-2	2680		
C-F-1	240		
C-F-2	<u>240</u>		
Total Wt.	5840#		

pipes and equipment, loosely adhering radioactive contamination will be remotely cleaned by use of in-cell sprays and water lance sprays using appropriate non-destructive decontamination chemical solutions. (See Table 2 of Ref. 5).

Overhead connecting jumpers and inter-connecting pipes would then be removed to facilitate access to the equipment skids by the overhead crane, the crane manipulator and the master slave manipulators. These connectors would be removed from the cell to a remote packaging facility (the EDR) where they are monitored for radiation dose level and then remotely packaged in shielded containers to minimize spread of contamination and exposure of personnel. The skids would then be removed from the CPC one at a time, and packaged or placed in shielded containers, and the containers loaded on ATMX railroad cars (9' x 9' x 50'). A total of 9 cars would be required for all the solidification equipment skids and cross-connectors (jumpers).

6.0 RADIATION EXPOSURE

The estimation of radiation exposure to personnel involved in this task was based on an assessment of the time required for each operation, the average dose rate to personnel performing the operation, and the number of personnel required for each operation. Table 6.1 lists the duration, manpower and exposure for subtasks A through C. The Subtask descriptions are given in Table 6.2.

In Subtask A, all activities are performed to remove existing contaminated equipment from the Chemical Processing Cell (CPC). The estimate performed is based on work done by NES in Task 1 for the removal of equipment without internal decontamination. The equipment is removed from the CPC, after surface decontamination to remove loosely adherent material, packaged and transferred to interim storage in a Low Level Waste Storage Area.

Subtask B includes the recommended activities required to install the solidification process equipment remotely. It includes activities for simulated installation and operation in a mock-up facility to check out feasibility. It also includes the final installation and checkout of system operation in the CPC, where the only exposure to personnel takes place in this Subtask.

In Subtask C, all the activities are performed to decontaminate and dismantle the solidification process equipment remotely, to decontaminate the CPC interior remotely and to remove the equipment and package it for interim storage as low level waste.

TABLE 6.1

Duration, Manpower, and Exposure for Various Subtasks

<u>Subtask A</u>			
<u>Activity Description</u>	<u>Duration (days)</u>	<u>Manpower (Man-hours)</u>	<u>Exposure (Man-Rem)</u>
1. Prepare EDR for remote operations	3	75	0.6
2. Prepare CPC for equipment removal	2	34	0.1
3. Remotely remove CPC equipment and package for storage	67	1835	1.8
4. Transfer packaged equipment to temporary storage facility	9	100	20.0
5. Remove dissolver criticality plugs	3	<u>76</u>	<u>0.1</u>
Total Subtask A		2120	22.6
<u>Subtask B</u>			
1. Mobilization	60	-	-
2. Erect mock-up building	160	960	-
3. Receive and erect equipment in mock building and test equipment	260	19,000	-
4. Dismantling of equipment in mock-up	40	9,000	-
5. Remote installation of equipment in CPC	320	<u>26,000</u>	<u>26.0</u>
Total Subtask B		44,960	26.0
<u>Subtask C</u>			
1. Remote Decontamination of equipment in CPC	58	1172	2.3
2. Remote dismantling and removal of skids from CPC	300	12,000	12.0
3. Remote Decontamination of cell walls, floors, cranes, manipulators	200	7239	7.2
4. Remote Packaging of Solidification Equipment	40	<u>1000</u>	<u>2.0</u>
Total Subtask C		21,411	23.5

TABLE 6.2

SUB-TASK DESCRIPTION

<u>SUB-TASK</u>	<u>DESCRIPTION</u>
A.	Initial Equipment Removal from CPC Without Decontamination of Equipment or Cell
B.	Construction of Mock Cell Remote Installation and Removal from Mock Cell Remote Installation of Solidification System Equipment in CPC
C.	Remote Removal of Solidification Equipment Remote Decontamination of Solidification Equipment Remote Packaging of Equipment for Storage

7.0 ESTIMATION OF COSTS

Estimation of costs for each of the activities evaluated within this section were based on estimating or approximating the time required to accomplish each required sub-activity and applying the appropriate labor rate for the West Valley-Buffalo, New York area in 1980 dollars. The cost factors were obtained from National average cost information and regional correction factors as published by the Bureau of Labor Statistics (Ref. 1) and include base wages, fringe benefits, per diem, and 60% contractor overhead and profit. A Man-hour rate of approximately \$22.50 was used in the cost calculations.

The crew required for remote CPC equipment removal and installation was based on Crew A described in Reference 5 consisting of 1 crane operator, 1 power manipulator operator, 1 supervisor (1/2 time), and 1 technician (1/2 time). The cost factor for Crew A was estimated as \$66.80/hr (See Table D-1 of the above report).

Staff administrative costs, insurance, site security, health physics coverage, quality assurance, and any equipment rental costs were added as indirect costs at 52% of the direct costs.

Engineering, design, drafting and construction management were added as 22.8% of direct cost.

Capital cost of solidification equipment and operating costs during solidification were not included in this assessment.

Total costs were calculated for each of the sub-tasks as listed in Table 6.2. The total costs for these tasks have been summarized and listed in Table 7.1.

Due to uncertainties in scheduling and anticipated difficulties and complexities imposed by remote operations, the total costs were increased by a factor of 25% above the originally estimated costs.

TABLE 7.1

SUB-TASK COSTS FOR FULLY REMOTE OPERATIONS

USE OF CPC FOR WASTE SOLIDIFICATION AT WEST VALLEY

<u>SUB-TASK</u>	<u>TOTAL COST</u>	<u>FINAL COST</u>
A	\$ 291,300	\$ 364,125
B	3,026,645	3,783,300
C	<u>1,392,375</u>	<u>1,740,500</u>
Total		\$5,887,925

8.0 REFERENCES

1. U.S. Department of Labor, Bureau of Labor Statistics: Employment and Earnings - October, 1979.
2. R.S. Means Company, Inc., Kingston, Massachusetts: Building Construction Cost Data - 1980.
3. Richardson Engineering Services, Inc., San Marcos, California: The Richardson Construction Cost Trend Reporter, July, 1980.
4. 1980 Dodge Guide to Public Works and Heavy Construction Costs, Annual Edition No. 12, McGraw-Hill, New York (1979).
5. Document 81A0690; Decontamination Study for Pre-immobilization Operation; Nuclear Energy Services, Inc., August, 1980.
6. TID-28905-2; Western New York Nuclear Service Center Study; U.S. Dept. of Energy.
7. E. Larson and W.F. Bonner; "High-Level Waste Vitrification by Spraying Calcination/In-Can Melting", U.S. Energy Research and Development Administration, Report BNWL 2092, November, 1976.
8. U. S. Department of Energy - Vitro Engineering Corp.; Block Flow Diagram - Immobilization Option A-1; Dwg. No. ES-079KO-M1; 6/23/80.

APPENDIX A

EQUIPMENT LIST

SHEET 1 OF 8

[illegible]

EQUIPMENT LIST

SHEET 2 OF 8

[illegible]

EQUIPMENT LIST

SHEET 3 OF 9

EQUIP PIECE Nº	DESCRIPTION	APPROX. SIZE	REMARKS	
			WEIGHT	SKID No.
TK-C-1	Cs ION EXCHANGE FEED TANK	1200 L 4'-0"Ø x 4'-0" h	1150	6
TK-C-2	Cs CONCENTRATOR FEED TANK	300 L 2'-6"Ø x 3'-0" h	339	8
TK-C-3	Cs WASH & REGENERATION CATCH TK	1000 L 3'-0"Ø x 5'-6" h	670	6
TK-C-4	Cs CONCENTRATE HOLDING/ FEED TANK	500 L 3'-0"Ø x 2'-6" h	480	8
TK-C-5	Cs ELUATE MAKE-UP TANK	600 L 3'-0"Ø x 2'-6" h	480	9
TK-C-6	Cs ELUATE BOUNCE TANK	300 L 2'-6"Ø x 3'-0" h	339	9
TK-C-7	Cs/SR REWORK TANK	300 L 2'-6"Ø x 3'-0" h	339	9
TK-C-8	ZEOLITE SLURRY TANK	1200 L 4'-0"Ø x 4'-0" h	1150	8
TK-C-9	Na ₂ CO ₃ CATCH TANK	300 L 2'-6"Ø x 3'-0" h	339	8
C-C-1	PURGE CONDENSER	6"Ø x 6'-0" L	110	7
C-C-2	DOWN DRAFT CONDENSER	12"Ø x 8'-0" L	271	7
CR-C-1	Cs CONCENTRATOR	2000 L 5'-0" x 5'-0" h	7 WITH 2"Ø x 10'-0" h STRIPPER COL.	
F-C-1	ZEOLITE FILTER BED	1200 L 4'-0"Ø x 4'-0" h	1150	8
S-C-1	CONCENTRATOR OFF-GAS SCRUBBER	2'-0"Ø x 6'-0" h	450	7
IEX-C-1	Cs ION EXCHANGE COLUMN Nº 1	12"Ø x 8'-0" h	271	9
IEX-C-2	Cs ION EXCHANGE COLUMN Nº 2	12"Ø x 8'-0" h	271	9

EQUIPMENT LIST

SHEET 4 OF 8

[illegible]

EQUIPMENT LIST

SHEET 5 OF 8

[illegible]

EQUIPMENT LIST

SHEET 6 OF 8

[illegible]

EQUIPMENT LIST

SHEET 7 OF 8

[illegible]

EQUIPMENT LIST

SHEET 13 OF 2

[illegible]

APPENDIX B

PLAN

SECTION "A-A"

SKID #1

BURNS AND ROE INDUSTRIAL SERVICES CORP.
Engineers and Constructors

Paramus, N. J.

Stamford, Conn.

Approved

Date

Work Order

Drawing No.

Rev.

Chief

Engineer

Scale $1/4" = 1'-0"$

001

SKID #2

BURNS AND ROE INDUSTRIAL SERVICES CORP.

Engineers and Constructors

Paramus, N. J.

Stamford, Conn.

Approved

Date

Work Order

Drawing No.

Rev.

Chief

Engineer

Scale 1/4" = 1'-0"

002

SKID #3

BURNS AND ROE INDUSTRIAL SERVICES CORP.

Engineers and Constructors

Paramus, N. J.

Stamford, Conn.

Approved

Date

Work Order

Drawing No.

Rev.

Chief

Engineer

Scale 1/4" = 1'-0"

003

PLAN

SECTION "A-A"

#12

SKID # 4

BURNS AND ROE INDUSTRIAL SERVICES CORP.
Engineers and Constructors

Paramus, N. J.

Stamford, Conn.

Approved

Date

Work Order

Drawing No.

Rev.

Chief

Engineer

Scale 1/4" = 1'-0"

004

SKID #5

BURNS AND ROE INDUSTRIAL SERVICES CORP.

Engineers and Constructors

Paramus, N.J.

Stamford, Conn.

Approved

Date

Work Order

Drawing No.

Rev.

Chief

Engineer

Scale 1/4"=1'-0"

005

SKID # 6

BURNS AND ROE INDUSTRIAL SERVICES, CORP.

Engineers and Constructors

Paramus, N. J.

Stamford, Conn.

Approved

Date

Work Order

Drawing No.

Rev.

Chief

Engineer

Scale $1/4" = 1'-0"$

006

PLAN

SECTION "A-A"

SKID #7

BURNS AND ROE INDUSTRIAL SERVICES CORP.

Engineers and Constructors

Paramus, N. J.

Stamford, Conn.

Approved

Date

Work Order

Drawing No.

Rev.

Chief

Engineer

Scale $\frac{1}{4}" = 1'-0"$

007

SKID # 8

BURNS AND ROE INDUSTRIAL SERVICES CORP.

Engineers and Constructors

Paramus, N. J.

Stamford, Conn.

Approved

Date

Work Order

Drawing No.

Rev.

Chief

Engineer

Scale
1/4" = 1'-0"

008

SKID #9

BURNS AND ROE INDUSTRIAL SERVICES CORP.

Engineers and Constructors

Paramus, N. J.

Stamford, Conn.

Approved

Date

Work Order

Drawing No.

Rev.

Chief

Engineer

Scale: 1/4" = 1'-0"

009

SKID # 10

BURNS AND ROE INDUSTRIAL SERVICES CORP.

Engineers and Constructors

Paramus, N. J.

Stamford, Conn.

Approved

Date

Work Order

Drawing No.

Rev.

Chief

Engineer

Scale 1/4" = 1'-0"

0010

PLAN

SECTION "A-A"

SKID # 11

BURNS AND ROE INDUSTRIAL SERVICES CORP.

Engineers and Constructors

Paramus, N. J.

Stamford, Conn.

Approved

Date

Work Order

Drawing No.

Rev.

Chief

Engineer

Scale 1/4" = 1'-0"

0011

PLAN

SECTION "A-A"

SKID # 12

BURNS AND ROE INDUSTRIAL SERVICES CORP.
Engineers and Constructors

Paramus, N. J.

Stamford, Conn.

Approved

Date

Work Order

Drawing No.

Rev.

Chief

Engineer

Scale 1/4" = 1'-0"

0012

SKID #13

BURNS AND ROE INDUSTRIAL SERVICES CORP.
Engineers and Constructors

Peramus, N. J.

Stamford, Conn.

Approved

Date

Work Order

Drawing No.

Rev.

Chief

Engineer

Scale
1/4"=1'-0"

0013

SKID #14

BURNS AND ROE INDUSTRIAL SERVICES CORP.
Engineers and Constructors

Paramus, N. J.

Stamford, Conn.

Approved

Date

Work Order

Drawing No.

Rev.

Chief

Engineer

Scale
1/4" = 1'-0"

0014

PLAN

SECTION "A-A"

SKID #15

BURNS AND ROE INDUSTRIAL SERVICES CORP.

Engineers and Constructors

Paramus, N. J.

Stamford, Conn.

Approved

Date

Work Order

Drawing No.

Rev.

Chief

Engineer

Scale 1/4"=1'-0"

0015

PLAN

SECTION "A-A"

SKID #16

BURNS AND ROE INDUSTRIAL SERVICES CORP.
Engineers and Constructors

Paramus, N. J.

Stamford, Conn.

Approved

Date

Work Order

Drawing No.

Rev.

Chief

Engineer

Scale 1/4" = 1'-0"

0016

PLAN

SECTION "A-A"

SKID #17

BURNS AND ROE INDUSTRIAL SERVICES CORP.

Engineers and Constructors

Paramus, N. J.

Stamford, Conn.

Approved

Date

Work Order

Drawing No.

Rev.

Chief

Engineer

Scale 1/4" = 1'-0"

0017

SKID #18

BURNS AND ROE INDUSTRIAL SERVICES CORP.
 Engineers and Constructors
 Paramus, N. J. Stamford, Conn.

Approved	Date	Work Order	Drawing No.	Rev.
Chief	Engineer	Scale 1/4" = 1'-0"	0018

SECTION "A-A"

SKID #19

BURNS AND ROE INDUSTRIAL SERVICES CORP.

Engineers and Constructors

Paramus, N.J.

Stamford, Conn.

Approved

Date

Work Order

Drawing No.

Rev.

Chief

Engineer

Scale
1/4" = 1'-0"

0019

PLAN

ELEVATION "A-A"

SECTION "B-B"

SKID #20

BURNS AND ROE INDUSTRIAL SERVICES CORP.

Engineers and Constructors

Paramus, N. J.

Stamford, Conn.

Approved

Date

Work Order

Drawing No.

Rev.

Chief

Engineer

Scale 1/4"=1'-0"

0020

TASK 6

MANAGEMENT ALTERNATIVES

TASK 6

MANAGEMENT ALTERNATIVES

During the year it became apparent that the Department of Energy (DOE) might be authorized to carry out a liquid high-level waste management demonstration project at West Valley. The pending legislation would require the DOE to manage the on-site solidification program and the State of New York to make available the facilities at the West Valley Center which would be necessary for the completion of the project. Since uncertainty existed in what the final legislation would state with regard to scope, federal/state responsibilities, and legal conditions, a study was initiated to identify solidification project activities anticipated to occur, project interfaces with the balance of the site, and potential management approaches that could be taken. Completion of the study was not required, since enactment of the West Valley Demonstration Project Act and finalization of the Cooperative Agreement between the DOE and the New York State Energy Research and Development Authority defined the approach to be taken.

TASK 7

**ASSESSMENT OF A SEPARATE
SOLIDIFIED HIGH LEVEL WASTE STORAGE FACILITY**

TABLE OF CONTENTS

ASSESSMENT OF A SEPARATE SOLIDIFIED HIGH LEVEL WASTE STORAGE FACILITY

		<u>Page</u>
1.0	INTRODUCTION	7-1
1.1	Background	7-1
1.2	Outline of Facility	7-3
1.3	Input Data	7-3
2.0	DESCRIPTION OF FACILITIES	7-3
2.1	Case A - Storage Facility	7-3
2.2	Case B - Storage Facility	7-7
3.0	STORAGE FACILITY OPERATION	7-7
3.1	On-Site Handling	7-7
3.2	Interfaces with Off-Site Transportation System	7-8
4.0	VAULT COOLING SYSTEM	7-10
5.0	EQUIPMENT/SYSTEMS	7-10
5.1	Equipment	7-10
5.2	Systems	7-11
5.3	Decommissioning Considerations	7-12
6.0	SHIELDING	7-12
7.0	COST/Schedule	7-12
7.1	Cost	7-12
7.2	Schedule	7-16
8.0	CONCLUSIONS	7-16
9.0	REFERENCES	7-17

LIST OF FIGURES

<u>Figure No.</u>	<u>Title</u>
1.1	Site Plan - Interim High Level Waste Storage Facility
2.1	Interim Storage Facility Case A, Storage Vault Transverse Section
2.3	Interim Storage Facility Case A, Storage Vault Floor Plan
2.4	Interim Storage Facility Case B, Floor Over Storage Vault Plan and Section
7.1	Interim Storage Facility Case A/B Construction Schedule

ASSESSMENT OF A SEPARATE
SOLIDIFIED HIGH LEVEL WASTE STORAGE FACILITY

1.0 INTRODUCTION

1.1 Background

A study was previously performed (Task 2) which examined the feasibility of using existing facilities at the Western New York Nuclear Service Center (WNYNSC) for storage of canisters of solidified waste until such time as they can be shipped off-site to a Federal facility. The previous study examined the feasibility of using the General Purpose Cell, the Process Mechanical Cell, the Chemical Process Cell, and the Fuel Receiving and Storage Pool. As a result of that study, it was decided to consider the use of a new, separate waste storage facility.

The following is a preconceptual outline of an interim storage facility proposed for storage of the canisters containing the solidified waste until a Federal geologic repository becomes available. The storage facility would be located at the WNYNSC as shown in Fig. 1.1.

Two separate assessments were carried out to reflect two solidification options under consideration. These options were selected because they were reasonably representative of options under consideration and would provide an upper and lower bound on the size of the interim storage facility required.

- (a) Case A, 224 canister facility. This option is based on solidification of the combined sludge, stripped radioactive components from supernate and tank 8D4 acidic waste.
- (b) Case B, 1200 canister facility. This option is based on solidification of all the neutral and acidic waste.

Interim storage of canisters containing Solidified High Level Waste (HLW) can be accomplished via a number of alternative storage concepts. These include:

- 1. Above ground concrete vault storage
- 2. Water basin storage
- 3. Subsurface caisson storage
- 4. Subsurface vault storage.

The above storage facilities are based on available technology and are representative of current thinking in association with HLW storage efforts. Reference 1 provides a discussion of a number of current HLW storage concepts.

The guidelines followed in selecting a reference storage concept for West Valley solidified waste canisters are the design considerations that follow herewith, and the extent to which each of the storage concepts satisfies these requirements.

- (a) Sufficient storage
- (b) Adequate shielding
- (c) Ease of on-site handling, placement in storage and retrieval of canisters
- (d) Interfaces with the off-site transportation system for transfer of canisters to a Federal Repository
- (e) The capability to retrieve stored canisters under all accident conditions, including a seismic event
- (f) Canister cooling considerations.

The concept selected for this study is the subsurface vault storage concept, item 4 of the above alternatives. The subsurface vault storage was selected because: (1) It allows easy placement in storage and retrieval of canisters; (2) It lends itself to remote handling of canisters and minimizes exposure; (3) It provides for easy interfaces with the off-site transportation system.

Above-ground storage was not pursued because shielding, provided by the ground-in subsurface storage, would have to be constructed for above-ground storage. Water basin storage was not pursued because of possible interaction between the canister material and the water. Subsurface caisson storage was not pursued because it was considered that working with many individual containment units would be less efficient than assembling all canisters into one cohesive facility.

It should, however, be pointed out that the other three storage concepts, as identified earlier, appear feasible and are all worthy of consideration. However, a detailed storage concept selection study is beyond the scope of this assessment and was not attempted under this framework, which merely considers the scheduler and cost impacts of such a facility.

This study was performed primarily to provide preliminary information on facility size and layout. The solidified waste considered in this study will not contain critical concentrations of fissionable material, and the

storage facility is not expected to be required for more than 15 years. Hence, no seismic requirements beyond those for normal construction were considered in this assessment. Further engineering and analysis will therefore be required to address, in detail, design and performance considerations.

1.2 Facility Outline

The two storage facilities described herein are based on the same design, the fundamental difference being the length and capacity of the respective storage vaults. The smaller facility (Case A) can accommodate up to 240 canisters, and the larger one (Case B) can accommodate up to 1200 canisters. The storage facility is to be located at the Western New York Nuclear Service Center (WNYNSC) site, and it is assumed that support services can be obtained from the main facility.

For both cases the proposed storage facility consists of a partially below-grade reinforced concrete structure, referred to as the storage vault or basement. The vault has a roof slab four feet thick. Built into this slab are removable shield plugs that facilitate placement in storage and retrieval of individual canisters. The canisters are stored in a single tier array on the vault's roof slab. Housed in this superstructure and supported from it is a 100/30-ton bridge crane. The placement in storage and subsequent removal of canisters is performed remotely by use of the bridge crane and an on-site transfer cask.

1.3 Input Data

The input data for this assessment consists of:

- (1) A characterization of the size and number of the solidified waste canisters provided by Pacific Northwest Laboratory (PNL), Battelle. The data is summarized in Table 1.1;
- (2) Identification of the off-site transportation system received from General Atomic (GA). GA is performing this work under contract from Sandia;
- (3) A description of the West Valley site, plant, and status of facilities, by references Nos. 2 and 3.

2.0 DESCRIPTION OF FACILITIES

2.1 Case A Storage Facility

The storage facility consists of a reinforced concrete structure almost entirely below grade referred to as the storage vault. Figs. 2.1 through 2.3 provide plan and elevation views of the facility. The inside dimensions of the vault are 127 feet by 59 feet, with a clear height of 13 feet. The canisters containing solidified waste are

TABLE 1.1

IDENTIFICATION OF WEST VALLEY HLW CANISTER CHARACTERISTICS

Canister O.D.	2'0"
Canister Height Overall	10'6-5/8"
Canister Shape	Bottle shaped; filled to 9'0"
Pintle Size (height)	6-5/8"
Canister Wall Thickness	about 5/8" 304L SS
Total Weight per Canister	2920 kg (6424 lb)

Option A-1 Waste

Number of HLW Canisters	224*
Heat Generation Rate/Canister	700 watts
Activity per Canister	2.14×10^5 Ci

Option A-3 Waste

Number of HLW Canisters	1200*
Heat Generation Rate/Canister	127 watts
Activity per Canister	4.2×10^4 Ci

*Figure includes a 30 percent contingency

stored in a single tier array and arranged in 24 rows, with 10 canisters in each row. This provides for a storage capacity of 240 canisters (Only 224 are required.), and is based on the cylinders standing in their upright position on a center-to-center spacing of five (5) feet.

A steel rack structure, for supporting the canisters and restraining their movement, is to be installed on the floor of the vault. The selected rack system will also be designed to accommodate crane misalignment.

The floor over the storage vault is a reinforced concrete slab four feet thick. Removable shield plugs are built into this slab and facilitate opening of the vault for placement in storage and retrieval of individual canisters. See Fig. 2.1. The design of the removable shield plugs is illustrated by the detail of Fig. 2.2. The plugs are made of concrete, are of a stepped design, and are provided with a lifting lug for their removal/insertion by the bridge crane. The removal of a shield plug provides for a circular opening in the four-foot thick slab (44 inches in diameter at the top and 32 inches at the bottom) over an individual canister storage location.

The storage vault structure below the 4'0" slab is almost entirely below grade and will require a nominal excavation of 16 feet in depth. The side walls are three feet thick, and the vault floor is also a 3-foot thick reinforced concrete mat on undisturbed soil. This mat will also support the vault walls and the steel superstructure columns. The vault floor slab is sloped transversely from the center toward the sides. Two longitudinal gutters, one on each side of the vault floor, are designed to collect floor drainage and transfer it to two sumps. Any drainage from the storage compartment is to be transferred outside the vault, sample monitored, and subsequently transferred either to the Low Level Waste Treatment (LLWT) facility for treatment or released to the environment.

The concrete thicknesses mentioned above and indicated on the drawings for the floor slab, walls, and 4'0" top slab have been sized, taking into consideration the reasonable requirements for radioactive shielding only. In the subsequent design development (which is outside the scope of this effort) the forces due to seismic events must be addressed and the structure analyzed accordingly. This will assure the capability to recover stored canisters during the interim storage span.

It has also been assumed that the bearing capacity of the in-situ soil can safely sustain the floor mat, together

with all the superimposed floor, roof and crane loads. This, too, is subject to change if the subsequent dynamic design analysis, which will also address the seismic and tornado forces, proves the in-situ soil to be inadequate, in which case, piles may be necessary.

One end of the storage facility serves as a loading/unloading area. It is through this area that the filled waste canisters intended for storage enter the storage facility and where loading of the canisters into shipping casks for off-site transportation to a Federal Repository following interim storage takes place. The loading/unloading bay consists of a railroad car loading area, a free space adjacent to the railroad car to be used for upending the empty cylindrical steel shipping casks from their horizontal shipping position to a vertical position. Upending is required for shipping cask loading and the reverse operation must be performed to permit placement of a loaded shipping cask on the railroad car. In addition, a below-grade loading cell is provided in this area, where the shipping cask is placed for vertical loading of the canisters for off-site shipment.

The entire facility is enclosed by an uninsulated metal siding and roof building supported by a structural steel frame. The structural steel building columns in the area of the storage facility are spaced at 25'0" centers in the longitudinal direction and support runway beams for a bridge crane. The enclosure measures approximately 158'0" x 65'0" and extends in height to approximately 34 feet above the top of the 4'0" thick slab (38 feet above grade).

This superstructure building serves to: (1) protect the vault's operating floor from the weather; (2) allow placement of canisters in the storage vault, as well as their retrieval and insertion into the shipping cask for off-site transportation under all weather conditions; (3) provide a support structure for the bridge crane.

The operation of placing a single canister in storage or its retrieval is to be carried out by use of an on-site shielded transfer cask and requires a crane with a lifting capacity of approximately 30 tons. On the other hand, the handling of a loaded off-site shipping cask and its loading on a railroad car for off-site transportation requires a crane with a 185,000 lb capacity. It is proposed that a single bridge crane be installed to serve both of the above handling operations. Such a scheme will eliminate the need for two cranes, will require only one set of rail girders, and will result in a more uniform superstructure building. It is proposed that a single bridge crane with a 60-foot span serve the entire facility. The crane bridge

TASK 7

FIGURE 2.1

REVISION

DATE

BY

CHK

APPROVED

ENGR

DRAWING RELEASE STATUS

☐ PRELIMINARY	☐ PARTIALLY APPROVED
RELEASED FOR	BY DATE RELATED TO
INFORMATION	FILE NO. AMEND ADD
COMMENT	
APPROVED FOR	
BIO	
CONSTRUCTION	

ENGINEERING REVIEW

REV	ENGR	DATE
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		

WESTERN NEW YORK NUCLEAR SERVICE CENTER INTERIM STORAGE FACILITY FOR H.L.W. CONTAINERS			
CASE - A FLOOR OVER STORAGE VAULT PLAN & SECTION			
BURNS AND ROE INDUSTRIAL SERVICES CORP. Engineers and Constructors			
PERMITS, N.Y.	DATE 6-18-80	WORK ORDER 4870	DRAWING NO. C-071
APPROVED			REV 0

2.2

Case B Storage Facility

This interim storage facility can be described as an expansion of the Case A facility and is designed to provide for an increased number of storage locations. It includes two identical reinforced concrete storage vaults almost entirely below grade, and a loading/unloading area in the center of the facility as shown in Fig. 2.4. The inside dimensions of each vault are 59'0" by 296'6", with a clear height of 13 feet. The canisters in each vault are stored in a single tier array of 60 rows, with 10 canisters in each row. This provides for a total storage capacity of 1200 canisters as required for the A-3 solidification option.

The two storage vaults are positioned along a single longitudinal axis and share a single loading/unloading station at the center of the facility (See Fig. 2.4.). The loading/unloading area is 30'0" in width and includes: a railcar bay area, a shipping cask upending area, and a shipping cask loading cell.

The entire storage facility is enclosed by a light metal building constructed over the concrete vault structure. The design of the light metal building is similar to the Case A facility enclosure. It measures approximately 633'0" x 65'0" and extends in height to approximately 34 feet above the top of the 4'0" slab (38 feet above grade). Serving the two vault areas and the loading/unloading station is a single bridge crane of 100-ton capacity. The design of the vault structure, shield plugs, rack system, crane and superstructure is identical to the Case A facility design.

3.0 STORAGE FACILITY OPERATION

3.1 On-Site Handling

A stand-alone solidified waste storage facility will require that the solidified waste canister be transferred and delivered to the storage facility from the solidification facility. This may be the Chemical Process Cell (CPC) in the main processing plant or a separate vitrification building to be added at the West Valley site. It has been assumed that this can be accomplished by use of an on-site shielded transfer cask and a transfer truck. The proposed transfer cask is a bell-shaped device, as shown by Fig. 2.2. It is designed for the transfer of one canister at a time, has a lead shield 5 inches thick, and is estimated to have a loaded weight of 50,000 lb.

Following arrival of a loaded transfer cask at the interim storage facility, the shield plug that covers

the selected canister storage space is removed by the crane. The on-site transfer cask containing the canister filled with solidified HLW is then picked up by the crane and placed over the storage opening, the shield gate on the bottom of the transfer cask is opened, and the canister is lowered into the storage space. The transfer cask is then removed to the facility loading station, and the shield plug is replaced over the stored canister. Retrieval of canisters for transportation to a burial repository is to be accomplished by reversing the above sequence of operations. It is important to point out that the above operations are performed remotely by use of the bridge crane, and no occupancy of the facility operating floor (top of the vault's roof slab) is required to place or retrieve canisters.

3.2 Interfaces with Off-Site Transportation System

The responsibility of establishing the design of the shipping casks to be used for the transportation of West Valley HLW canisters to a Federal Repository and the selection of the transportation mode has been assigned to Sandia. Based on preliminary information received from General Atomic Company (contractor for Sandia), transportation of West Valley High Level Waste (HLW) canisters to a Federal Repository is to be by railroad cars. A cylindrical steel shipping cask capable of accommodating five (5) canisters is to be employed. The characteristics of the off-site shipping cask and related data received from General Atomic Company (GA) are summarized in Table 3.1. The GA plan is based on vertical loading and horizontal shipping of the off-site shipping casks. GA is considering the use of a cask-handling mechanism that will be capable of picking up the shipping cask and upending it for vertical loading. Such a cask loading system has been proposed in association with the handling of High Level Defense Waste (HLDW). However, it is not imperative that the same system be adapted for West Valley waste. The general consensus is that the shipping cask on-site handling and loading system can be worked out through close liaison among the interfacing participants.

The system proposed herewith for handling of the shipping casks intended for off-site transportation can be characterized as both simple and as providing for easy interfacing between the interim storage system and the off-site transportation system. It consists of a railcar area, a shipping cask laydown/upending area, a below-grade shipping cask loading cell (well), and a 100-ton bridge crane. (It is proposed that a single bridge crane be used to place containers in storage and to handle the off-site shipping cask.) The bridge crane will remove the empty shipping cask from the railcar, upend the cask from its horizontal shipping

TASK 7

FIGURE 2.3

REVISION				DATE	DWN	CHK	APPROVED	DRAWING RELEASE STATUS				ENGINEERING REVIEW				WESTERN NEW YORK NUCLEAR SERVICE CENTER INTERIM STORAGE FACILITY FOR H.L.V. CANISTERS			
								☐ PRELIMINARY ☐ PARTIALLY APPROVED RELEASED FOR BY DATE RELATED TO SPEC NO. AMEND ADD INFORMATION COMMENT APPROVED FOR SIGNED CONSTRUCTION				DIV _____ ENG _____ DATE _____ MECH _____ ELEC _____ CIVIL _____ ARCH _____ NUC _____ DWN: DWN, S.J. CHK: SL LDE				CASE-A FLOOR OVER STORAGE VAULT PLAN BURNS AND ROE INDUSTRIAL SERVICES CORP. Engineers and Constructors PRINCIPAL, R.I.			
												APPROVED				DATE: 7-1-80			
												SCALE: 1/8" = 1'-0"				WORK ORDER: 4870			
																DRAWING NO: C-073			
																REV: 0

PLAN - FLOOR OVER STORAGE VAULT

LONGITUDINAL SECTION

TASK 7

FIGURE 2.4

REVISION				DATE	DWN	CHK	APPROVED	DRAWING RELEASE STATUS				ENGINEERING REVIEW				WESTERN NEW YORK NUCLEAR SERVICE CENTER INTERIM STORAGE FACILITY FOR H.L.W. CANISTERS			
																CASE - D FLOOR OVER STORAGE VAULT PLAN & SECTION			
																BURNS AND ROE INDUSTRIAL SERVICES CORP. Engineers and Constructors			
																Permes, N.J.			
																APPROVED			
																DATE 7-8-80			
																SCALE 1/8" = 1'-0"			
																WORK ORDER 4870			
																DRAWING NO. C-074			
																REV 0			

TABLE 3.1

WEST VALLEY HLW OFF-SITE TRANSPORTATION DATA PROVIDED BY GA

Transportation Mode:	Railroad Car
Shipping Cask:	Cylindrical, Steel, Capable of Accommodating five (5) Canisters
Shipping Cask Dimensions:	Diameter 7'8"; Height 13'4½"
Cask Shipping Position:	Horizontal (Lying down)
Position of Cask for Loading Canisters:	Vertical
Estimate Weight of Shipping Cask (loaded):	185,000 lb
Overall Height of Rail- car and Shipping Cask:	15'1"

position to a vertical position, place it into the adjacent loading cell, and prepare the cask for vertical loading by removing the cask closure. With some adjustments, the transfer cask proposed for on-site handling of canisters can be employed to load HLW canisters into the shipping cask.

4.0 VAULT COOLING SYSTEM

The storage vault can be cooled by a natural draft air cooling system. This is based on producing a stack effect via heating of ambient air by the radioactive decay heat generated within the canisters.

As shown by Figs. 2.1 through 2.4, several air intakes are provided along the sides of the vault to permit entry of ambient air into the vault. The intakes are at ground level, are covered with steel gratings and extend to the floor of the vault. Passage of air into the vault is through openings in the side walls near the vault's floor. Inside the vault, the air circulates around the canisters, removes the radioactive decay heat, and the hot air is collected by a ductwork running along the length of the vault near the top floor. The hot air collection duct terminates at the end wall outside the vault, and a sheet metal stack, estimated to be forty (40) feet tall, provides the stack effect for discharging the heated air to the atmosphere.

It is estimated that, for the Case A Storage vault with a storage capacity of 240 canisters and 700 watts per canister (See Table 1.1.), the required air flow rate is 12,500 cfm. For the Case B storage facility that is based on a storage capacity of 600 canisters (Total capacity is 1200 canisters.), in each of the two vaults that comprise the facility and with 127 watts per canister, an air flow rate of 6,000 cfm per vault will be required. The Case B storage facility will require two ductworks for hot air collection and two stacks. The above is based upon a maximum ambient temperature of 88°F, as specified by reference 5.

5.0 EQUIPMENT/SYSTEMS

5.1 Equipment

The stand-alone interim storage facility will require the following equipment:

1. A 100-ton bridge crane, as discussed in Sections 2.0 and 3.0.
2. An on-site shielded transfer cask, as described in Section 3.0. A single cask may suffice, since no more than a single transfer per day is anticipated; however, a backup cask to accommodate equipment malfunction is recommended.

3. An on-site transfer truck for moving the cask shielded canisters from the solidification area to the interim storage facility.
4. A loadout station at the solidification facility for placing the filled canisters into the on-site transfer cask.

5.2 Systems

The following is a listing of the various systems and utilities that will be needed to serve the storage facility.

1. Vault Drains

Piping to transfer sump drainage outside the vault, sample monitoring equipment, and a suitable piping system for releasing the drainage to the environment or its transfer to the existing LLWT facility.

2. Electric Power

Electric power is to be provided from the existing 480 v switchgear in the Utility Building of the main reprocessing facility. An aerial pole line consisting of 3-350 MCM, insulated copper conductors will carry 480 v, 3 ϕ power from the existing reprocessing plant to the storage facility. The feeders will be terminated in a 400 A, 3 ϕ , 3 W power panel with main circuit breaker for distribution of electric power throughout the facility. A 480-120/208 volt transformer will serve miscellaneous lighting, receptacles, instrument and control power requirements. The interim storage facility will also be provided with an emergency diesel-driven generator rated at 30 kW, 120/208 v, 3 ϕ , 60 Hz, to provide emergency power to vital instrumentation, egress lighting, radiation monitoring and security systems.

3. Space Heating

Since the building will be unoccupied for most of the time, no central heating system is being considered. To provide for temporary occupancy it is planned to provide for one electric blast unit heater in the loading/unloading bay and the immediately adjacent bay(s), in each of the two facilities considered. Each blast heater has an estimated capacity of 50 kW. The heaters will be located in the truss space and manually started.

(4. Fire Protection System

In order to protect the structural integrity of the superstructure and the crane from damage and loss due to

fire, the building will be provided with a fire sprinkler system.

Since the building will not be heated, the sprinkler system will be of the dry pipe; i.e., it will be filled with air or inert gas and, upon release, will allow for water to fill the system. The sprinkler system will be connected to the existing fire protection system by means of a buried fire line.

5. Physical Security

The interim storage facility will be surrounded with security doors and integrated into the plant's existing security system.

5.3 Decommissioning Considerations

No contamination of the facility as a result of interim storage is expected; thus, no decontamination prior to decommissioning will be required.

6.0 SHIELDING

The activity of the Case A canisters was estimated as 0.21×10^6 Ci per canister. In order to shield personnel from the gamma rays emanating from the HLW canisters inside the vault, a four-foot thick slab is being proposed for the vault's roof. It is estimated that such a slab will result in a dose rate of approximately 2.5 mrem/hour outside the vault (top of slab) and will allow occupational occupancy of the floor area above the vault. Additional shielding is provided by the vault's concrete side walls and the soil surrounding the vault.

It is estimated that the proposed on-site transfer cask will have to include a 5-inch thick lead shield. This will limit the cask outside surface dose rate to less than 200 mrem/hour (and 10 mrem/hour at 3 feet from cask surface). These dose rates reflect DOT radiological requirements (See reference 4.), and will allow for safe on-site transfer of the shielded HLW canisters from the vitrification area to interim storage by use of the transfer truck and their subsequent placement in storage by use of the bridge crane.

7.0 COST/SCHEDULE

7.1 Cost

Capital cost estimates were prepared for the two (2) interim storage facilities described herein. These capital cost estimates are summarized in: (1) Table 7.1 for

TABLE 7.1

CAPITAL COST ESTIMATE FOR CASE A
INTERIM STORAGE FACILITY - 240 CANISTERS

(In 2nd Quarter 1980 Dollars)

<u>Cost Element</u>	<u>Material</u>	<u>Labor</u>	<u>Total</u>
Major Equipment	\$ 891,000	\$ 22,300	\$ 913,300
Building and Structures	1,305,400	726,800	2,032,200
Utilities	36,600	36,900	73,500
Site Improvements	<u>74,500</u>	<u>51,400</u>	<u>125,900</u>
Sub-Total Direct Cost	\$2,307,500	\$837,400	\$3,144,900
Indirect Costs			<u>\$1,482,900</u>
Total Field Costs			\$4,627,800
Engineering, Design, Drafting and Construction Management			<u>700,000</u>
Sub-Total			\$5,327,800
Contingency @ 25%			<u>1,332,000</u>
Total Facility Cost			\$6,659,800

the Case A interim storage facility; (2) Table 7.2 for the Case B Storage facility. The capital cost estimates as presented in the above tables have been broken down into the following direct cost components:

1. Major Equipment - The major equipment considered includes, among others, transfer casks, a cask transfer truck, a bridge crane, and radiation monitoring equipment.
2. Buildings and Structures - This includes the storage vault structures, On-Site and Off-Site cask loading and handling areas, vault ventilation, heating, dry sprinkler system, lighting and on-site power generator.
3. Utilities - These include a sump drain system, electric power system, communication system, and a fire line for fire fighting.
4. Site Improvements - The site improvements considered include site grading, paved areas, extension of the existing railroad spur and outside lighting.

Construction craft labor rates included in the direct cost portion of the estimates were developed specifically for the West Valley, New York project and reflect mid-1980 rates. These rates include fringe benefits.

Material costs were taken from various estimating publications such as: R.S. Means, Richardson Engineering Services, National Price Service and Burns and Roe in-house Cost Data Bank. The cost for special items of material and equipment were solicited from vendor sources who have familiarity and experience with the products involved.

Labor manhours were developed for each task using the above publications and established industry-wide standards as a basis adjusted to suit the nature of work involved.

Indirect costs cover such items as:

1. Field supervision
2. Quality assurance
3. Unemployment Insurance, Workman's Compensation, Social Security and Liability Insurance
4. Field office trailers, telephone, water and electrical hook-ups
5. Minor construction equipment such as scaffolding, welding machines, small cranes, A-frames and trucks. Major construction equipment is included in the Direct Cost portion of the estimate.
6. Small tools and consumables

TABLE 7.2

CAPITAL COST ESTIMATE FOR CASE B
INTERIM STORAGE FACILITY - 1200 CANISTERS

(In 2nd Quarter 1980 Dollars)

<u>Cost Element</u>	<u>Material</u>	<u>Labor</u>	<u>Total</u>
Major Equipment	\$ 977,000	\$ 29,300	\$ 1,006,300
Building and Structures	4,996,700	2,142,400	7,139,100
Utilities	61,000	60,700	121,700
Site Improvements	112,600	86,800	199,400
Sub-Total Direct Cost	\$6,147,300	\$2,319,200	\$ 8,466,500
Indirect Costs			3,593,100
Total Field Costs			\$12,059,600
Engineering, Design, Drafting and Construction Management			<u>1,800,000</u>
Sub-Total			\$13,859,600
Contingency @ 25%			<u>3,464,900</u>
Total Facility Cost			\$17,324,500

7. Contractor home office costs, including Purchasing, Estimating, Administrative, Bonds, Permits and other costs
8. Job clean-up
9. General contractor mark-up on subcontracted work
10. Profit.

Included in the estimates is a contingency allowance of 25 percent, based on the conceptual nature of the design and the complexity and uncertainties of the component parts of the estimates.

Estimates reflect mid-1980 costs and do not include any escalation.

The cost for a facility to accommodate 240 canisters is estimated to be \$6,660,000, and the cost for a facility to accommodate 1200 canisters is estimated to be \$17,325,000.

7.2 Schedule

Schedules were developed for the elapsed time required to construct the interim storage facilities described herein. The schedules are shown in Fig. 7.1 and include consideration for the following activities:

1. Mobilization for construction
2. Site preparation and site improvements
3. Procurement of equipment
4. Earth work
5. Concrete work
6. Steel work
7. Siding and roofing installation
8. Equipment installation and testing.

The schedule does not include time for facility design, which may take approximately fifteen (15) and eighteen (18) months, respectively, for the two facilities described in this assessment. It is estimated that it will take approximately twenty (20) months to construct the Case A facility (storage locations for 240 canisters), and twenty-six (26) months to construct the larger Case B facility (1200 storage locations).

8.0 CONCLUSIONS

A preconceptual design for two stand-alone interim storage facilities was developed and appropriate cost assessments performed. The reference facilities are based on a subsurface vault storage concept and the assumption that certain support services can be obtained from existing WNYNSC facilities.

TASK 7

FIGURE 7.1

		DATE	DWN	CHK	APPROVED ENGR	DRAWING RELEASE STATUS						ENGINEERING REVIEW			WESTERN NEW YORK NUCLEAR SERVICE CENTER					
						☐ PRELIMINARY ☐ PARTIALLY APPROVED						DIV			INTERIM STORAGE FACILITY FOR HLW. CANISTERS					
						RELEASED FOR	BY	DATE	RELATED TO SPEC NO	AMEND	ADD	MECH			SCHEDULE CASE "A" / CASE "B" CONSTRUCTION OF INTERIM STORAGE FACILITIES					
						INFORMATION						ELEC								
						COMMENT						CIVIL								
						APPROVED FOR						ARCH								
						BID						NUC								
						CONSTRUCTION						DSG DWN			CHK	SL/LDE	BURNS AND ROE INDUSTRIAL SERVICES CORP. Engineers and Constructors Paramus, N. J. Stamford, Conn.			
															APPROVED	DATE 8-7-80 SCALE	WORK ORDER 4870	DRAWING NO.	REV	

The Case A interim storage facility with 240 HLW canister storage locations was estimated to cost \$6.7 million, and will require a construction time of twenty (20) months following the authorization to proceed (ATP) notice. The Case B storage facility with 1200 HLW canister storage locations, was estimated to cost \$17.3 million and will require a construction schedule of twenty-six (26) months.

9.0 REFERENCES

1. DOE/ET-0028, "Technology for Commercial Radioactive Waste Management", U.S. Department of Energy Office of Nuclear Waste Management, May 1979.
2. TID-28905-1, "Western New York Nuclear Service Center Study", Companion Report, U.S. Department of Energy, Washington, DC 20545.
3. Western New York Nuclear Service Center, West Valley, NY, Safety Analysis Report, Docket No. 50-201, NFS, Rockville, MD, 1973.
4. 49CFR173 - Department of Transportation, Regulations for Radioactive Material Shipments.
5. ASHRAE Guide, 1977 issue, American Society of Heating, Refrigeration and Air Conditioning Engineers.

TASK 8

**ASSESSMENT OF A SEPARATE FACILITY
FOR HOUSING THE SOLIDIFICATION EQUIPMENT**

TABLE OF CONTENTS

ASSESSMENT OF A SEPARATE FACILITY
FOR HOUSING THE SOLIDIFICATION EQUIPMENT

	<u>Page</u>
1.0 INTRODUCTION	8-1
1.1 Background	8-1
1.2 Waste Treatment Process	8-2
1.3 Design Considerations	8-2
1.4 Input Data	8-4
2.0 DESCRIPTION OF FACILITY	8-4
2.1 HLLW Pretreatment Cell (PTC)	8-6
2.2 PTC Hot Maintenance Cell	8-8
2.3 PTC Decontamination Cell	8-8
2.4 Waste Vitrification Cell (WVC)	8-9
2.5 WVC Maintenance Cell	8-10
2.6 WVC Decontamination Cell	8-11
2.7 Off-Gas Treatment Cell	8-11
2.8 Canister Decontamination Cell	8-12
2.9 Full Canisters Transfer Tunnel	8-12
2.10 Frit Feed Cell	8-13
2.11 New Canister Transfer Cell	8-13
2.12 In-Can Melter Control Cell	8-13
3.0 SERVICE SYSTEMS/UTILITIES	8-13
3.1 Ventilation of Radioactive Cells	8-13
3.2 Radioactive Drains	8-14
3.3 HLLW Feed System	8-14
3.4 Glass Frit System	8-14
3.5 Sampling System	8-15
3.6 Miscellaneous Piping Systems	8-15
3.7 Electric Power	8-15
3.8 Instrumentation/Radiation Monitoring	8-16
4.0 DECOMMISSIONING CONSIDERATIONS	8-10
5.0 SHIELDING AND REMOTE HANDLING	8-17
6.0 COST/SCHEDULE	8-18
6.1 Cost	8-18
6.2 Schedule	8-20
7.0 CONCLUSIONS	8-21
8.0 REFERENCES	8-23

LIST OF FIGURES

<u>Figure No.</u>	<u>Title</u>
1.1	West Valley HLLW Vitrification Option A-1 Simplified Process Flowsheet
2.0	Stand-Alone Solidification Facility, Site Plan.
2.1	Stand-Alone Solidification Facility, Plan at El. 100'0" and El. 110'0"
2.2	Stand-Alone Solidification Facility, Plan at El. 131'3"
2.3	Stand-Alone Solidification Facility, Sections
2.4	Stand-Alone Solidification Facility, Sections
6.1	Separate Facility for Housing the Solidi- fication Equipment, Construction Schedule

ASSESSMENT OF A SEPARATE FACILITY FOR HOUSING THE SOLIDIFICATION EQUIPMENT

1.0 INTRODUCTION

1.1 Background

One of the ongoing efforts in support of the proposed project to solidify HLLW stored at WNYNSC includes an examination of utilizing the Chemical Process Cell (CPC) in the main process building to carry out the solidification process. The feasibility of utilizing the CPC for HLLW solidification is under review and has not yet been established. This assessment provides an alternative for consideration before a final selection is made of the facilities needed to solidify the HLLW.

The objective of the study presented herewith is to outline the scope and assess the cost of a separate stand-alone building, to be constructed at the West Valley site, and to be used for housing the solidification equipment being considered for the solidification of High Level Liquid Waste (HLLW) currently stored in two underground tanks (Tank 8D2 and 8D4).

The proposed facility is assumed to be located in close proximity to the existing main process building and High Level Waste (HLW) tank farm. It will receive HLLW from the existing underground tanks, convert the liquids into a containerized vitrified solid, and will transfer the canister of solidified waste to on-site interim storage.

The facility was designed to accommodate the solidification equipment as identified by Pacific Northwest Laboratory (PNL) for solidification option A-1. A simplified flowsheet for this vitrification option is given in Fig. 1.1. The proposed solidification process consists of spray calcination and in-can melting. A brief description of the PNL option A-1 immobilization process is provided under Section 1.2. The study does not address other solidification alternatives being considered for West Valley HLLW. This study was performed primarily to provide preliminary information on facility size and layout. Further engineering and analysis will be required to address in detail design and performance considerations.

1.2 Waste Treatment Process

The solidification process considered herein consists of two processing steps: pre-immobilization treatment of the HLLW, followed by calcination and vitrification of the waste. The Tank 8D2 neutralized waste is to be centrifuged to produce a clarified supernate containing the bulk of the salts. This is followed by filtration and passage through Cesium and Strontium ion exchangers to remove these radio-nuclides. The decontaminated supernate is then converted to salt cake.

The centrifuge sludge and the stripped radioactive components from the supernate are combined with the Tank 8D4 waste and introduced into a spray calcination chamber. The spray calciner decomposes the chemicals in the HLLW to a metal oxide calcine and a process off-gas. The reaction gases are treated by the off-gas system, while the calcine powder is fed into the in-can melter, where it is mixed with borosilicate glass powder, and the calcine-frit mixture is melted to form glass. It should be noted that the stainless steel canisters that are to contain the waste glass product are inserted into a melter furnace and serve as the melting crucible. The process is completed by removing the filled canisters from the furnace, placing a lid on the canister, and seal welding the canisters.

1.3 Design Considerations

The following is a brief summary of the various design considerations and requirements that had to be satisfied in the assessment of the stand-alone HLLW solidification facility:

1. Space and layout considerations intended to satisfy the PNL/Vitro requirements for the HLLW process equipment. This applies to the pretreatment equipment as well as the solidification equipment, and is reflected in the sizes of the various cells, as well as the relative arrangement of the cells.
2. Separation of the pretreatment equipment from the calcination/vitrification equipment. This approach is preferred in order to limit spread of contamination.
3. Shielding considerations as governed by operational and maintenance requirements and safety considerations (minimizing radiation exposure of personnel).

4. Operational and maintenance consideration as set forth by PNL. Due to the high radiation levels of the equipment, the facility is designed for fully remote operation and maintenance.
5. Confinement considerations as specified by PNL. This relates to certain airtight requirements applied to the vitrification cell which is designed to limit the dispersion of radionuclides.
6. The logistics of moving equipment in and out of the facility. This relates to interfaces between the proposed facility and the on-site transportation mode for fresh (empty) canisters and canisters containing solidified product.
7. The facility will be designed to contain and prevent dispersion of radioactivity under all credible accident and natural phenomena, including earthquake, tornado and fire.
8. The waste solidification facility is to be operated for approximately three years and is to be decommissioned following completion of the HLLW solidification effort.
9. Decommissioning considerations. This applies to the incorporation of certain decontamination cells, cell lining, and decontamination equipment into the design of the facility in order to facilitate ready decontamination and decommissioning following completion of the waste solidification phase.
10. Process system interface considerations. This relates to incoming HLLW sludge slurry piping, secondary radioactive wastes produced by the solidification process (salt slurry), and a feed stream of glass frit.
11. Accessibility and constructability considerations. This relates to the design of doorways, access hatches and cranes in order to permit the entry of equipment to be installed and its removal for maintenance/decommissioning.
12. Economic considerations. The objective is to limit the capital expenditures of constructing the add-on solidification facility without impairing its operability.

1.4 Input Data

In order to assess the scope and cost of stand-alone solidification facility, a clear characterization of the immobilization equipment is required as a prerequisite. The data available to date with respect to the solidification equipment intended for WNYNSC high level wastes are limited and consist of the following PNL inputs:

1. Immobilization Option A-1, Block Flow Diagram, Preliminary.
2. A Preliminary Equipment Listing of the Immobilization Equipment, giving approximate sizes of components.
3. Information gathered through meetings and communications with PNL and Vitro.

The equipment data presently available is highly pre-conceptual and lacks the detail needed for design work. Additional input data that is needed for more detailed design includes, among others: (1) Immobilization equipment arrangement; (2) Operational and maintenance requirements; (3) Various service systems, and utility requirements.

In light of the present status of the solidification equipment design described above, numerous assumptions were made and simplifications were instituted to bridge the gap between needed and available data. In addition, technical material, presented in References 1 and 2 with respect to high level waste vitrification technology, was used to fill in some of the voids.

2.0 DESCRIPTION OF FACILITY

The proposed solidification facility is to be constructed at the Western New York Nuclear Service Center (WNYNSC) site, and is to be located in close proximity to the existing main fuel reprocessing building. Fig. 2.0 provides a layout of the WNYNSC site plan and shows the location of the new solidification building relative to existing facilities. It is assumed that support services and utilities such as ventilation air and electric power can be obtained from the main process building.

The reference facility is a heavily shielded reinforced concrete structure; overall dimensions are 199 ft long x 87 ft wide. The overall height of the building extends to 66 ft (61 ft above grade); a full canister transfer tunnel extends 32 ft below grade; a portion of the building is only 36 ft in height. The overall arrangement of the process

PLAN AT EL. 110:0'
(GRADE AT EL. 100:0')

- LEGEND**
- ① VIEWING WINDOW
 - ② ACCESS HATCH
 - ③ SLIDING SHIELDING DOOR
 - ④ LOADOUT STATION
 - ⑤ SHIELDING ACCESS DOOR

TASK 8

FIG. 2.1

										REVISION				DATE	OWN	CHK	APPROVED ENGR	DRAWING RELEASE STATUS						ENGINEERING REVIEW			WESTERN NEW YORK NUCLEAR SERVICE CENTER STAND-ALONE SOLIDIFICATION FACILITY																						
																☐ PRELIMINARY ☐ PARTIALLY APPROVED						DIV			ENGR	DATE																							
																RELEASED FOR						BY	DATE	RELATED TO P&C NO.	AMEND	ADD	FILE			PLAN AT EL. 100' 0" AND EL. 110' 0"																			
																INFORMATION												CL.																					
																COMMENT												ANAL.			BURNS AND ROE INDUSTRIAL SERVICES CORP. Engineers and Constructors																		
																APPROVED FOR												NLS.																					
																BID															DWG. BY			CHK	SLD	DATE	Paramet. B. J. Signford, Conn.												
																CONSTRUCTION															OWN																		
																																								APPROVED						DATE 7-1-10	WORK ORDER 4870	DRAWING NO C-081	REV 0

N

PLAN AT EL. 131.3'
(GRADE AT EL. 100.0')

TASK 8

FIG. 2.2

REVISION

DATE DWN CHR APP. VED

DRAWING RELEASE STATUS

RELEASED FOR	BY	DATE	RELATED TO	AMEND	ADD
INFORMATION					
COMMENT					
APPROVED FOR					
SIC					
CONSTRUCTION					

ENGINEERING REVIEW

DIV	CHK	DATE
MECH		
ELEC		
CIVIL		
ARCH		
NUC		
DRG. BY	CHK	SLIDE
CHK		

WESTERN NEW YORK NUCLEAR SERVICE CENTER
STAND-ALONE SOLIDIFICATION FACILITY

PLAN AT EL. 131.3'

BURNS AND ROE INDUSTRIAL SERVICES CORP.
Engineers and Constructors

APPROVED	DATE	WORK ORDER	DRAWING NO.	REV
	7-4-80	4870	C-082	0

SECTION B-B

TASK 8

FIG. 2.3

REVISION

DATE	OWN	CMS	APPROVED
------	-----	-----	----------

DRAWING RELEASE STATUS

☐ PRELIMINARY		☐ PARTIALLY APPROVED	
RELEASED FOR	BY	DATE	RELATED TO SPEC NO
INFORMATION			
COMMENT			
APPROVED FOR			
BID			
CONSTRUCTION			

ENGINEERING REVIEW		
DIV	ENGR	DAT
MECH		
ELEC		
CIVIL		
ARCH		
NUC		
DSGN OWN	CHK	SL/L

	VESTERN NEW YORK NUCLEAR SERVICE CENTER STAND-ALONE SOLIDIFICATION FACILITY.
	<u>SECTIONS</u>
	BURNS AND ROE INDUSTRIAL SERVICES CORP. Engineers and Constructors Stamford, Conn.
DE	Paramus, N.J.

APPROVED	DATE 7-3-80	WORK ORDER 4870	DRAWING NO. C-083	REVISION 0
----------	----------------	--------------------	----------------------	---------------

SECTION D-D

SECTION C-C

TASK 8

FIG. 2.4

REVISION				DATE	DWN	CHK	APPROVED	DRAWING RELEASE STATUS				ENGINEERING REVIEW				WESTERN NEW YORK NUCLEAR SERVICE CENTER STAND-ALONE SOLIDIFICATION FACILITY			
								☐ PRELIMINARY	☐ PARTIALLY APPROVED			REV	DATE	DATE		SECTIONS			
								RELEASED FOR	BY	DATE	RELATIVE TO	AMEND	ADD			BURNS AND ROE INDUSTRIAL SERVICES CORP.			
								INFORMATION								Engineers and Constructors			
								COMMENT								P. JAMES, R. J.			
								APPROVED FOR								DATE			
								SID								7-8-82			
								CONSTRUCTION								WORK ORDER			
																4870			
																C-084			
																REV			
																0			

cells, operating aisles, and support areas is presented in Figs. 2.1 through 2.4. These figures provide both plan and elevation views of the proposed facility.

The thicknesses of the walls, floors and roof have been sized, taking into consideration only the shielding aspects. Subsequently, in the next phase of design development, the elements may be increased when all the structural design loads, dead, live, crane service, wind, seismic, etc., with all the multiplicity of combinations, are addressed. The configuration of the various functional areas, with their thick walls, precludes the use of bearing wall type construction.

There are many varied material handling cranes throughout the building which subsequently will require a more complete study. The cranes presently indicated on the attached drawings represent the simplest type, consistent with the time allowance and scope of this effort.

In the absence of more complete sub-soil information, it has been assumed that the bearing walls will be supported on a thick overall mat foundation, and that the allowable soil bearing capacity is capable of safely supporting the design loads. This, of course, is subject to modification when complete sub-soil information is obtained and the design development is advanced, taking into consideration all the combinations of loads, including seismic.

The bulk of the immobilization equipment is housed in two separate process cells: (1) a pretreatment cell (PTC) that houses the process equipment associated with initial treatment of the HLLW prior to its calcination. This includes centrifuges, filters, ion-exchangers, evaporators and feed/holdup tanks; (2) a waste vitrification cell (WVC) that contains the solidification equipment. This includes the spray calciner, in-can melters, canister sealing equipment and storage racks for a number of canisters. Each of the above cells is served by a maintenance cell and a decontamination cell. Access to these cells is through sliding shield doors. The pretreatment cell, vitrification cell, and their respective maintenance and decontamination cells are surrounded by operating aisles and are provided with shielded viewing windows, cranes, and master slave manipulators that will allow all operation and maintenance activities to be performed remotely.

The various process and auxiliary cells included in the proposed solidification facility, their inside dimensions,

and their principal functions are tabulated in Table 2.1. The more important process cells in addition to the cells described above are: (1) an off-gas treatment cell, (2) a glass frit feed cell, (3) a cell for housing the services and controls of the in-can melter, (4) areas for transferring empty/full canisters in/out of the vitrification cell, and (5) a decontamination cell for filled canisters. Additional details concerning the solidification process cells follow herewith.

2.1 HLLW Pretreatment Cell

This cell contains the process equipment required for pretreatment of HLLW. The cell is a heavily shielded reinforced concrete structure; cell walls are 5 ft thick; inside dimensions are 74 ft long x 25 ft wide x 26 ft high. To aid in decontamination subsequent to completion of the immobilization effort, the cell floor and walls are lined with stainless steel 1/8-inch thick.

Major equipment located in the PTC includes:

1. Centrifuges (2)
2. Filtration Equipment, including a gravity settler and filters
3. Cesium and Strontium Ion Exchange Columns (3)
4. Evaporators (4), and Condensers (6)
5. Various Hold, Sample, and Feed Tanks (41)

The outline presented herewith does not include a detailed equipment layout plan, since such a layout has not yet been developed by PNL. However, the space of the PTC should suffice in accommodating all of the above equipment. As shown in Fig. 2.1, access to the PTC is through two sets of shield doors leading to the PTC hot maintenance and decontamination cells. All maintenance and operation activities are performed remotely. Equipment that needs maintenance or repair is transferred to the PTC hot maintenance cell. The cell is served by a 20-ton remotely operated bridge crane with crane rails extending to the maintenance and decontamination cells. (See Fig. 2.3.) Most cell equipment is assumed to be designed for remote removal. To facilitate remote operation and maintenance, the cell is provided with a crane manipulator, six (6) shielded viewing windows, two (2) impact wrenches, two (2) periscopes, and is surrounded by operating aisles as shown in Figs. 2.1 and 2.3.

The PTC is provided with equipment that will facilitate decontamination. This includes: decontamination headers,

TABLE 2.1

WASTE VITRIFICATION FACILITY
MAJOR CELLS AND AREAS

<u>Compartment</u>	<u>Inside Dimensions (ft)</u>	<u>Function</u>
HLLW Pretreatment Cell (PTC)	74'x25', Height 26'	Contains equipment used for Pretreatment of the HLLW, including: Centrifuges, Filters, Ion Exchangers and Evaporators
PTC Equip. Maintenance Cell	23'x25', Height 26'	Contains equipment for Remote Maintenance of HLLW Pretreatment Equipment
PTC Equip. Decontamination Cell	17'x25', Height 26'	Contains equipment for Remote Decontamination of the Pretreatment Equipment, and for its Preparation for Decommissioning
Waste Vitrification Cell (WVC)	35'x20', Height 58'	Contains equipment to Calcine and Vitrify the HLLW
WVC Maintenance Cell	35'x18', Height 28'	Contains equipment for Remote Maintenance of Vitrification Equipment
WVC Decontamination Cell	35'x20', Height 58'	Contains equipment for Remote Decontamination of Vitrification Equipment
Off-Gas Treatment Cell (OGC)	31'x27', Height 60'	Contains equipment for Treatment of the Calciner Off-Gas Stream, such as: Heaters, Adsorbers and HEPA Filters
Canister Decon. Cell (CDC)	7'x22', Height 32'	Contains equipment for Decontamination of canisters filled with Solidified HLLW and their Transfer to the Transfer Tunnel
Frit Feed Cell	40'x15', Height 28'	Storage and Feed of Glass Frit and Other Makeup Materials
New Canister Transfer Cell	32'x29', Height 19'	Transfer of Empty Canister into the WVC
Full Canisters Transfer Tunnel	7'x32', Height 22'	Allows for Underwater Transfer of Canisters from Decontamination to Loadout Station
Hot Pipe Chase	10'x35', Height 28'	Used for routing of the Radioactive Slurry into the Vitrification Cell
In-Can Melter Control Cell	35'x15', Height 10'	Contains the In-Can Melter Control & Service Equipment; e.g., Push Rods, Electrical Connections, and Cooling Air

spray nozzles for internal and external spraying of process equipment, and hose connections for high pressure water/steam hookup. The PTC is an airtight cell; the shield doors leading to the hot maintenance cell are of a sealed design, and the cell is served by a filtered air cooling/ventilation system that will maintain the cell under a slightly negative pressure. The cell floor is sloped and is provided with a sump for collection of spills and drains. A pipe chase runs along one side of the cell and is to be utilized for routing of the various hot and service piping leading to the cell.

2.2 PTC Hot Maintenance Cell

This cell contains equipment for remote maintenance of the waste pretreatment equipment; it can also be used to prepare equipment, bound for decommissioning, for transfer to the decontamination cell. The cell is constructed of reinforced concrete; inside dimensions are 23 ft x 25 ft x 26 ft high. Cell floor and lower portion of cell walls (10 ft in height) are lined with stainless steel 1/8-inch thick. All concrete surfaces that are not lined with stainless steel will be covered with a strippable coating to ease removal of surface contamination. To facilitate remote operation, the cell is provided with two (2) shielded viewing windows and a master slave manipulator. Access to the cell is through the sliding shield doors shared with the PTC. Process equipment that needs maintenance or repair is to be brought into the cell by the same crane that serves the PTC. The cell also shares a sliding shield door with the decontamination cell. Access is also provided from one of the adjacent operating aisles through a shield door, as shown in Fig. 2.1.

2.3 PTC Decontamination Cell

The decontamination cell contains equipment for remote decontamination of the pretreatment equipment prior to contact maintenance operations or prior to decommissioning. It will also be used to prepare equipment for on-site storage during the post-immobilization phase.

The cell is shown in Fig. 2.1 and like the PTC and hot maintenance cells, it is a reinforced concrete cell, 5 ft thick. Inside dimensions are 17 ft x 25 ft x 26 ft high. The cell floor and the lower 10 ft of the walls are lined with stainless steel 1/8-inch thick. The floor is sloped to allow for drainage of spray solutions into a cell sump. To assist in remote operation, the cell is provided with a remote CCTV camera and is surrounded with operating aisles.

Access is through a sliding shield door leading to the hot maintenance cell. A shield door provides for access from an adjacent operating aisle. The path for removal of decontaminated pretreatment equipment from the cell is through a sliding shield door leading to the outside.

2.4 Waste Vitrification Cell

The Waste Vitrification Cell (WVC) contains the process equipment required for calcination and vitrification of the pretreated HLLW. The WVC also contains equipment for sealing and inspecting the filled HLW solidified canisters. The cell is a heavily shielded reinforced concrete structure; cell walls are 5 ft thick; inside dimensions are 35 ft long x 20 ft wide x 58 ft high. To aid in decontamination subsequent to the completion of immobilization and to protect the cell walls from process vapors and chemicals, the cell floor and walls are lined with stainless steel 1/8-inch thick.

The solidification equipment located in the WVC includes:

1. A HLW Slurry Feed Tank (1)
2. A Spray Calciner/Filter Assembly (1)
3. Two (2) In-Can Melter Assemblies
4. A Canister Lid Welding Station
5. A Canister Inspection/Cooling Station
6. Storage Racks for Six (6) Canisters.

Figs. 2.2 and 2.4 provide a schematic outline of equipment layout. Access to the WVC is through a set of sliding shield doors leading to the hot maintenance cell and an access hatch to the canister decontamination cell. The cell is served by a 20-ton bridge crane, three (3) sets of master-slave manipulators (two near the calciner in-can melter assemblies and one in association with the lid welding station), two (2) periscopes, and four (4) shielded viewing windows.

All operation and maintenance activities are performed remotely. This is achieved by having equipment that is designed for remote replacement, employing either remote maintenance techniques or remotely transferring equipment that needs maintenance/repair to the maintenance cell by use

of the bridge crane. The path for transferring empty canisters into the WVC and for the removal of full canisters is via the canister decontamination cell. A schematic arrangement of the solidification equipment inside the WVC is shown in Figs. 2.2 and 2.4. In support of the remote operation and maintenance approach, the vitrification equipment is arranged to provide an easy flow path for canisters, to assure adequate viewing, and to allow for crane access. The in-can melters are located below the calciner assembly; melters overhead access is achieved by having the melters mounted on fixed rails and by translating the melters away from the calciner where they are accessible to the cell crane. As shown in Figs. 2.1 through 2.4, the WVC is surrounded by a number of operating aisles from which the operation is viewed and guided.

The WVC is an airtight cell; the shield doors leading to the adjacent hot maintenance cell are of a sealed design. The access hatch to the canister decontamination cell is also of an airtight design. The WVC atmosphere is cooled by a filtered air cooling system. To preclude the escape of airborne radioactivity to the outside, the cell will be maintained at a slightly negative pressure. A sloped cell floor and a cell sump will collect spills and assist in cell decontamination.

2.5 WVC Maintenance Cell

The maintenance cell contains equipment for remote maintenance of the solidification equipment. The cell is made of reinforced concrete; walls are 5 ft thick; inside dimensions are 35 ft long x 18 ft wide x 28 ft high. The cell floor is at elevation 131'3" (approximately 31 ft above the WVC floor). The cell floor and lower 10 ft of the walls are lined with stainless steel. To facilitate remote operation, the cell is provided with two (2) shielded viewing windows, a master slave manipulator, and is operated from two adjacent operating aisles.

Access is through a sliding shield door leading to the vitrification cell, as shown in Figs. 2.2 and 2.4. Vitrification equipment that needs maintenance or repair will be brought into the cell through the above shield door opening by use of the WVC crane. The maintenance cell also shares a sliding shield door with the WVC decontamination cell. A shield door provides access from one of the adjacent aisles. The maintenance cell will also serve as the path for the removal of WVC equipment to the decontamination area. This applies to equipment that requires direct maintenance or equipment bound for decommissioning.

2.6 WVC Decontamination Cell

The decontamination cell contains equipment for remote decontamination of the vitrification equipment on either a periodic (maintenance) basis or for eventual decommissioning. This includes: spray headers, connections for high pressure water/steam hookups for internal spray of components, portable water lances, special lighting, and visual monitoring equipment. The decontamination cell will also be used to prepare equipment (packaging) for on-site storage during the post immobilization phase.

Plan and elevation views of the cell are shown in Figs. 2.1, 2.2 and 2.4. It is a reinforced concrete cell. Inside dimensions are 35 ft long x 20 ft wide x 58 ft high. The cell floor and the lower 20 ft of the cell walls are lined with stainless steel 1/8-inch thick. The cell floor will be sloped for collection of spray drainage and spills. Concrete surfaces are to be provided with a strippable coating to assist in contamination removal.

To facilitate remote operation, the cell is provided with a shielded viewing window, a remote CCTV camera, and is surrounded by operating aisles from which the operation is viewed and guided. Access is through a sliding shield door leading to the maintenance cell. A shield door provides access from an adjacent operating aisle. The path for removal of decontaminated equipment bound for decommissioning is through a sliding shield door leading to the outside.

2.7 Off-Gas Treatment Cell

The Off-Gas Treatment Cell (OGC) houses equipment for treatment of the calciner off-gas stream. Primary equipment includes:

- (a) Cyclone separator
- (b) Off-Gas condenser
- (c) Heaters (2)
- (d) Off-Gas Filters (2)
- (e) Fission product bed
- (f) Demister
- (g) NO_x destructor.

Plan and elevation views of the cell are shown in Figs. 2.1, 2.2 and 2.4. The cell is made of reinforced concrete. The walls are 3 ft thick; inside dimensions are 21 ft x 27 ft x 60 ft high. To aid in decontamination subsequent to completion of the waste solidification effort,

the cell floor and the lower 20 ft of the cell walls are lined with stainless steel 1/8-inch thick. All bare concrete surfaces are covered with a strippable coating, and the cell floor is sloped for collection of the spray streams and drainage. A periscope and remote CCTV camera are provided for remote viewing. Access is through a roof shield plug, and a shield door from an adjacent operating aisle.

2.8 Canister Decontamination Cell

The Canister Decontamination Cell (CDC) is used to move canisters in and out of the WVC and for external decontamination of the filled canisters.

The cell is shown in Figs. 2.3 and 2.4. It is constructed of reinforced concrete and can be viewed as consisting of two separate areas: (1) A canister decontamination and handling area at elevation 75 ft (25 ft below grade). The inside dimensions are 22 ft x 7 ft. (2) An empty/full canister handling area at elevation 95 ft, with inside dimensions of 31 ft x 7 ft. Each area is served by a 5-ton bridge crane. The decontamination area floor and walls are lined with stainless steel 1/8-inch thick, while the handling area will only be coated with a strippable coating. The decontamination area is equipped with spray headers, water lances, and steam water supply lines.

Full canisters are lowered into the decontamination area through an access hatch shared with WVC. Following spray decontamination and water rinsing, the canisters are placed where they are accessible to the 5-ton handling area crane above and can subsequently be lowered into the full canister transfer tunnel for underwater transfer to the loadout station. The above operation is performed remotely and can be viewed and guided by use of two (2) periscopes provided for this purpose.

2.9 Full Canisters Transfer Tunnel

The full canister transfer tunnel is provided for underwater transfer of full HLW canisters from the CDC to the loadout station outside the waste solidification facility. The tunnel is shown in Fig. 2.3. It is constructed of reinforced concrete, and is fully below grade (floor elevation at 73 ft). The inside dimensions are 32 ft long x 7 ft wide x 22 ft high. This will allow for transfer of canisters in their upright position. The tunnel is served by a 5-ton remotely operated bridge crane.

2.10 Frit Feed Cell

This cell contains frit storage and feed equipment and will feed glass frit to the adjacent WVC through an air lock gravity feed system. The cell is shown in Figs. 2.3 and 2.4. Inside dimensions are 40 ft x 15 ft x 28 ft high. The cell floor is at elevation 131'3".

2.11 New Canister Transfer Cell

The new canister transfer cell is provided for introducing empty stainless steel canisters into the solidification facility. New canisters are brought into the cell through an outside unloading station and are subsequently lowered into the CDC via an access hatch. The cell inside dimensions are 32 ft x 29 ft x 19 ft high. The floor is at elevation 110 ft. The cell is served by a 2-ton bridge crane.

2.12 In-Can Melter Control Cell

The cell houses the in-can melter and canister welding station service and control equipment. The cell is shown in Fig. 2.4. The cell is constructed of reinforced concrete; inside dimensions are 35 ft x 15 ft x 10 ft high. The floor is at elevation 100 ft. The above service and control equipment includes in-can melter cooling air, control equipment for moving the in-can melters as required for canister replacements, in-can melter electric leads, inert gas control, and the canister seal welding controls.

3.0 SERVICE SYSTEMS/UTILITIES

The proposed solidification facility will be provided with various service piping and building services. Space allowances for various support systems such as electrical equipment, air ventilation and filtration equipment were factored into the assessment and are indicated in Figs. 2.0 through 2.4. In light of the close proximity of the stand-alone solidification facility to the existing utility building, (See Fig. 2.0.) numerous services/utilities such as cooling water, plant air, and steam can be provided from existing systems in the utility building. The following is a brief discussion of the various systems covered by this assessment.

3.1 Ventilation of Radioactive Cells

The contaminated cells include the waste pretreatment

cell, waste vitrification cell, off-gas cell and associated hot maintenance and decontamination cells. Operation of the above radioactive cells will be controlled to preclude discharges that could result in dispersal of contamination to other parts of the facility or to the outside. This will be achieved by having cells that are airtight, as well as the application of a controlled ventilation system. Contaminated cells will be maintained under a slight negative pressure.

Supply air will be drawn from outdoors across medium efficiency roughing filters, preheat and reheat coils, and distributed to the process cells by means of an installed ductwork. Exhaust air will be filtered by filtration units consisting of roughing prefilter, HEPA filters, and activated charcoal. Exhaust fans will discharge the air through an added stack.

Heat generated in association with process equipment will be removed by local unit coolers, through which cooling water will be circulated.

3.2 Radioactive Drains

A radioactive drain system will be provided to collect all the radioactive spills and washes from the process cell and deliver the same to a stainless steel lined sump. The sump will be provided with two (2) stainless steel pumps and piping for transfer of the collected drainage to the low level waste treatment facility.

3.3 HLLW Feed System

The reference assessment includes a pipeline for receiving HLLW from the existing underground waste storage tanks and for feeding the same to the pretreatment cell. This transfer line will consist of a double stainless steel pipe system in which the outer pipe serves as a secondary containment.

3.4 Glass Frit System

A system for storing, handling, and feeding of glass frit to the vitrification cell will be provided.

The system will include a feeder with a feed hopper which is to be housed in the frit feed cell outside the vitrification cell. The feeder will supply frit to the calciner in-can melter assembly via a gravity feed system. An airlock will be built into the frit addition line in order to preclude backflow of contaminated material from the calciner assembly to the frit feed cell.

3.5 Sampling System

Provision will be made for routine sampling and analysis of various process streams and tanks. All sampling will be done remotely. This can be achieved by providing wall penetrations and quick disconnect couplings so that compressed air can be used to educt samples into a shielded sample container and subsequently moving the sample container to the test laboratory.

3.6 Miscellaneous Piping Systems

A number of services and utilities required in association with the stand-alone solidification facility can be provided from the existing facility (Utility Building). These can be conveyed via an underground tunnel that will connect the new facility with the existing utility building. The following is a listing of these services:

1. Process and Instrument Air
2. Process (plant) Water
3. Steam (150 psig)
4. Cooling Water
5. Fire Protection Water
6. Inert Gas System.

3.7 Electric Power

It is estimated that the stand-alone solidification facility will require a 900 KVA electric power supply. This power can be provided from the 2500 KVA transformer serving the existing reprocessing facility by adding a new circuit breaker to the existing 480 V switchgear in the Utility Building and extending 480 V power from this switchgear to the new solidification facility via a pole line. The aerial portion of this line will be triplexed messenger cable and, where cables are extended from pole lines to switchgear, they will be run in conduit. New switchgear will consist of insulated case circuit breakers with static overcurrent trip elements.

Two Motor Control Centers (MCCs) will be provided, one for process equipment and one for heating and ventilating equipment. MCCs will be indoor-type, NEMA Class I type B construction. Standby (on-site) power for the solidification

facility can be obtained from the existing 500 kW standby diesel generator located in the utility building of the reprocessing facility by adding an additional breaker, and utilizing the existing generator transfer scheme. On-site power will be delivered to the solidification facility via aerial construction using triplexed messenger cable, carried on poles, and isolated from the utility supply connections.

3.8 Instrumentation/Radiation Monitoring

The HLLW solidification process will be controlled and monitored from a centrally located graphic panel with duplicate local control panels where necessary. Local transmitter racks shall be located in accessible areas outside the cells close to the process equipment such as operating aisles. All transmitters will be electronic type, with 4 to 20 mA output. For this Study, it is assumed that seismic and Class IE qualification testing for instruments, racks, and panels are unnecessary. Process parameters such as temperature, pressure, level, flow, etc., shall be monitored, as appropriate, at the panels with off-limit conditions annunciated.

Facility radiation levels are monitored by both permanently installed and portable radiation detectors. Permanent radiation detectors will be mounted throughout the facility. Special attention will have to be given to continuous monitoring of air in facility operating aisles and other areas frequented by personnel. Radiation monitors will be provided with readout in the control room. The air stream leaving the facility stack and other service streams (i.e., cooling water return lines) will be monitored continuously.

4.0 DECOMMISSIONING CONSIDERATIONS

The proposed solidification facility will have a useful life of three (3) years and is to be decommissioned upon completion of the waste solidification effort. The design presented herein incorporated numerous features that will both simplify and ease the decontamination and decommissioning effort. The Section 2.0 description of the various process and maintenance cells included an identification of those features and installations designed to facilitate the decontamination effort. These decontamination features are summarized below:

1. Both main process cells; namely, the pretreatment cell and the vitrification cell, were provided with adjacent decontamination cells to which process equipment bound for decommissioning can be brought, remotely decontaminated, and prepared for on-site storage.
2. The above decontamination cells include equipment for remote decontamination of process equipment. This includes spray headers, connections for high pressure water/steam hookups for internal spray of equipment component, hose connections for remote attachment of water lances, shielded windows and CCTV cameras for remote viewing, sloped floors for collection of spray water and solutions.
3. The facility process cells walls are either lined with stainless steel or covered with a strippable coating to facilitate removal of surface contamination.
4. The process cells are provided with spray headers with capability for complete cell coverage and hose connections for remote high pressure water/steam hookups. Floors are sloped for complete drainage of spray water.
5. The remote handling and viewing equipment such as manipulators, remote cranes, and remote viewing windows, built into the process cells in support of the facility remote operation and maintenance plan will also support decontamination activities by allowing for remote removal/decontamination of process equipment.

5.0 SHIELDING AND REMOTE HANDLING

The proposed facility is designed for fully remote operation and maintenance. This is accomplished by incorporating a design based on remote replacement of failed equipment and remote maintenance techniques. All major equipment that needs maintenance/repair is designed for remote replacement and the component can be transferred to the maintenance cell, where it can undergo remote maintenance/repair. Remote operation and maintenance is achieved by use of remote bridge cranes, crane manipulator, master slave manipulators, and remote viewing equipment.

Cell wall thicknesses were selected to allow for unlimited occupancy of operating aisles and areas. In light of the remote operation and maintenance approach, radiation exposure of operating personnel should be in conformance with ALARA guidelines.

6.0 COST/SCHEDULE

6.1 Cost

A capital cost estimate was prepared for the Stand-Alone Solidification Facility described herein. This estimate is summarized in Table 6.1. The capital cost estimate, as presented in the table has been broken down into the following direct cost components:

1. Major Equipment - The major equipment considered includes, among others, radiation sampling equipment, master slave manipulators, remote T.V. cameras, periscopes, glass frit equipment, HEPA filtration package, overhead cranes, uninterrupted power supply and instrumentation.
2. Building and Structures - This includes shield doors, shielded viewing windows, radioactive drain system, plumbing, HVAC, fire protection, and lighting.
3. Utilities - These include various piping systems, a communication system and an electric power system.
4. Site Improvements - The site improvements considered include site grading, paved areas and outside lighting.

Construction craft labor rates, included in the direct cost portion of the estimates, were developed specifically for the West Valley, New York project and reflect second quarter 1980 rates. These rates include fringe benefits.

Material costs were taken from various estimating publications such as: R.S. Means, Richardson Engineering Services, National Price Service and Burns and Roe in-house Cost Data Bank. The cost for special items of material and equipment were solicited from vendor sources who have familiarity and experience with the products involved.

Labor manhours were developed for each task using the above publications and established industry-wide standards as a basis adjusted to suit the nature of work involved.

Indirect costs cover such items as:

1. Field supervision
2. Quality assurance
3. Unemployment Insurance, Workman's Compensation, Social Security and Liability Insurance.
4. Field office trailers, telephone, water and electrical hookups

TABLE 6.1

CAPITAL COST ESTIMATE FOR WYNSC
STAND-ALONE SOLIDIFICATION FACILITY

(In 2nd Quarter 1980 Dollars)

<u>Cost Element</u>	<u>Material</u>	<u>Labor</u>	<u>Total</u>
Major Equipment	\$1,932,300	\$ 402,500	\$2,334,800
Building and Structures	4,542,900	2,579,600	7,122,500
Utilities	320,700	223,100	543,800
Site Improvements	<u>134,800</u>	<u>88,400</u>	<u>223,200</u>
Sub-Total Direct Cost	\$6,930,700	\$3,293,600	\$10,224,300
Indirect Costs			4,876,300
Total Field Costs			15,100,600
Engineering, Design, Drafting and Construction Management			2,265,000
Sub-Total			17,365,600
Contingency @ 25%			4,341,400
Total Facility Cost			\$21,707,000

5. Minor construction equipment such as scaffolding, welding machines, small cranes, A-frames and trucks.

Note: Major construction equipment is included in the Direct Cost portion of the estimate.

6. Small tools and consumables
7. Contractor home office costs, including Purchasing, Estimating, Administrative, Bonds, Permits and other costs
7. Job clean-up
8. General contractor mark-up on subcontracted work
9. Profit

Included in the estimates is a contingency allowance of 25 percent, based on the conceptual nature of the design and the complexity and uncertainties of the component parts of the estimates.

Estimates reflect 2nd quarter 1980 costs and do not include any escalation.

The cost for a facility to accommodate the equipment needed to solidify the HLLW is estimated to be approximately \$21,700,000. This includes all the required utility services but does not include the cost of the process equipment.

6.2 Schedule

A schedule was developed for the elapsed time required to construct a separate facility to house the solidification equipment. The schedule is shown in Fig. 6.1 and includes consideration of the following activities:

1. Mobilization for construction
2. Site preparation and site improvements
3. Earth work
4. Concrete work
5. Mechanical Installation and Testing
6. Electrical Installation and Testing

FIGURE 6.1

CONSTRUCTION SCHEDULE

TASK 8

28 MONTHS

A M J J A S O N D J F M A M J J A S O N D J F M A M J J

WESTERN NEW YORK NUCLEAR SERVICE CENTER
SEPARATE FACILITY FOR HOUSING
THE SOLIDIFICATION EQUIPMENT

CONSTRUCTION SCHEDULE

BURNS AND ROE INDUSTRIAL SERVICES CORP.

Engineers and Constructors

Paramus, N.J.

Stamford, Conn.

APPROVED

DATE
8-7-80
SCALE

WORK ORDER
4870

DRAWING NO.

REV

7. Building Services Installation and Testing
8. Architectural
9. Utilities

The schedule does not include time for facility design. It is estimated that it will take approximately twenty-eight (28) months to construct the facility assessed in this study.

7.0 CONCLUSIONS

A reference design of a stand-alone facility for housing the WNYNSC HLLW solidification equipment was developed and appropriate cost assessments performed. The reference facility is a heavily shielded reinforced concrete structure, consisting of numerous process cells and operating aisles. With the capital cost of the immobilization equipment excluded, the reference facility was estimated to cost \$21.7 million, and will require a construction time of twenty-eight (28) months.

As indicated in the introduction, consideration has also been given to utilizing the Chemical Process Cell (CPC) of the main process building to house the solidification equipment. In considering the above alternatives, a number of advantages/penalties associated with a stand-alone solidification facility can be identified. The advantages of a separate facility are:

1. The construction schedule of a separate waste solidification facility will be uncoupled from the CPC decontamination effort.
2. The new solidification facility can be constructed to incorporate the latest remote maintenance techniques and decontamination features, thus reducing personnel exposure.
3. The construction of a separate solidification facility implies that the WNYNSC decommissioning effort will require that the CPC and associated areas be decontaminated only once, and not twice, as would be required if the solidification equipment was to be installed in the existing facility.
4. The immobilization equipment can be installed using direct (hands-on) techniques and no radiation exposure will be experienced during installation.

5. The construction of a separate solidification facility allows for simpler and more direct interfaces with the rest of the plant and will eliminate costly retrofit work should the CPC be utilized; e.g., paths for moving canisters in/out of the CPC.

The disadvantages of a separate solidification facility are:

1. The capital cost penalty of constructing a new facility with a limited life span.
2. Following completion of the waste immobilization effort, the new facility will require decontamination and decommissioning.
3. The former reprocessing plant will require decontamination and decommissioning in any event.
4. May require more time to design and construct a new facility than to decontaminate and decommission the existing cells.

8.0 REFERENCES

1. DOE/ET-0028, "Technology for Commercial Radioactive Waste Management," U.S. Department of Energy Office of Nuclear Waste Management, May 1979.
2. NUREG-0278, "Technology, Safety, and Costs of Decommissioning a Reference Nuclear Fuel Reprocessing Plant," Battelle Pacific Northwest Laboratory for U.S. Nuclear Regulatory Commission, October 1977.
3. Western New York Nuclear Service Center, West Valley, New York, Safety Analysis Report, Docket No. 50-201, NFS, Rockville, MD, 1973.