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

Project Hanford Management Contractor for the
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Processing Hanford Remote-Handled and Large Package Mixed Low-Level Waste and Transuranic Waste Engineering Study

Program/Project: Waste Stabilization and Disposition

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Executive Summary

More than 10,800 m^3 of mixed low-level waste (MLLW) and transuranic (TRU) waste[1] that are remote-handled and/or contained in large packages will be managed through the Richland Operations Office for the U.S. Department of Energy Hanford Site. The MLLW will be processed to meet Resource Conservation Recovery Act (RCRA) and State Hazardous Waste Management Act (HWMA) requirements and on-site waste acceptance criteria for disposal. The TRU waste will require processing to meet Waste Isolation Pilot Plant (WIPP) waste acceptance criteria for disposal at WIPP.

Approximately 2,000 m^3 of this waste is forecast to be generated during site cleanup, more than 3,000 m^3 is now in above-ground storage, and more than 5,800 m^3 of retrievably stored waste (suspect TRU waste[2]) will be retrieved from the Low Level Burial Grounds (LLBGs). Approximately 93% of the waste by volume is TRU or suspect TRU waste.

This Engineering Study defines the strategy and the capabilities required to process the MLLW for disposal on-site in the mixed waste trenches (MWTs), the Environmental Restoration Disposal Facility (ERDF) and/or the Integrated Disposal Facility (IDF), and the capabilities required to process TRU waste for disposal at WIPP.

Commercial facilities are being used to process (e.g., macroencapsulate, remove prohibited items, repackage) contact-handled (CH) MLLW in packages up to 15 m^3. Use of commercial facilities will be expanded to treat CH MLLW in larger packages up to 35 m^3.

Hanford's T Plant Complex will be upgraded to process CH MLLW in packages greater than 35 m^3, large size packages of CH TRU, RH MLLW, and RH TRU waste. These upgrades will allow processing of packages measuring up to 20 ft x 13 ft x 11 ft, weighing up to 83,000 lb, having does rates (unshielded at the container surface) up to 20,000 rem/hr, and containing up to 2,100 g of plutonium. Plans are to process 600 m^3 per year of TRU waste and 300 m^3 per year of MLLW through the upgraded complex.

The T Plant upgrades are estimated to cost $390 million, including escalation and contingency. Startup of new T Plant processes is planned for June 30, 2016.

[1] In this report, TRU waste refers to both non-mixed and mixed TRU waste. Planning and volumes for non-mixed TRU waste are included for DOE planning purposes. Any information on non-mixed TRU waste in this report is for information purposes only and is not subject to the RCRA or the HWMA. The hazardous and/or dangerous waste portion of mixed TRU waste is subject to the RCRA and HWMA. Statements and information related to radiological constituent in non-mixed and mixed TRU waste are not commitments enforceable under either RCRA or HWMA.

[2] The retrievably stored waste is considered suspect TRU waste until it is assayed to determine whether it is TRU waste or low-level waste/mixed low-level waste.

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Acronyms and Abbreviations

200 ETF	200 Area Effluent Treatment Facility
AEA	Atomic Energy Act
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CH	contact-handled
CNS	Chem-Nuclear Systems
CSB	Canister Storage Building
COTS	commercial off-the-shelf
CWC	Central Waste Complex
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy - DOE Richland Operations Office
DOF	degrees of freedom
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
ESD	explanation of significant difference
FRP	fiberglass reinforced plywood
FY	fiscal year
HEPA	high-efficiency particulate air (filter)
HPU	hydraulic power unit
HSSWAC	Hanford Site Solid Waste Acceptance Criteria
HVAC	heating, ventilation, and air conditioning
HWMA	Hazardous Waste Management Act (Washington State)
IDF	Integrated Disposal Facility
ISA	200 Area Interim Storage Area
LCD	liquid crystal display
LDC	large-diameter container
LDR	Land Disposal Restriction
LLBGs	Low Level Burial Grounds
LLW	low-level waste
MLLW	mixed low-level waste
MWT	mixed waste trench
NRC	U.S. Nuclear Regulatory Commission
O/C	organic/carbonaceous
PFP	Plutonium Finishing Plant
PMP	Project Management Plan
POSSM	Primary Open Sort and Size reduction Module
PUREX	Plutonium-Uranium Extraction Plant
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington

REDOX	Reduction Oxidation Plant
RH	remote-handled
ROD	record of decision
RSW	retrievably stored waste
SWB	standard waste box
SWHF	Solid Waste Handling Facility
SWIFT	Solid Waste Integrated Forecast Technical (Report or Database)
SWITS	Solid Waste Information Tracking System
SWPC	Solid Waste Processing Center
SWPMs	Solid Waste Processing Modules
TOSSM	TRU waste Open Sort and Size reduction Module
TRU	transuranic waste
TRUPACT-II	Transuranic Package Transporter Model 2
VPU	vertical pipe units
WAC	Washington Administrative Code
WAC	waste acceptance criteria
WESF	Waste Encapsulation and Storage Facility
WHC	Westinghouse Hanford Company
WIPP	Waste Isolation Pilot Plant
WM	waste management
WRAP	Waste Receiving and Processing Facility
WTP	Waste Treatment Plant

Glossary

Contact-Handled (CH) – Having a dose rate less than or equal to 200 mrem/hr at the container surface.

Large Package – For mixed low-level waste, a waste container with a volume greater than or equal to 10 m^3. For transuranic waste, a container that is not a 55-gallon drum or a 55-gallon drum over-packed in an 85-gallon drum, and cannot be placed in a 55-gallon drum. The exception to the transuranic large package waste definition is a standard waste box. For the purposes of this document, package and container are synonymous. Note that when referring to package size this Engineering Study may use "large" differently. See Section 2.0 for an explanation.

Mixed Low-Level Waste (MLLW) – Radioactive waste that is not high-level waste, spent nuclear fuel, transuranic waste, byproduct material (as defined by the Atomic Energy Act) or naturally occurring radioactive material that also contains a hazardous component subject to the Resource Conservation Recovery Act or the Washington State Hazardous Waste Management Act.

Remote-Handled (RH) – Having a dose rate greater than 200 mrem/hr at the container surface.

Transuranic Waste – Radioactive waste containing more than 100 nanocuries of alpha-emitting transonic isotopes per gram of waste with half-lives greater than 20 years (excepting high-level waste and spent nuclear fuel). For the purposes of this document, transuranic waste includes transuranic waste that also contains a hazardous component subject to the Resource Conservation Recovery Act or the Washington State Hazardous Waste Management Act.

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1.0 Introduction

Remote-handled (RH) and large package mixed low-level waste (MLLW) and transuranic (TRU) waste[1] that is forecast to be generated during site cleanup, in above-ground storage, and retrievably stored waste (suspect TRU waste) from the Low Level Burial Grounds (LLBGs) will require processing prior to disposal. Existing Hanford facilities (Waste Receiving and Processing Facility [WRAP], Central Waste Complex [CWC], and the T Plant Complex) and commercial facilities are being used, within their waste acceptance criteria, to support these needs. For example, commercial facilities are treating most contact-handled (CH) MLLW in containers up to 15 m^3 in size. MLLW and TRU waste requiring new capabilities and/or facilities to process include:

- CH MLLW in containers larger than 15 m^3
- MLLW
- CH TRU waste in boxes and large containers
- RH TRU waste.

Consistent with the *TRU Mixed/Mixed Low-Level Waste Project Management Plan* (PMP) (FHI 2004), this Engineering Study defines the strategy for new T Plant Complex capabilities and expanded use of commercial facilities. The strategy defines the capabilities required to process 1) the MLLW for disposal on-site in the mixed waste trenches (MWT), 2) the Environmental Restoration Disposal Facility (ERDF) and/or the Integrated Disposal Facility (IDF), and 3) the TRU waste for disposal at the Waste Isolation Pilot Plant.

The strategy described in this study supports the *Hanford Federal Facility Agreement and Consent Order* (also known as the Tri-Party Agreement, or TPA) (Ecology et al. 1989) M-91 milestone series to "complete the acquisition of new facilities, modifications of existing facilities, and modification of planned facilities necessary for retrieval, storage, treatment/processing, of all Hanford Site RCRA (Resource Conservation and Recovery Act) mixed and suspect mixed low-level waste and RCRA mixed or suspect mixed transuranic waste." TPA Milestones M-16-67 and M-16-93 address additional needs for processing mixed waste generated from Hanford Site Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) cleanup actions. These needs will be integrated as requirements are identified. The relevant milestones can be summarized as follows:

[1] In this report, TRU waste refers to both non-mixed and mixed TRU waste. Planning and volumes for non-mixed TRU waste are included for DOE planning purposes. Any information on non-mixed TRU waste in this report is for information purposes only and is not subject to the RCRA or the HWMA. The hazardous and/or dangerous waste portion of mixed TRU waste is subject to the RCRA and HWMA. Statements and information related to radiological constituent in non-mixed and mixed TRU waste are not commitments enforceable under either RCRA or HWMA.

M-91-01 – Complete the acquisition of capabilities and/or acquisition of new facilities, modification of existing facilities and/or modification of planned facilities necessary for retrieval, designation, storage and processing of post-1970 RH TRUM and large container CH TRUM.

M-91-03 – Revise the Hanford Site TRUM Waste and MLLW PMP to comply with Tri-Party Agreement Section 11.5 requirements by December 31, 2003, March 31, 2009, and March 31, 2013.

M-91-05-T01 – Complete and submit RH and large container CH TRUM retrieval and processing facilities Engineering Study/Functional Design Criteria Study by December 31, 2007.

M-91-12A – Complete thermal treatment of at least 240 m^3 of CH Mixed Waste by September 30, 2005.

M-91-12 – Complete thermal treatment of an additional 360 m^3 of CH Mixed Waste by November 16, 2007.

M-91-15 – Complete acquisition of facilities and/or capabilities and initiate treatment of RH and CH mixed waste in large boxes and containers by June 30, 2008.

M-91-40 – Retrieve all CH-RSW within burial grounds 218-W-4C, 218-W-4B, 218-W-3A, and 218-E-12B by December 31, 2010.

M-91-41 – Initiate full-scale retrieval of RH RSW by January 1, 2011. Retrieval of non-caisson RH RSW shall be completed by December 31, 2014. Retrieval of the 200 Area caisson RH RSW in the 218-W-4B burial ground shall be completed by December 31, 2018.

M-91-42 – Treat specified newly generated CH and CH mixed waste in storage in accordance with the required treatment schedule through December 31, 2009. After June 30, 2009, treat all newly generated mixed waste in accordance with the treatment requirements in compliance with WAC 173-303-140 and 40 CFR 268.

M-91-43 – Designate all RH LLW and boxes[2] and large containers of CH mixed waste in above-ground storage as of June 30, 2003 by December 31, 2008. Begin treatment of CH and RH mixed waste and boxes and large containers of CH mixed waste at a minimum rate of 300 m^3/yr beginning no later than June 30, 2008.

M-91-44 – Designate and begin processing of RH and box/large container CH TRUM waste at a rate of 300 m^3/yr beginning no later than June 30, 2012.

[2] Treatment of CH MLLW boxes is being credited toward Tri-Party Agreement milestone M-91-42.

M-91-45 – Submit a report describing completed and scheduled work relating to RH mixed waste and CH mixed waste in large boxes and containers by September 30, 2004 and annually thereafter to Ecology.

M-16-67 – Submit a technology development summary report by March 31, 2007, for Phases I, II and III; an intermediate design report; a remediation schedule; and a treatability investigation work plan for remedial actions at the 618-10 and 618-11 burial grounds. The intermediate design report should represent a 60% complete design and should include, at a minimum, the remediation approach (i.e., process definition), evaluation of infrastructure requirements (M-91 and WIPP integration planning), and updated drawings/technical specifications.

M-16-93 – Submit an implementation work plan to EPA for the acquisition of capabilities necessary to prepare TRU and TRUM waste generated by CERCLA cleanup actions at the Hanford Site for disposal at WIPP by September 30, 2006. To avoid duplicative requirements, the M-16-93 work plan will integrate plans developed pursuant to the M-91 milestones to provide capabilities for RCRA mixed and suspect TRUM waste where such capabilities also can be used for CERCLA TRU/TRUM waste.

Appendix A contains the full text of these milestones from the Tri-Party Agreement.

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2.0 Waste Inventories and Projections

RH and large-package MLLW and TRU waste comes from three sources: 1) waste forecast to be generated during site cleanup (including RH TRU waste from 618-10/11 burial grounds cleanup), 2) waste currently in above-ground storage, and 3) retrievably stored waste in the LLBGs. Newly generated MLLW from non-Project Hanford Management Contract organizations is required to be compliant with Land Disposal Restrictions upon receipt (with exception on a case-by-case basis).

The solid waste inventories and projections (Table 2.1) must be defined adequately to evaluate processing requirements. This evaluation includes waste volumes, weights, container types and counts, and dose rates. Information in this section is based on current waste inventories and projections and is subject to change as these are updated.

Multiple data sources were used to compile the information in this section. The Solid Waste Information Tracking System (SWITS) database was used to collect data for stored waste, both above-ground and in the LLBGs. Waste identified in SWITS as TRU waste that is suspected to be reactor irradiated nuclear material was excluded from this report. The Solid Waste Integrated Forecast Technical (SWIFT) database and report (FHI 2005b) were used to collect data for the forecasted waste. The SWIFT database provides life-cycle information about the radioactive solid waste expected from on-site and off-site generators and extends through FY 2035. The SWIFT forecast is updated semi-annually to reflect changes in Program needs. This report does not include CERCLA waste, with the exception of RH TRU waste from the 618-10/11 burial grounds.

This report groups waste by waste handling and type and container size. The containers are placed in the following size groups[1]:

- Drum – 55-gallon drums
- Small – Containers with a volume less than that of a 55-gallon drum
- Medium – Containers with a volume greater than a 55-gallon drum and less than 10 m^3 (excluding standard waste boxes)
- Large – Containers with a volume greater than 10 m^3

[1] These size groups differ from the definition of "Large Package" contained in the glossary to provide further breakout of package sizes. For MLLW, the glossary definition of "Large Package" is the same as "Large" as listed above. For TRU waste, the glossary definition of large package includes "Medium" and "Large" as listed above (with the exception of 55-gallon drums over-packed with 85-gallon drums). For the waste that is the subject of this study, "Small" is only applicable to RH waste.

The volume calculations for the SWITS (above-ground storage and post-1970 LLBGs) and SWIFT (forecast) use different bases. The individual container volume primarily used in SWITS is based on the internal volume of the package, while SWIFT uses external container volumes. In some instances where there is no container or it is integral to the waste such as bulk waste or an ion exchange module, these volumes are identical. Typically, however, a 10-25% volume increase can be assumed to adjust from internal volumes to external (e.g., a typical 55-gallon drum has an internal volume of 0.208 m^3 and an external volume of 0.257 m^3, a 23% increase).

The total volume of RH and large package MLLW and TRU waste that is in above-ground storage, retrievably stored waste in the LLBGs, and forecast is approximately 11,400 m^3 (Table 2.1).

Table 2.1. Waste Source Summary (cubic meters)

Waste Type	Container Size	Above Ground Storage	Retrievably Stored Waste	Forecast	Total
CH MLLW	Large	126	-	-	126
RH MLLW	Drum	4	-	334	338
	Medium	80	-	194	274
	Large	65	-	-	65
CH TRU(M)	Medium	1,867	1,020	330	3,218
	Large	606	5,109	126	5,841
RH TRU(M)	Drum	44	29	558	631
	Small		24	-	24
	Medium	216	150	451	817
	Large		36	-	36
Total		3,006	6,369	1,994	11,369

It is assumed that half of the CH retrievably stored waste (suspect TRU waste) in "Medium" packages will assay out as low-level waste/mixed low-level waste and can be processed with existing capabilities and facilities. New waste processing capabilities and/or facilities are required for about 10,800 m^3 of waste.

Several waste characteristics were evaluated on an individual container basis to identify the bounding conditions expected to be encountered during waste processing. The waste characteristics evaluated and the constraining values are:

- Volume – 66 m^3
- Container Size – 20 ft x 13 ft x 11 ft (Note that this is the largest primary, secondary, tertiary dimension for all containers, not the dimensions of the container with the largest volume)
- Weight – 38,000 kg (83,000 lb)

- Plutonium Mass – 2,100 g
- Unshielded Container Surface Contact Dose Rate – 20,000 rem/hr (unpackaged waste will have a higher activity)

Historical data are often incomplete or unavailable and assumptions must be made about the waste characteristics. Assumptions have been noted in the following discussion of the waste characteristics. The following sections discuss each waste type, with subsections on the different sources of waste.

2.1 CH MLLW

In some instances, RH MLLW shielded to CH levels may have been identified in SWITS as CH MLLW. Waste containers that indicate the presence of lead shielding are assumed in this report to be RH MLLW.

2.1.1 CH MLLW in Above-Ground Storage

There are six containers identified in SWITS as containing large (>10 m^3) CH MLLW. All six containers are identified as metal boxes. The largest of these containers measures 17.7 ft × 9.7 ft × 13.6 ft and contains exhauster system equipment from underground storage tanks. The largest dimension from the remainder of these containers is 12 ft. There is potential to treat up to five of these large CH MLLW containers using existing capabilities. Table 2.2 lists the six large containers individually.

Table 2.2. Treatment Options for Large CH MLLW in Above-Ground Storage

Container ID	Size (m^3)	Gross Weight (kg)	Disposition Comments
Potential existing capabilities for treatment			
3597-9-151	13	1,970	Awaiting CERCLA authorization prior to macroencapsulation.
EFSG-95-1666	12	2,550	Waste contains PCBs, requires sorting of non-conforming items.
3597-6-98	12	1,960	Awaiting CERCLA authorization prior to macroencapsulation.
3597-6-100	11	1,940	Awaiting CERCLA authorization prior to macroencapsulation.
3597-6-101	11	2,000	Awaiting CERCLA authorization prior to macroencapsulation.
Sub-Total	60	10,420	
No existing capabilities for treatment			
9519114	66	6,900	Too large for commercial treatment.
Totals	126	17,320	

The total mass of CH MLLW in permitted above-ground storage is approximately 17,320 kg. Approximately one-third of that total is assumed to be waste weight. The heaviest of the containers in this group weighs approximately 6,900 kg. Weights are included in this inventory to estimate the number of containers generated from waste processing.

2.2 RH MLLW

The SWITS database indicates handling (i.e., CH vs. RH) as well as waste type and the presence of shielding. In some instances, RH MLLW shielded to CH levels may have been identified in SWITS as CH MLLW. Waste containers that indicate the presence of lead shielding or have a contact dose rate greater than 200 mrem/hr are assumed in this report to be RH MLLW. It is also assumed that any CH MLLW identified in SWITS as LDR treatment code MLLW-07 that is smaller than 10 m^3 is also RH waste.

2.2.1 RH MLLW in Above-Ground Storage

A total of 47 containers containing 148 m^3 of waste have been identified as probable RH MLLW in above-ground storage. Of these, five are larger than 10 m^3 by container volume. The largest of these containers measures 9.7 ft × 8.6 ft × 6.2 ft. Twenty-four of the RH MLLW containers are metal boxes. The remainder consists of five 85-gallon drums and eighteen 55-gallon drums.

The total mass of the RH MLLW in permitted above-ground storage is 63,300 kg (Table 2.3). The majority of the weight is expected to consist of the container, shielding, and packing. The largest of the containers weighs approximately 7,900 kg, with three containers weighing more than 5,000 kg. Thirty-two weigh less than 1,000 kg gross weight.

Table 2.3. Weights (kg) of RH MLLW in Above-Ground Storage

Shielding	Number of Containers	Gross Weight (kg)	Waste Weight (kg)	Waste Percent
Large (>10 m^3)				
Lead	3	16,400	7,800	48%
None	2	9,900	6,500	66%
Sub-Total	5	26,300	14,300	54%
Non-Large (<10 m^3)				
Lead	21	20,700	6,900	33%
Steel	2	900	100	11%
Other	2	400	200	50%
None/Blank	17	15,000	9,300	62%
Sub-Total	42	37,000	16,500	45%
Totals	47	63,300	30,800	49%

The dose rate for these containers is measured at the container surface and is not representative of the dose expected from the waste. Fifteen of the RH MLLW containers have a dose rate of 100 mrem/hr or higher, with a maximum recorded dose rate of 1,700 mrem/hr.

2.2.2 Newly Generated RH MLLW

A total of 529 m^3 of waste is forecasted (see Figure 2.1) starting in FY 2006 and continuing through FY 2032. The waste comes from three sources: the Waste Treatment Plant (WTP), waste tank management activities, and the Waste Encapsulation Storage Facility (WESF). The dates for waste generation and waste receipt are based on current estimates of facility operations. Dates and volumes may change as better planning information becomes available.

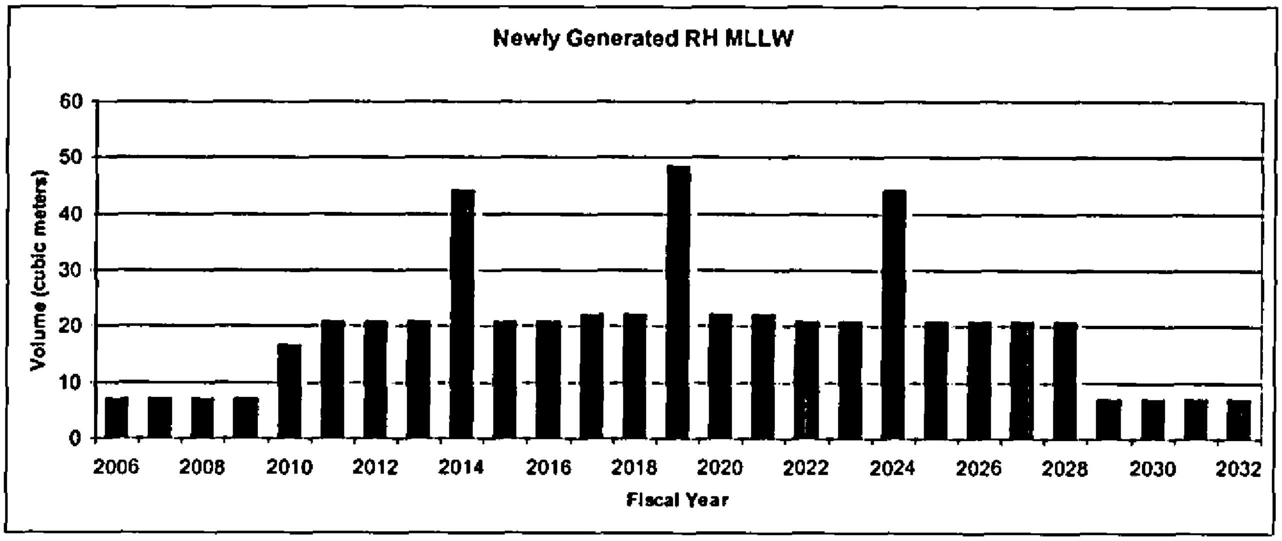

Figure 2.1. Annual Volumes of Newly Generated RH MLLW Requiring Treatment

The waste forecast by WTP is expected to be generated in association with normal operations and planned maintenance including routine filter and thermowell change-out. The waste is to be packaged in 55-gallon drums starting in FY 2010 and continuing through FY 2028 per SWIFT 2006.0. The waste is expected to be debris containing inorganics (65% by volume), metals (30% by volume), and organics (5% by volume).

The waste forecast by CHG is expected to be generated from activities associated with the management of the 200 Area Tank Farms. The waste from waste tank management activities is expected to be packaged in 5 ft x 5 ft x 9 ft metal boxes at the rate of one per year starting in FY 2006 and continuing through FY 2032. The waste is expected to be debris containing contaminated metal (80% by volume) and organics (20% by volume).

The waste forecast by WESF is expected to be packaged in 55-gallon drums at the rate of five per year starting in FY 2017 continuing through FY 2021. The waste is expected to be debris containing metals (50% by volume), inorganics (25% by volume), and plastic/rubber (25% by volume).

Waste weight and dose rate information is not collected from generators in the SWIFT forecasting process. The weights can be estimated using an assumed density of similar waste. The average density for RH MLLW in above-ground storage is approximately 425 kg/m^3. Using this density and applying it to the volume of forecasted RH MLLW, the total mass of newly generated waste would be 225,900 kg, with the containers weighing on the order of 3,000 kg per box and 110 kg per drum.

2.3 CH TRU Waste in Medium and Large Containers

In some instances, RH TRU waste shielded to CH levels may have been identified in SWITS as CH TRU waste. Waste containers that indicate the presence of lead shielding are assumed in this report to be RH TRU waste.

2.3.1 CH TRU Waste in Above-Ground Storage

CH TRU waste in above-ground storage is located primarily in the CWC. Some waste is stored at the 212-N Fuel Storage Building, T Plant, and temporarily at the WRAP as it is prepared for shipment to WIPP.

There are nearly 2,100 containers of CH TRU waste in above-ground storage, comprising a volume of 2,470 m^3. Thirty-nine of these containers are designated as large containers; the largest measures 15.5 ft × 16.8 ft × 7.8 ft, and five containers have a volume greater than 20 m^3. The largest CH TRU waste container stored at CWC measures 17 ft × 7 ft × 5 ft.

The total mass of CH TRU waste in above-ground storage is estimated to be approximately 921,300 kg. Less than half of that mass is estimated to be waste weight; the remainder is container, packaging, and shielding. The heaviest of these containers weighs 25,100 kg and is also the largest in waste volume (43 m^3). Six containers are known to weigh more than 10,000 kg.

The weight of the CH TRU waste, as opposed to the weight of the container, packaging, and shielding, is not recorded in all instances in SWITS. Table 2.4 identifies the number of records and the masses of those containers that have both gross and waste weight identified. The majority of CH TRU waste containers in above-ground storage have both identified; however, several of the larger containers do not.

2.3.2 Retrievably Stored CH TRU Waste in the LLBGs

The retrievably stored CH TRU waste in the LLBGs (which includes the portion that is expected to assay out as MLLW) was packaged in several different types of containers. Each of these is described in this section.

Drums – There is nearly 140 m^3 in 110-, 85-, 55-gallon, and miscellaneous drums in 396 containers. Many of these containers contain lead shielding and are identified as CH in SWITS.

Fiberglass Reinforced Plywood Boxes – There is more than 4,700 m^3 in fiberglass reinforced plywood (FRP) boxes in 189 containers. The largest of the FRP boxes measure 20 ft × 12.7 ft ×

9 ft (65 m^3). A total of 126 of these boxes are larger than 10 m^3, and the majority of those (95) are larger than 20 m^3.

Metal Boxes – There is approximately 885 m^3 of metal boxes within 156 containers. The largest of these containers measures 20 ft × 8 ft × 8 ft (36 m^3). Thirty-four of the metal boxes are larger than 10 m^3 while 54 are smaller than 1 m^3.

Table 2.4. CH TRU in Above-Ground Storage

	Number of Containers	Volume (m^3)	Gross Weight (kg)	Waste Weight (kg)	Waste Percent
Gross and Waste weights identified					
Medium	2,037	1,824	690,400	348,800	51%
Large	29	397	94,000	44,000	47%
Gross weight only identified					
Medium	10	37	21,100	NA	NA
Large	8	180	104,000	NA	NA
Waste weight only identified					
Medium	12	6	NA	600	NA
Large	1	15	NA	900	NA
Neither Gross nor Waste weights identified					
Large	1	13	NA	NA	NA
Estimated Totals					
Medium	2,059	1,867	713,700	360,600	51%
Large	39	606	207,600	97,200	47%
Totals	2,098	2,473	921,300	457,800	50%

Concrete Boxes – Approximately 135 m^3 of waste is in concrete boxes in 22 containers. Only three are large containers; the largest measures 19.6 ft × 10.6 ft × 8 ft (48 m^3) and contains waste generated at the Plutonium Finishing Plant (PFP). The majority of the containers are less than 1 m^3.

Miscellaneous – The remaining 200 m^3 of CH TRU suspect waste is packaged in a total of 68 miscellaneous containers. These consist of boxes of unidentified construction and items such as HEPA filters, glove boxes, and ion exchange equipment. Four of these containers are greater than 10 m^3.

The heaviest of the CH TRU suspect waste containers holds more than 37,600 kg of waste generated at PFP and is within a concrete box measuring 19.6 ft × 10.6 ft × 8.3 ft. A total of 58 containers have a weight in excess of 10,000 kg, and approximately half of those are larger than 35 m^3. Over one-half of the containers have a mass less than 1,000 kg.

The majority of the SWITS records for the CH TRU suspect containers do not list waste weight. Table 2.5 lists the number of containers by container type that identify both gross and container weight. The total mass of the CH TRU suspect waste to be processed is approximately 2,006,300 kg. Extrapolating from the known waste weight percents, approximately 69%, or 1,383,000 kg, is waste; the remainder consists of the container, packaging, and shielding.

Table 2.5. Retrievably Stored CH TRU Waste in the LLBGs

	Number of Containers	Volume (m^3)	Gross Weight (kg)	Waste Weight (kg)	Waste Percent
Gross and Waste weights identified					
Drums	284	94	34,500	16,200	47%
FRP	4	78	14,200	10,000	70%
Metal	27	208	85,700	49,000	57%
Other	2	16	40,000	40,000	100%
Gross weight only identified					
Drums	62	28	11,400	NA	NA
FRP	185	4,691	1,348,100	NA	NA
Metal	128	641	273,500	NA	NA
Concrete	22	135	95,700	NA	NA
Other	66	185	81,900	NA	NA
Waste weight only identified					
Drums	50	16	NA	1,300	NA
Metal	1	36	NA	1,000	NA
Estimated Totals					
Drums	396	138	51,900	24,400	47%
FRP	189	4,769	1,362,300	959,400	70%
Metal	156	885	374,500	214,100	57%
Concrete	22	135	95,700	63,200	66%
Other	68	201	121,900	121,900	100%
Totals	831	6,129	2,006,300	1,383,000	69%

2.3.3 Newly Generated CH TRU Waste

The majority of forecasted CH TRU waste is packaged in WIPP-compliant containers, either 55-gallon drums or standard waste boxes (SWBs). Only three generators, K Basins, the Plutonium Finishing Plant (PFP), and the 327 Building, have forecast non-WIPP-compliant containers with a total volume of 456 m^3. K Basins forecasts CH TRU waste in the form of a concrete monolith measuring 29.5 ft long, 13.1 ft wide, and 8.2 ft high (90 m^3) and four ion exchange modules measuring 8.8 m^3 each, for a total of 125 m^3. The monolith consists of six ion exchange columns and some water filters encapsulated together. The monolith will require some size reduction prior to receipt for processing. PFP forecasts large IP-2 containers associated with cleanup activities at the facility. The 327 Building forecasts generating two containers of CH TRU waste packaged in metal boxes measuring 4 ft × 4 ft × 8 ft. The waste consists of ion exchange column parts.

The weights are not provided in the SWIFT forecast; however, using a density of 2,400 kg/m^3 for concrete, the total weight of the concrete monolith would be approximately 216,000 kg.

Assuming an average density of concrete for the monolith and ion exchange modules and an average density for CH TRU waste in above-ground storage and the TRU retrieval trenches of 320 kg/m^3, the gross weight of newly generated CH TRU waste would be approximately 405,000 kg.

2.4 RH TRU Waste

The SWITS database indicates handling as well as waste type and the presence of shielding. On occasion, RH TRU waste shielded to CH may have been identified in SWITS as CH TRU waste. Waste containers that indicate the presence of lead shielding or have a contact dose rate of greater than 200 mrem/hr are assumed in this report to be RH TRU waste.

2.4.1 RH TRU Waste in Above-Ground Storage

A total of 266 m^3 of RH TRU waste is stored above ground in 353 containers. The waste is stored primarily at burial ground 218-W-3AE, T Plant, and the CWC. The total mass of RH TRU waste in permitted above-ground storage is approximately 728,300 kg (see Table 2.6). Approximately 14% of that weight is estimated to be actual waste; the rest is container, packaging, and shielding weight. Eighteen containers are heavier than 10,000 kg and each contains either lead or steel shielding.

Table 2.6. RH TRU Waste in Above-Ground Storage

Number of Containers	Volume (m^3)	Gross Weight (kg)	Waste Weight (kg)	Waste Percent
Gross and Waste weights identified				
352	264	721,900	99,900	14%
Waste weight only identified				
1	2.3	NA	100	NA
Estimated Totals				
353	266	728,300	100,000	14%

RH TRU waste contained in Hittman liners has the highest measured dose rate of the containers. The highest recorded container surface spot dose rate is 20,000 rem/hr measured at the bottom surface of one of the containers. The average container dose rates for the liners range from 0.4 to 720 rem/hr. See Table 2.7.

Table 2.7. Dose Rates of RH TRU Waste Containers in Above-Ground Storage

Dose Rate (mrem/hr)	Number of Containers
>100,000	10
>10,000	33
>1,000	16
>200	26
<200	268
Total	353

2.4.2 Retrievably Stored RH TRU Waste in the LLBGs

There is a total of 240 m^3 of retrievably stored RH TRU waste in the LLBGs (which includes the portion that is expected to assay out as MLLW) to be processed. The waste includes containers in LLBG trenches as well as hot cell waste stored in the LLBG caissons. The caisson waste was generated in the 300 Area hot cells and is packaged mainly in 1-gallon paint cans. The remainder of the caisson waste is 2- and 5-gallon cans and plastic wrapped equipment.

The largest of the trench waste containers measures 20 ft × 8 ft × 8 ft and has a surface dose rate of 330 mrem/hr. The heaviest of the RH TRU waste containers is over 4,000 kg and thirty-six containers weigh more than 1,000 kg. The majority of the containers have a mass less than 50 kg.

The total weight of the retrievably-stored RH TRU waste in the LLBGs is approximately 159,000 kg. Very few container records list both gross weight and waste weight; however, it is assumed that the majority of the waste will be container, packaging, and shielding weight. Assuming the same waste weight percentage, 14%, as the RH TRU in above-ground storage, the waste weight of the RH TRU would be 22,300 kg.

The highest recorded dose rate for RSW is 30,000 mrem/hr in a 55-gallon drum. Seven containers have dose rates in SWITS listed at greater than 5,000 mrem/hr. The dose rate from caisson waste is not precisely known. A dose rate of 1,800 rem/hr was measured in the caissons at up to 1,800 rem/hr in 1985 (Rockwell 1985); however, this was a gross caisson measurement. The dose rates of individual containers are unknown.

2.4.3 Newly Generated RH TRU Waste

A total of 1,009 m^3 is forecast (Table 2.8 and Figure 2.2) to be received for processing between FY 2006 and 2032. The majority of the waste is related to the treatment of sludge from the cleanup of the 105-K basins and cleanup and closure of Hanford's waste tanks. The treated sludge will be packaged in 55-gallon drums containing a sludge/grout mixture. The Tank Closure waste is packaged in shielded metal boxes measuring 4 ft × 4 ft x 8 ft and containing mostly contaminated metal.

Table 2.8. Newly Generated RH TRU Waste (cubic meters)

Generator	Drums	Medium	Total
Balance of Sludge	450		450
Tank Closure		359	359
618-10/111 Burial Grounds	10	92	102
Waste Treatment Plant	37		37
M-91 Facility	33		33
PNNL	27		27
Totals	558	451	1,009

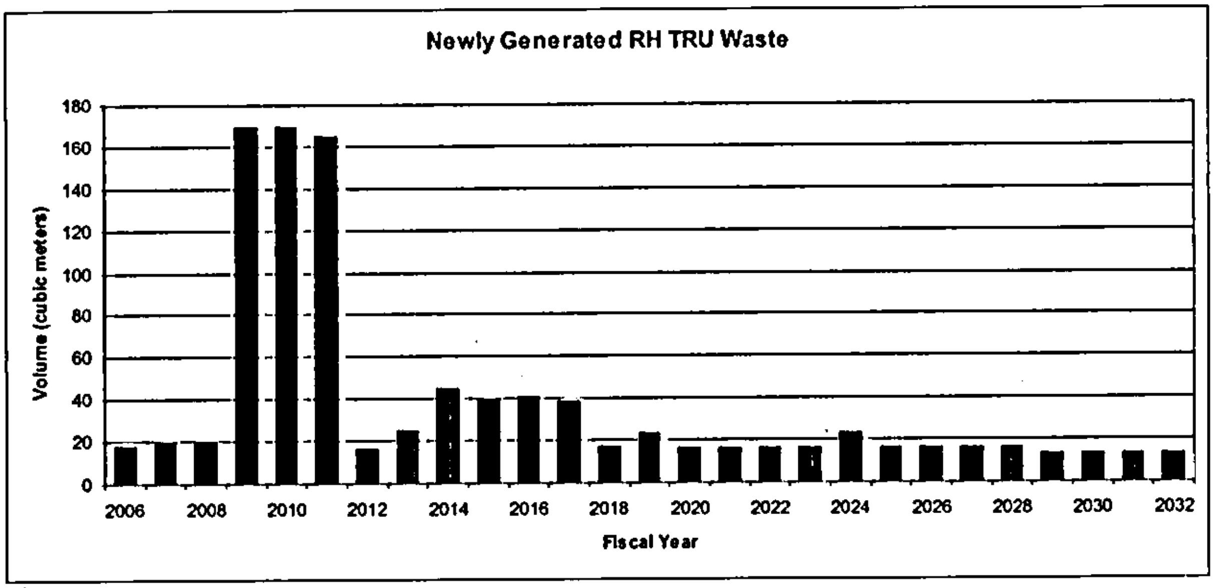

Figure 2.2. Newly Generated RH TRU Waste

The 618-10 and 618-11 Burial Grounds contain a number of trenches, caissons, and vertical pipe units (VPU) that were used between 1954 and 1967. Although this waste was disposed of pre-1970, the decision has been made to retrieve this waste, treat as necessary, and send the TRU waste to WIPP for disposal. The caissons and VPUs are assumed to contain primarily RH TRU waste.

RH TRU waste forecast in SWIFT 2006.0 consisting of waste from the waste tanks is not included in this report.

2.5 Container Size and Weight Summaries

The total volume requiring treatment or handling is approximately 11,400 m^3. The total by gross weight is approximately 6,300,000 kg (Table 2.9). Records exist for gross weight for nearly all containers in above-ground storage and for the retrievably stored waste in the LLBGs. Estimates for the forecasted waste were based on densities of similar waste types.

Table 2.9. Gross Weight Summary (thousands of kg)

Waste Type	Above Ground Storage	Retrievably Stored Waste	Forecast	Total
CH MLLW	7	-	-	7
RH MLLW	31	-	110	141
CH TRU	458	1,383	305	2,146
RH TRU	100	22	243	365
Totals	595	1,405	658	2,659

The SWITS records for waste in above-ground storage and for retrievably stored waste in the LLBGs are much less reliable for calculating actual waste weight. Approximately 88% of the records by volume in above-ground storage list both the gross and waste weight; however, only 14% of the records by volume for the retrievably stored waste list both. Assuming average densities for similar waste, the total waste weight to be processed is approximately 2,700,000 kg (Table 2.10) or roughly 42% of the total weight.

Table 2.10. Waste Weight Summary (thousands of kg)

Waste Type	Above Ground Storage	Post-1970 LLBGs	Forecast	Total
CH MLLW	7	-	-	7
RH MLLW	31	-	110	141
CH TRU(M)	458	1,383	305	2,146
RH TRU(M)	100	22	243	365
Totals	595	1,405	659	2,659

The waste discussed in this chapter is forecast in many different containers in variety of configurations. A complete list of containers is provided in Appendix B. The recorded dimensions in SWITS do not always identify length, width, or height. The largest container by volume is 66 m^3 and contains CH MLLW and measures 17.7 ft × 9.7 ft × 13.6 ft. The largest individual dimensions for containers listed in SWITS are 20 ft (primary dimension), 13 ft (secondary dimension), and 11 ft (tertiary dimension).

2.6 Plutonium Inventory

The amount of plutonium to be processed, as well as the maximum possible facility loading at any one time, is of particular importance to the processing operations. Facility operations are likely to be affected by the total mass of plutonium in process at any one time.

The plutonium inventory for waste in above-ground storage and retrievably stored waste is calculated using SWITS records. Prior to 1976, the common practice was to record a single plutonium inventory for a package. Since then the inventory is recorded by isotope for each package. The SWIFT forecast requests radioactive concentrations, measured in curies per cubic meter. The plutonium concentrations are multiplied by volume to determine the activity, and then a conversion factor is used to estimate the inventory. See Table 2.11.

A total of 130 kg of plutonium is present in the waste requiring processing in T Plant. Nearly all, as expected, is in TRU waste with nearly equal amounts in above-ground storage and retrievably stored in the LLBGs. The forecast plutonium inventory is nearly all from the K Basin sludge waste.

Table 2.11. Plutonium Inventory (kg)

Waste Type	Above Ground Storage	Retrievably Stored Waste	Forecast	Total
CH MLLW	0.0	-	-	0.0
RH MLLW	0.0	-	0.0	0.0
CH TRU	46	38	0.9	85
RH TRU	4.2	6.3	35	46
Totals	50	44	36	130

A small volume of waste accounts for a majority of the plutonium inventory. The top 1% of containers (3.8% by volume) contains 22% (~21 kg) of the plutonium. The container with the highest plutonium mass is a metal container located in the LLBGs that contains 2,100 g. See Table 2.12.

Table 2.12. Plutonium Distribution by Container

Pu g/cont	Volume (m3)	Pu (g)	Number of Containers
≥1000	15	3,509	2
500 ≤x<1000	8	1,625	2
400 ≤x<500	256	10,039	22
300 ≤x<400	80	5,602	16
200 ≤x<300	469	10,664	43
100 ≤x<200	1,042	28,863	199
50 ≤x<100	1,079	12,069	165
10 ≤x<50	1,802	18,028	907
5 ≤x<10	929	2,026	277
<5	3,701	2,090	2,722
Totals	9,381	94,515	4,355

2.7 Retrievably Stored Waste

It is assumed that 50% of the retrievably stored waste in the LLBGs will assay as low-level waste/mixed low-level waste. Table 2.13 revises Table 2.1 to include the reclassification of waste. The CH TRU suspect waste in medium boxes will not require processing in T Plant; this volume consists of 510 m^3.

Approximately 1,800 m^3 of the large retrievably stored CH TRU waste in the LLBGs is less than 35 m^3. Assuming one-half assays out as MLLW, more than 900 m^3 could be treated commercially based on the strategy presented in this Engineering Study. Nearly one-half, 60 m^3 (see Table 2.2), of the large CH MLLW in storage may be commercially treatable. Figure 2.3 shows the volumes provided in Table 2.13, along with information on the number of containers and the mass of plutonium.

Table 2.13. Volumes of Waste after Reclassification of Retrievably Stored Waste (m^3)

Waste Type	Container Size	Above Ground Storage	Retrievably Stored Waste	Forecast	Total
CH MLLW	Large	126	2,554	-	2,680
RH MLLW	Drum	4	15	334	353
	Small	-	12	-	12
	Medium	80	75	194	349
	Large	65	18	-	83
CH TRU	Medium	1,867	510	330	2,707
	Large	606	2,554	126	3,286
RH TRU	Drum	44	15	558	616
	Small		12	-	12
	Medium	216	75	451	742
	Large		18	-	18
Total		3,006	5,859	1,994	10,859

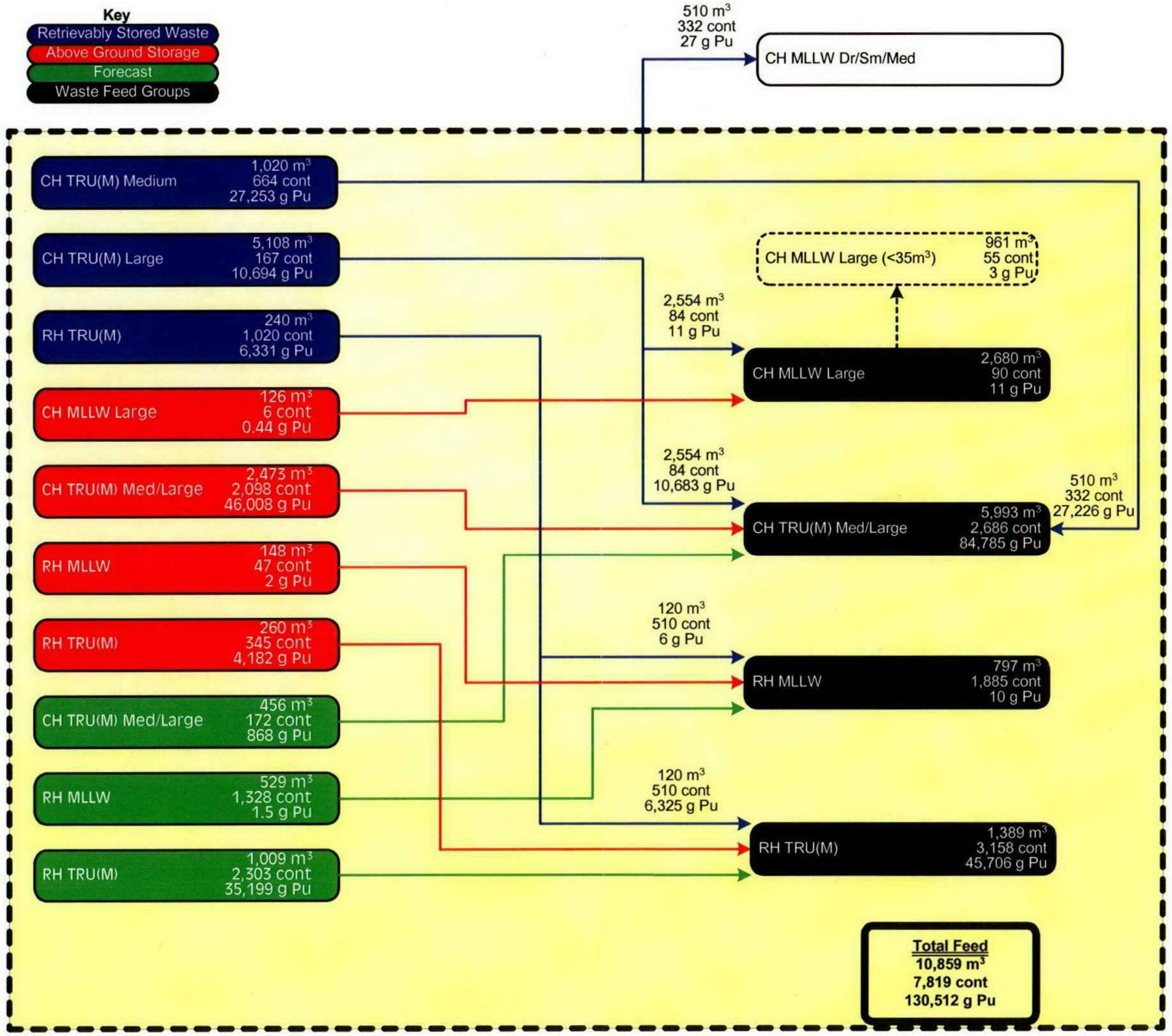

Figure 2.3. Waste Source Summary Chart

3.0 Waste Disposal

MLLW will be disposed in the Hanford LLBG MWTs (218-W-5, Trenches 31 and 34) and the ERDF. Future waste disposal is also planned at the Integrated Disposal Facility (IDF). CH TRU and RH TRU waste will be disposed at WIPP.

3.1 MWTs

The first MWT (218-W-5 Burial Ground, Trench 34) was built in 1993 and the second (218-W-5 Burial Ground, Trench 31) in 1994. Waste storage in Trench 34 began in 1997 and disposal operations began in 1999 after the leachate that is generated from the cell was accepted for treatment at the 200 Area Effluent Treatment Facility (200 ETF). Waste storage and disposal in Trench 31 began in 2003. Both MLLW trenches are RCRA-compliant and meet Subtitle C disposal requirements. They have a double-liner system with leachate collection (Figure 3.1).

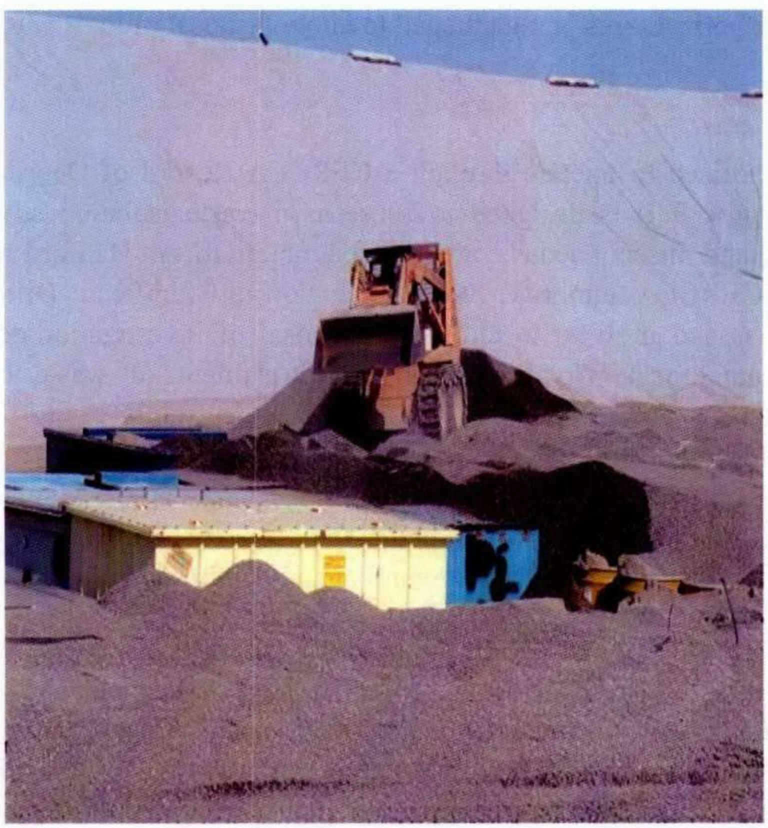

Figure 3.1. Container Disposal in the MWT

A substantial portion of Hanford's RCRA MLLW will be disposed in the MWTs. Waste for disposal in these units must meet the Hanford Site Solid Waste Acceptance Criteria (HSSWAC) (FHI 2005a). During 2004, the MWTs began accepting LLW for disposal due to the shutdown of the unlined portion of Hanford's low-level burial grounds. The MWTs are authorized to accept RCRA MLLW containing many different characteristic (e.g., Dxxx) and listed (e.g., Fxxx, Uxxx, and Pxxx) wastes codes for both storage and disposal. For a current list of acceptable waste code, see Table 3-1 in the HSSWAC. There also are safety-based and environmentally based limits on the radionuclide concentrations of waste received.

Each disposal trench has a free air volume capacity of approximately 24,000 m^3. The actual disposed waste capacity will vary for each trench depending on the size of the disposed waste packages and the number of operational lifts ultimately used in each trench. Trench 34 is approximately one-third full. These trenches are projected to be filled by 2016.

The HSSWAC sets forth the baseline criteria for acceptance of waste at the MWTs. The WAC ensure that waste can be managed within the operating requirements, including environmental regulations, DOE Orders, permits, nuclear safety requirements, waste analysis plans, performance assessments, and other applicable requirements. The HSSWAC identifies non-conforming waste items and container requirements. Regulatory approval of in-trench treatment of conforming MLLW is being pursued. In addition, a Toxic Substances Control Act Chemical Waste Landfill Authorization is being pursued to allow disposal of PCB waste.

3.2 ERDF

The ERDF is authorized to operate through a CERCLA Record of Decision (ROD) issued by EPA. ERDF (Figure 3.2) is designed to serve as a waste isolation structure for bulk soil, demolition debris, and miscellaneous contaminated material from Hanford remediation activities conducted under CERCLA authority. An Explanation of Significant Difference (ESD) to the ERDF ROD was issued in 1996 to allow for disposal of investigation-derived waste, and in 1997, a ROD amendment was issued allowing treatment of waste by encapsulation or stabilization. There is an additional ROD amendment currently going through the approval process that would authorize ERDF to dispose of additional quantities of MLLW that is/was generated under RCRA authority and other D&D activities at the Hanford Site, including a significant portion of the MLLW that is under the scope of this Engineering Study. Current plans have ERDF available to receive waste until closure in 2034.

The ERDF WAC (BHI 2002) sets forth the baseline criteria for acceptance of waste at ERDF. The WAC have been established to ensure that waste can be managed within the operating requirements, including environmental regulations, DOE Orders, permits, nuclear safety requirements, waste analysis plans, performance assessments, and other applicable requirements. The ERDF WAC identifies non-conforming waste items and container requirements.

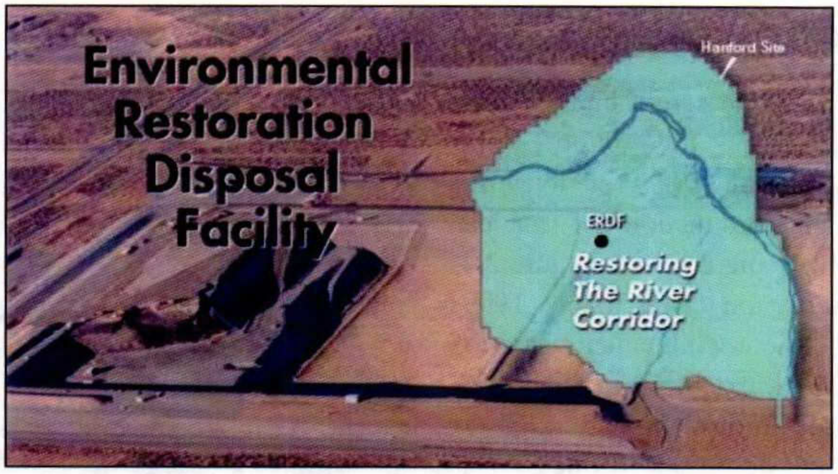

Figure 3.2. ERDF

3.3 IDF

The IDF (Figure 3.3) is a facility that consists of a single landfill with two separate expandable cells. One cell is permitted as a RCRA Subtitle C-compliant landfill system and the other will not be permitted under RCRA. Both landfill cells will include a double liner, a leachate collection and removal system, and a leak detection system. The landfill liner system complies with RCRA requirements for hazardous waste landfills. The IDF is designed to allow for future expansion. Each future liner construction project will connect the previously constructed liner and the operations systems and then extend the disposal area. The disposal landfill cover will be designed and located to satisfy the dangerous waste disposal requirements once a decision is made to construct the final cover over the landfill. Plans are to begin operations before reaching the capacity limitation of the current MWTs and to close IDF after 2035.

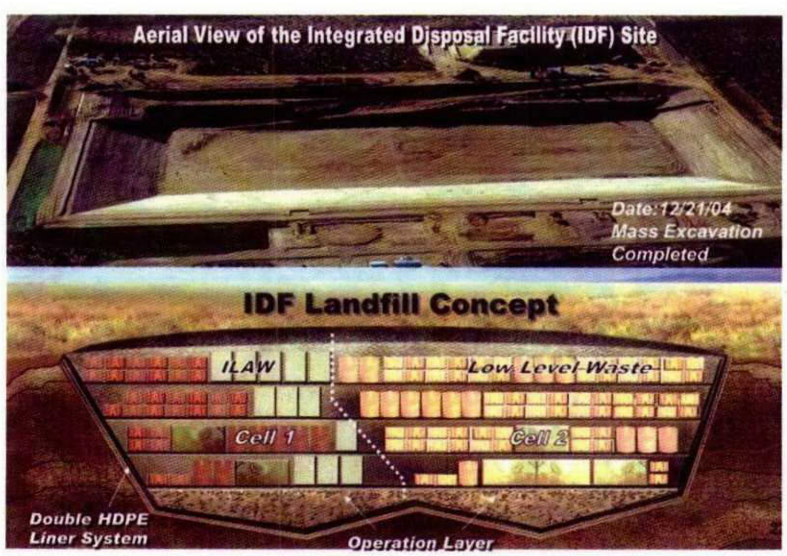

Figure 3.3. Conceptual Drawing of IDF

3.4 WIPP

The WIPP is the world's first underground repository licensed to safely and permanently dispose of TRU waste left from the research and production of nuclear weapons. WIPP, pictured in Figure 3.4, began operations on March 26, 1999. Situated in the remote Chihuahua Desert of southeastern New Mexico, project facilities include disposal rooms mined 2,150 ft underground in a 2,000-ft-thick salt formation that has been stable for more than 200 million years. Since WIPP opened in 1999, DOE has prioritized and planned the removal, repackaging, and shipment of about 141,000 m^3 of TRU waste to the repository. WIPP plans to close in 2033.

Figure 3.4. WIPP Transuranic Package Transporter Model 2

In 1980, DOE committed to transporting TRU waste to WIPP in U.S. Nuclear Regulatory Commission (NRC)-certified Type B containers. DOE chose to have the NRC approve these containers even though it is not required. To obtain approval, DOE must submit a safety report for each transportation container, demonstrating compliance with applicable regulations. Waste acceptance requirements are defined in DOE/WIPP (2005a). The Transuranic Package Transporter Model 2 (TRUPACT-II) designed to carry CH TRU waste and the RH-72B designed to carry RH TRU waste have been approved for TRU waste shipments to WIPP.

Each stainless steel TRUPACT-II (Figure 3.5) is approximately 8 ft in diameter and 10 ft high and constructed with leak-tight inner and outer containment vessels. The TRUPACT-II can hold up to fourteen 55-gallon waste drums, or two standard (63 ft^3 capacity) waste boxes (Figure 3.6), or one 10-drum overpack.

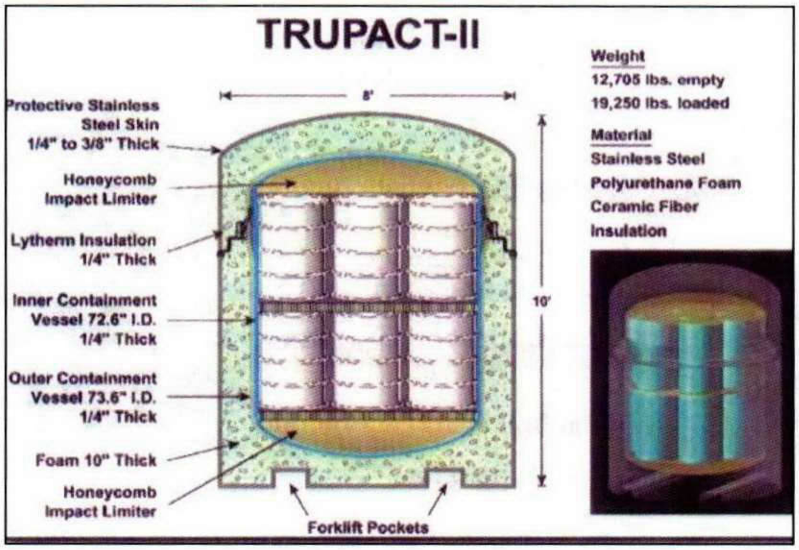

Figure 3.5. TRUPACT-II

Figure 3.6. WIPP SWBs

The RH-72B (Figures 3.7 and 3.8) was designed to safely transport RH TRU waste. The RH-72B is leak-tight and constructed with inner and outer containment vessels. A sealed payload container is loaded into the inner containment vessel. It is a large cylinder approximately 12 ft long and 3.5 ft in diameter. The cylinder fits into circular impact limiters, similar to shock absorbers, designed to protect the container and its contents in the event of an accident. The RH-72B has a 1 5/8-inch-thick lead liner to shield people from gamma rays. It also has an outer thermal shield to protect the container against fire damage. RH shipments are anticipated to begin in the near future. The RH-72B can hold three 55-gallon drums.

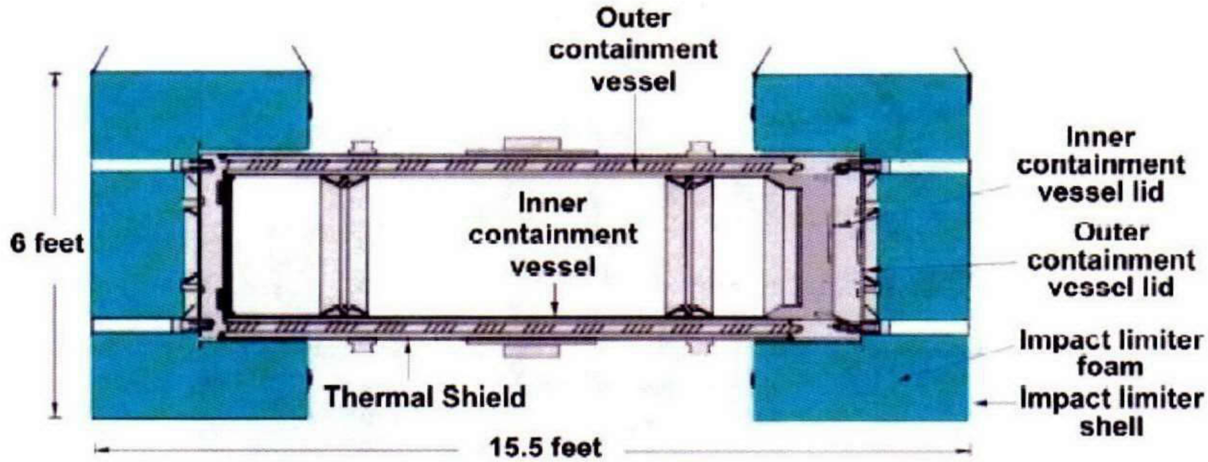

Figure 3.7. RH-72B

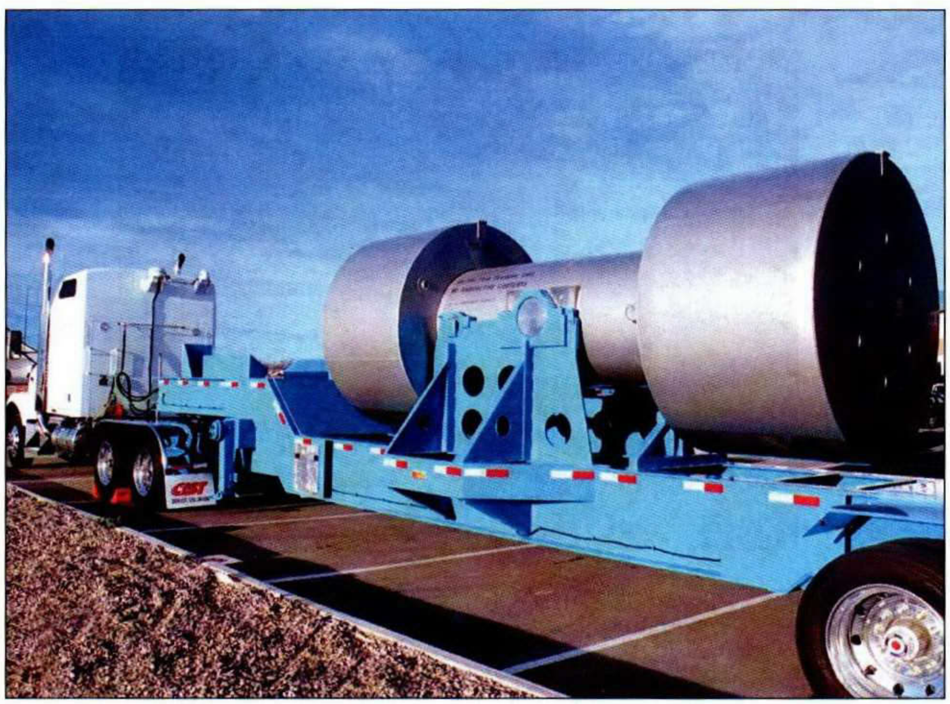

Figure 3.8. RH-72B Cask

4.0 Existing Waste Processing Facilities

4.1 Commercial Waste Processing

Existing capabilities at commercial facilities are being used to treat (e.g., macroencapsulation, thermal treatment, prohibited item removal) MLLW prior to disposal. Commercial facilities, within their license limits and container size and weight constraints, are being used to process MLLW in containers up to 15 m^3. Some commercial facilities may be able to handle small quantities of RH and CH TRU waste. About 9% of the 10,800 m^3 of waste that is the subject of this study could be processed if the use of commercial facilities was expanded to treat CH MLLW in larger packages up to 35 m^3.

4.2 T Plant Complex Waste Processing

The T Plant Complex (Figure 4.1) consists of the 221-T Canyon (Figures 4.2 and 4.3), the 2706-T Facility, and several support structures. The canyon has internal dimensions of 37 ft wide by nearly 800 ft long. There is 26 ft of clearance between the canyon deck and the crane rails. T Plant processing cells are 17 ft long, 13 ft wide, and 21 ft deep. The T Plant Canyon crane can lift 90,000 lb. Container size in the canyon is limited to less than 22 ft long, 13 ft high, and 18 ft wide. Current activities in the canyon facility include storage, verification, treatment, venting, sampling, and repackaging of CH and RH waste.

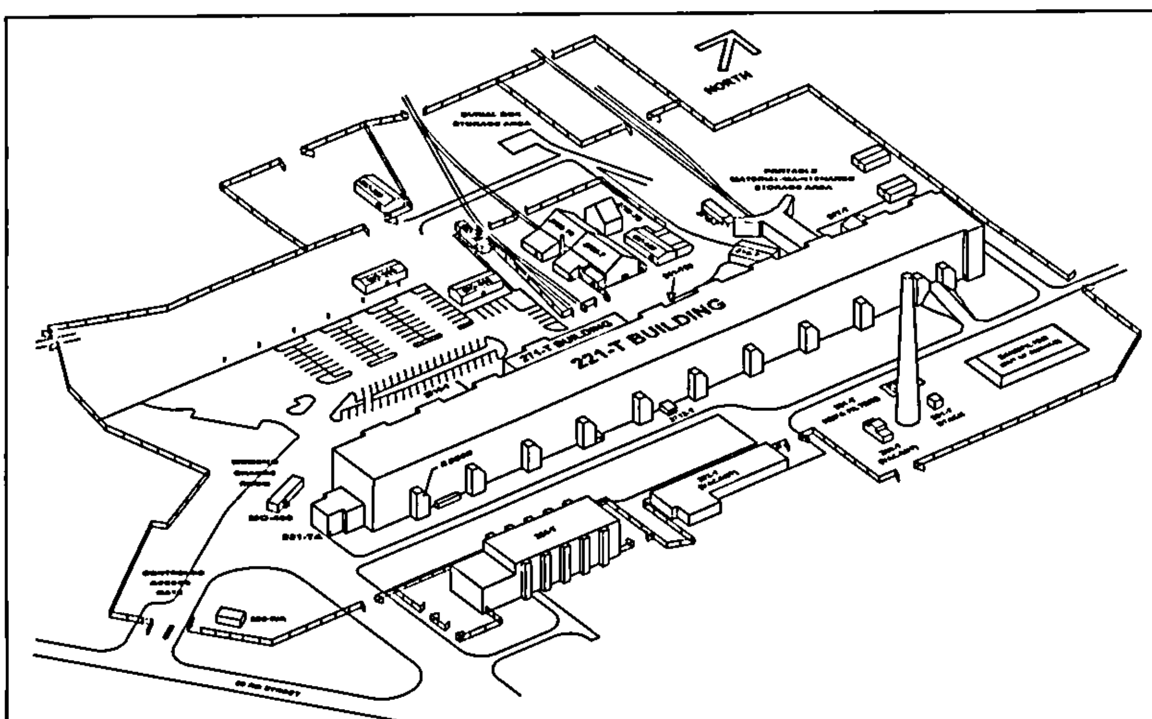

Figure 4.1. T Plant Complex

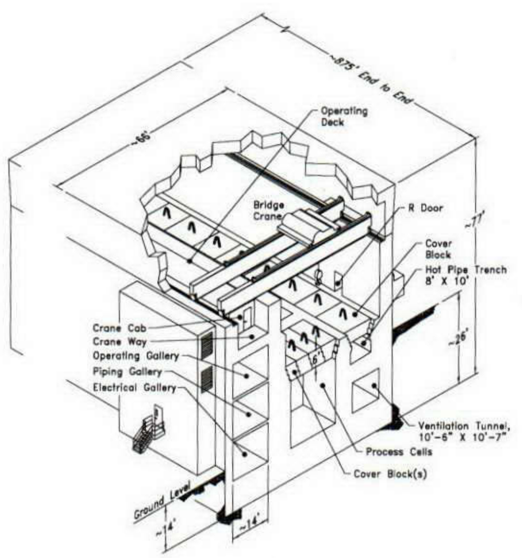

Figure 4.2. Typical Canyon Cutaway

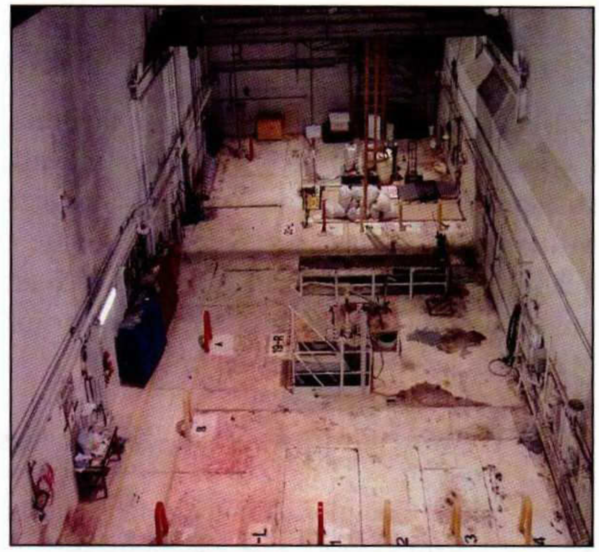

Figure 4.3. 221-T Canyon

The 2706-T Facility was upgraded in 1999 to provide secondary containment and leak detection for wet decontamination operations. Container size in the 2706-T Facility is limited to less than 40 ft long, 14 ft high, and 12 ft wide. The facility is limited to handling CH waste. Current activities at the facility include storage, verification, treatment, venting, sampling, and repackaging of CH waste.

The HSSWAC sets forth the criteria for acceptance of waste at the T Plant Complex. The WAC ensure that waste can be managed within the operating requirements of the unit, including environmental regulations, DOE Orders, permits, nuclear safety requirements, waste analysis plans, performance assessments, and other applicable requirements.

4.3 WRAP Waste Processing

The WRAP (Figure 4.4) was designed to process 55-gallon drums of CH TRU waste to meet WIPP WAC and to package 55-gallon drums, 85-gallon drums, and SWBs into TRUPACT-II (Figure 4.5) containers for shipment to WIPP. WRAP also has automated processes to examine and characterize waste using x-ray (nondestructive examination), gamma, and neutron assay (nondestructive assay) equipment.

The HSSWAC sets forth the baseline criteria for acceptance of waste at WRAP. The WAC ensure that waste can be managed within the operating requirements of the unit, including environmental regulations, DOE Orders, permits, nuclear safety requirements, waste analysis plans, performance assessments, and other applicable requirements.

Figure 4.4. WRAP Facility

Figure 4.5. Loading the TRUPACT II with TRU Waste Drums in WRAP

4.4 Central Waste Complex Waste Staging

The CWC, a series of buildings conforming to RCRA requirements, receives and stores MLLW and TRU waste in a safe and regulatory compliant manner. The design storage capacity is approximately 81,000 55-gallon drum equivalents. The operational capacity is about 64,000 drum equivalents. See Figure 4.6.

Figure 4.6. Waste Storage at CWC

All newly generated waste must meet acceptance criteria set by the Hanford Site Solid Waste Acceptance Program. The WAC was established to ensure that waste can be managed within the operating requirements of the unit, including environmental regulations, DOE Orders, permits, nuclear safety requirements, waste analysis plans, performance assessments, and other applicable requirements.

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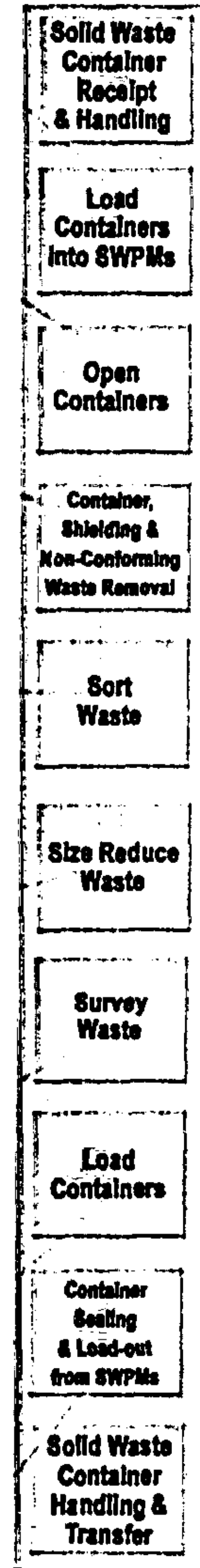
5.0 Waste Processing Analysis

5.1 Use of Commercial Treatment Capabilities



As indicated earlier, commercial facilities are being used to process (e.g., macroencapsulate, remove prohibited items, repackage) contact-handled (CH) MLLW in packages up to 15 m^3. Use of commercial facilities will be expanded to treat CH MLLW in larger packages up to 35 m^3. An estimated 961 m^3 of large-package CH MLLW up to 35 m^3 that is in above-ground storage, retrievably stored waste, or is forecast to be generated would be treated using the expanded commercial treatment capabilities. Plans are to have the expanded commercial treatment capabilities available by 2008 and the 961 m^3 of large-package CH MLLW up to 35 m^3 treated by 2012.

5.2 Expanded Use of the T Plant Complex

Hanford's T Plant Complex will be upgraded to process CH MLLW in packages greater than 35 m^3, RH MLLW, and RH TRU waste. These upgrades will allow processing of packages measuring up to 20 ft x 13 ft x 11 ft, weighing up to 83,000 lb, having does rates (unshielded at the container surface) up to 20,000 rem/hr, and containing up to 2,100 g of plutonium. Preliminary scheduling indicates the expanded capabilities would be available for use by June 30, 2016 to process 600 m^3 per year of TRU waste and 300 m^3 per year of MLLW.

5.3 Required Processing Functions at T Plant

The *Initial Engineering Study and Functions* report described the processing functions required for T Plant to have the capabilities to process MLLW and TRU waste in containers to meet waste acceptance criteria for disposal (Appendixes C, D, E, and F). New functions include (see illustration in sidebar):

1. Solid waste container receipt and handling
2. Loading containers into the process
3. Opening the containers
4. Removal of non-conforming waste[1]
5. Sorting waste
6. Size reducing waste to meet packaging requirements
7. Surveying waste to determine if the waste is CH or RH
8. Loading containers
9. Container sealing and load-out from the process (including RH TRU waste assay)

[1] Items not consistent with waste profile or prohibited items.

10. Solid waste container handling and transfer.

5.4 Remote Processing Feasibility

Pacific Northwest National Laboratory (PNNL) assessed and provided general guidance on the following issues:

- Remote processing feasibility
- What remote equipment would be required, and to what extent is that equipment available commercially off-the-shelf
- The extent to which technology development is required
- The feasibility of siting the proposed facility within T Plant.

PNNL issued the *Solid Waste Processing Center Primary Opening Cell Remote Equipment Report*, PNNL-15779, which addressed these issues (Appendix G). PNNL concluded that, based on its analysis of the preliminary information of the processing requirements, remote processing within T Plant appears to be technically feasible. In performing this assessment, information was gathered on other remote facilities across the DOE complex, including the West Valley Remote-Handled Waste Facility, the Idaho Advanced Mixed Waste Treatment Project, and the Oak Ridge Spallation Neutron Source Target Facility. Experts in the fields of hot cell operation, TRU assay, and criticality safety were interviewed, and detailed discussions were conducted with major equipment vendors. PNNL stated that remote systems/equipment/tool testing was essential to the project success. Types of equipment needed to process the waste are provided in Table 5.1.

Table 5.1. Basic Example Equipment

Equipment Type	Estimated Number	Non-Inclusive Vendor List	In-Use Location
Heavy Lift	1-3	ACECO, Ederer	1
Gantry	2	PaR Systems, BMI Automation	2,4
Heavy Duty Articulated Manipulator	4-12	Shilling, PaR Systems, Fanuc, Kraft	3,4
Transport		Automated Solutions, Inc., Conveyer & Castor	
Camera	20	*Rad Hardened:* Roper Resources Ltd, Thermo Electron Corp., IST, SIRA *Non-Rad Hardened:* Industrial Video Systems, Inc., Sony, Panasonic, etc.	1,2,3,4
Shredder	1-3	SSI	4
Hydraulic Boom	1-2	Case, Cat, John Deere, Brokk	1,3,4

Location Key:
1 = Hanford, WA – Spent Fuel Handling, Tank Farms
2 = West Valley, NY – Remote-Handled Waste Facility
3 = Oak Ridge, TN – Spallation Neutron Source Target Facility, CP-5 Program[2]
4 = Idaho Falls, ID – Security Training Facility[3], Advanced Mixed Waste Treatment Project

Figures 5.1 through 5.8 show pictures of some of the types of processing equipment and tools needed.

[2] DOE/EM-0389, Technology Summary Report, Dual Arm Work Platform Teleoperated Robotics System, Office of Environmental Management, Office of Science and Technology, U.S. Department of Energy, December 1998

[3] DOE/EM-0597, Technology Summary Report, Modified Brokk Demolition Machine with Remote Operator Console, Office of Environmental Management, Office of Science and Technology, U.S. Department of Energy, September 2001.

Figure 5.1. Overhead Heavy Lift (Photograph courtesy of Zinter Handling, Inc.)

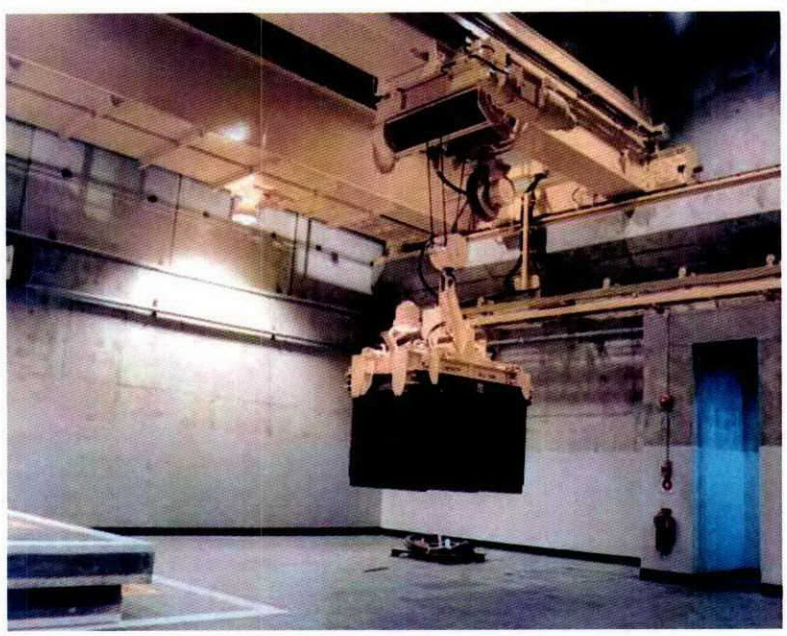


Figure 5.2. Overhead Heavy Lift Container Grappler (Photograph courtesy of American Crane and Equipment)

Figure 5.3. Gantry (Photograph courtesy of PaR Systems, Inc.)

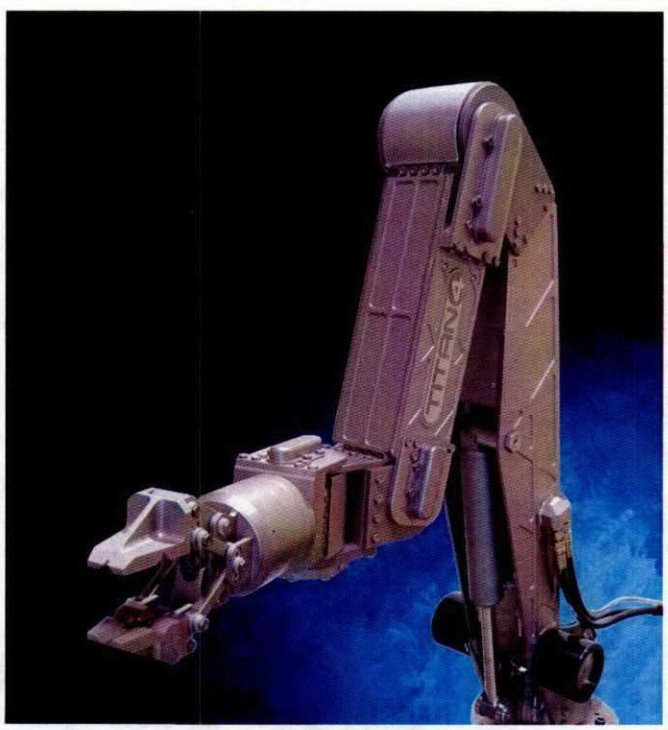


Figure 5.4. Hydraulic Manipulator (Photograph courtesy of Schilling Robotics, LLC)

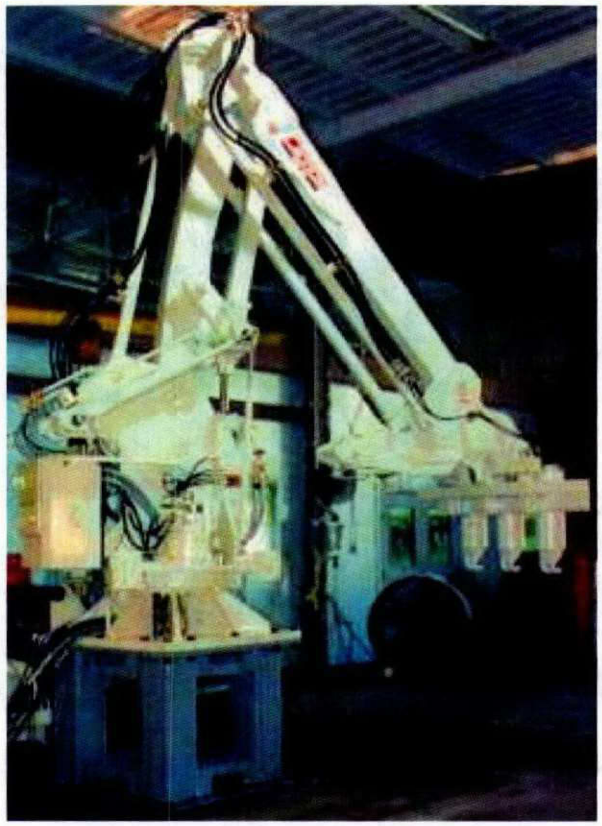


Figure 5.5. Hydraulic Boom

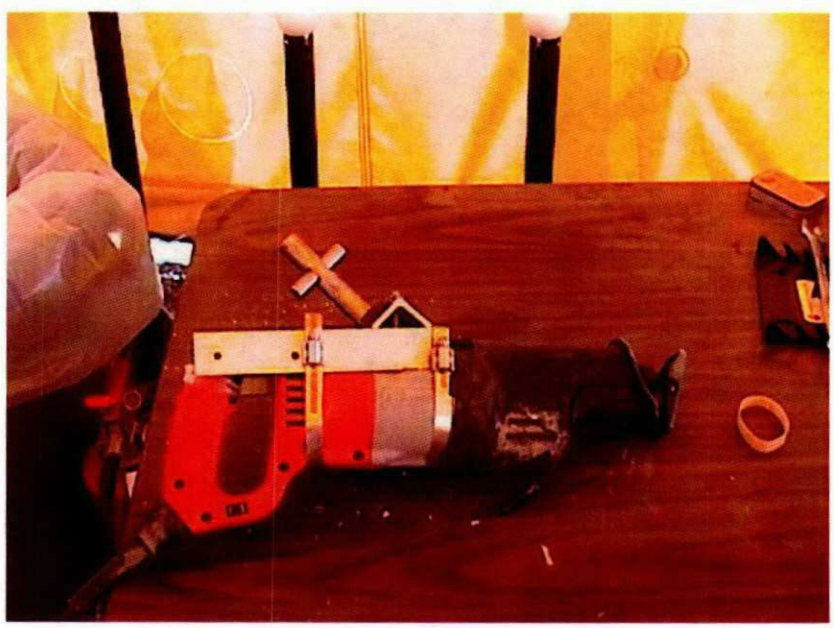


Figure 5.6. T-handle

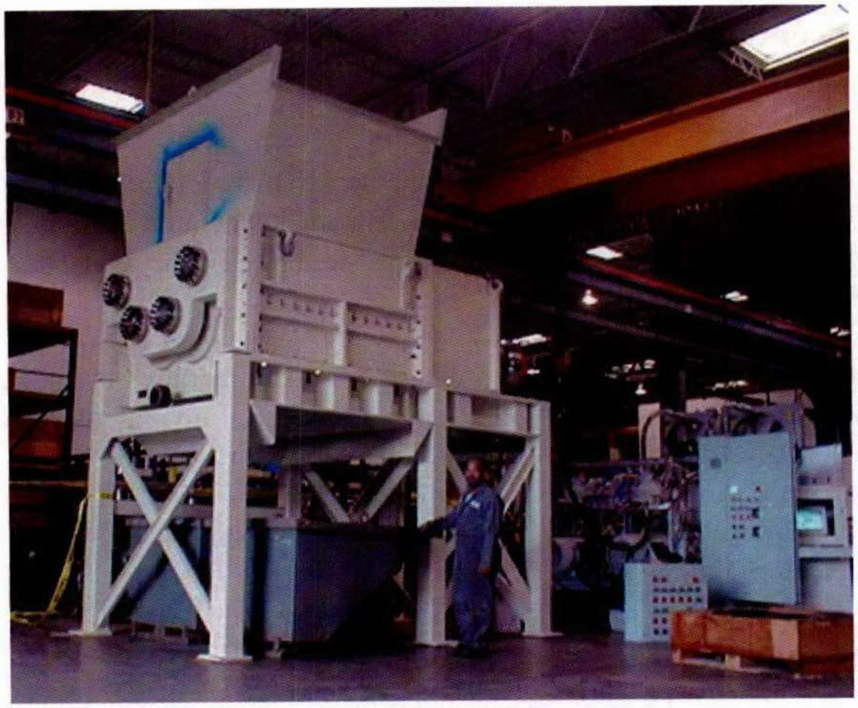


Figure 5.7. Shredder

Figure 5.8. Shredder Teeth (Photograph courtesy of SSI Shredding Systems, Inc.)

5.5 Pre-conceptual Design Assumptions and Background

It was assumed that:

- All waste received at T Plant must be in containers that are CH or are shielded to CH levels. RH waste containers will be over-packed into shielded containers for transport to and receipt at T Plant. Upon receipt into the SWPMs load-in airlocks, the over-pack will be removed and loaded-out for reuse.

- Transporting large containers, up to 66 m^3, from on-site facilities to T Plant is viable. On-site shipping of waste packages will be in accordance with Safety Analysis Reports for Packaging (SARPs), One-Time Shipment Request (OTSR), etc.

- Waste feeds will meet existing T Plant waste acceptance criteria and process inventories will be within inventory limitations.

- LDR compliant MLLW will be disposed in the MWT, ERDF or future IDF.

- TRU waste meeting the requirements of the WIPP WAC will be disposed at WIPP

With modifications, T Plant can process very large containers of CH MLLW using techniques similar to commercial processes. New capabilities would need to be added to T Plant to handle the large sizes and weights of the containers requiring processing. The *Initial Engineering Study and Functions* Report issued in September 2005 (FH-0502947) discusses the new processing functions, provides background information on remote manipulators and gantry systems, provides general information on remote processing systems, and identifies potential remote equipment by process function. Containment facilities are required to control contamination and dose. Work could be performed by personnel in special work permit (SWP) protective clothing or remotely. New capabilities will include: cranes to lift and move containers within the containment facilities; new capabilities to open containers, new capabilities to size reduce waste and containers, new capabilities to remove and manage non-conforming waste, new capabilities to package containers for disposal, etc. In addition, many large CH MLLW containers have a greater potential of containing some RH MLLW after un-packaging, making it necessary to process the waste in facilities that are capable of handling RH waste.

CH TRU could be processed in a similar containment facility using personnel in special work permit (SWP) protective clothing or remotely. CH TRU waste processing would require additional contamination and fissile material controls (i.e., fresh air, additional airlocks). TRU waste containers and shielding will generate an estimated 1,400 m^3 of CH MLLW (note: separation of MLLW minimizes TRU waste volume to WIPP). Processing steps to handle and size reduce containers and the wide assortment of waste have risks to hands-on workers (e.g., projectiles from cutting). The risks to workers increase as the size of the container requiring processing increases, as well as with higher dose and alpha contamination levels.

Handling and processing non-conforming waste items further increases risk to hands-on workers (e.g., reactive metals). The ALARA challenges of processing large quantities of CH TRU waste warrants handling this material remotely. Processing RH waste will require remote operated capabilities for dose and containment.

Options on where to process these wastes include construction of a new on-site facility, modification of an existing on-site facility, or shipping waste off-site. Previous Hanford studies (e.g., The 1993 *Engineering Study for Waste Receiving and Processing (WRAP) Facility Module 2)*[4] investigated the option of new facilities. The Idaho Cleanup Project Advance Mixed Waste Handling Facility (AMWHF) is a recent example of a CH TRU waste remote processing facility. The AMWHF has been in operation for a little over one year, and was designed and built at a cost of approximately $650 million. It runs 24/7/365 with a continuous influx of operators that basically hot bunk. When one operator gets fatigued, another replaces him/her and he/she goes on break or goes home. Facility throughput is estimated at about 8,000 cubic meters per year. The AMWHF handles only alpha contaminated, CH waste. The facility is limited to receiving standard sized wood boxes and metal 55-gallon drums. Hanford TRU waste would require size reduction prior to shipping, which eliminates any benefits that could be obtained from processing the waste at Idaho.

Each container is x-rayed before it is allowed into the AMWHF, and any container too shielded to see the equivalent of a light bulb filament inside the container is not allowed in. The facility then manually uses a PaR gantry with a giant cut-off saw to open the lids. The gantry is manually controlled because the operators have found that their "standard" 4 ft x 4 ft x 8 ft wood boxes are, in fact, all different sizes and shapes. After the box is open, all the contents are dropped onto a tray for sorting, sifting, size reduction by Brokks, or if they are drums, taken to a manual mechanical master slave manipulator (MSM) station for more dexterous cleanout. An additional PaR gantry is used for pick-and-place tasks. The boxes are shredded and the drums are compacted.

Operational feedback indicates that the Brokks may present serious maintenance issues if personnel cannot get their hands on them at all or very often. The AMWHF makes between three and five cell entries per week for decontamination and equipment maintenance. Most of those entries are related to the Brokks, to clean up leak points that are collecting contamination, replacing O-rings that have ruptured, and other nuisance maintenance. The facility regularly plans outages where they will shut down for four days to make 12 entries (between three and four hours each) to repair the three Brokks in the cell. It is reported that the demolition work (mostly jack-hammering waste items) that they do with the Brokks generates a significant amount of dust and airborne contamination.

The AMWHF has been generally pleased with the PaR systems and has not had any major downtime. The pick-and-place PaR system is maintenance free so far. The larger PaR with the cut-off saw has given them some challenges, but the problems are related to the Class I Div I Facility requirement. The special positive gas purge system and special tool plate required by that have been problematic. There have been two fires, neither of which caught waste on fire. The first one happened when the dust being collected from the cut-off saw plugged the vacuum hose and ignited. The second one happened when someone left a mop in the cell after a decontamination entry and sparks from the cut-off saw landed on the mop and ignited it. The AMWHF is now in the process of declassifying the facility to eliminate of the Class I Div I rating, which would allow them to go to a commercially available tool plate for the cut-off saw. The shredder works well and three wooden 4 ft x 4 ft x 8 ft boxes can be placed in the hopper at one time.

Other applicable off-site activities include:

- West Valley Demonstration Project – Approximately 75,000 ft^3 (2,124 m^3) of waste will be processed through the Remote Handled Waste Facility (RHWF) at the West Valley Demonstration Project (Hurst et al. 2004). After processing, the bulk of the waste is expected to be classified as LLW, CH TRU, RH TRU, and small amounts of mixed MLLW.

  The facility will use a bagless waste packaging systems, high purity germanium (HPGe) gamma assay systems, power manipulators, overhead and wall-mounted cranes, a shielded forklift, and floor conveyors. The goal for the RHWF is to process the least contaminated, lowest dose material first and then the highest contaminated, highest dose material over a four-year period.

  Waste inventory includes long-shafted pumps, spent resins, water filters, and crane components. The RHWF, at approximately 190 ft × 90 ft, will handle 13 different waste streams with varying sizes, weights, and contamination levels. The process flow is generally through a central corridor of three connected rooms: the receiving area, the buffer cell, and the heavily shielded work cell. The rooms have 30-inch reinforced concrete walls.

  Container processing in the shielded work cell will include opening the container; visually inspecting its internals; sampling, dewatering, segregating, and size-reducing large components using saws on power manipulators; nondestructive assaying; and repackaging. Waste removed from the facility will be packaged in 55-gallon TRU drums or B-25 (carbon-steel) waste boxes.

- Idaho Cleanup Project – The Idaho Cleanup Project will use existing facilities to prepare RH-TRU shipments to WIPP. Shipments may begin as early as September 2007. Idaho's RH-TRU waste is already stored in drums, and no repackaging is anticipated. They will remove some (small volume) non-conforming items. Headspace gas sampling, real-time

[4] WRAP 2A (CH MLLW only facility that was never constructed) cost estimated at $140 million in 1995 – seven and a half year project after KD-0.

radiography, and a limited assay (cobalt and cesium) will be completed. Approximately 700 drums of waste are expected to be processed.

The facility has 2-ft-thick shield walls that can be easily decontaminated. Should repackaging be necessary, the facility has a process hot cell with three windows, each with two mechanical master-slave manipulators. The cell also contains a side-mounted PaR and a crane. The cell has two areas, each approximately 15 ft × 25 ft, separated by a shield wall.

- United Kingdom – The Active Waste Vault Retrieval Project has a facility that has been constructed over active waste vaults. They remotely operate heavy-duty manipulators for picking up waste from the vault and placing it in containers. These containers are then transferred via bogies in a shielded transfer tunnel to another shielded facility. A roller conveyor is used to transfer the container into the cell. There the container is tipped and the waste dumped onto a vibrating table. The waste passes along the table, under assay instrumentation, and into a container. Two remote cranes are used to assist in the cell. The waste is then grouted and container lidded (Smith 2002).

The basic infrastructure to support processing of high activity wastes (RH and alpha) and large volume containers of waste is available at T Plant. With only 16% of the waste requiring processing at T Plant being CH MLLW, establishing separate capabilities for CH MLLW and TRU waste within T Plant would be costly and inefficient. An additional comparable volume of CH MLLW will be generated from T Plant processing the containers and shielding of TRU waste packages. A common capability to process both MLLW and TRU waste allows for ease of separation of the various waste types during processing within the limitations (the 37 foot width being the most restrictive) of the T Plant canyon. Startup of the new remote T Plant capabilities using CH MLLW will allow for ease of trouble-shooting of remote systems and gain valuable experience prior to processing CH TRU and RH waste. T Plant, unlike other Hanford facilities with similar capabilities, has been used for processing waste over the past decades. With the addition of new capabilities to perform the ten processing functions, a common system for processing both MLLW and TRU waste in T Plant is viable and practical.

5.6 Pre-conceptual Design Approach

The pre-conceptual design approach is to construct a new Solid Waste Processing Center (SWPC) at T Plant (Figure 5.9) to receive assayed MLLW and TRU waste containers shielded to CH and process them through a common system to meet waste acceptance criteria for disposal. The SWPC will be capable of receiving containers up to 20 ft × 13 ft × 11 ft (these are the largest possible external dimensions) and up to 38,000 kilograms (83,000 lb), and able to process unshielded packages up to 20,000 rem/hr at the waste container surface (unpackaged waste will have higher activity) and containing up to 2,100 g of plutonium (highest plutonium concentration in a package is 660 grams in 0.4 cubic meters). The SWPC will include modular cells (Solid Waste Processing Modules [SWPMs]) installed on the deck level of the south end of the T Plant

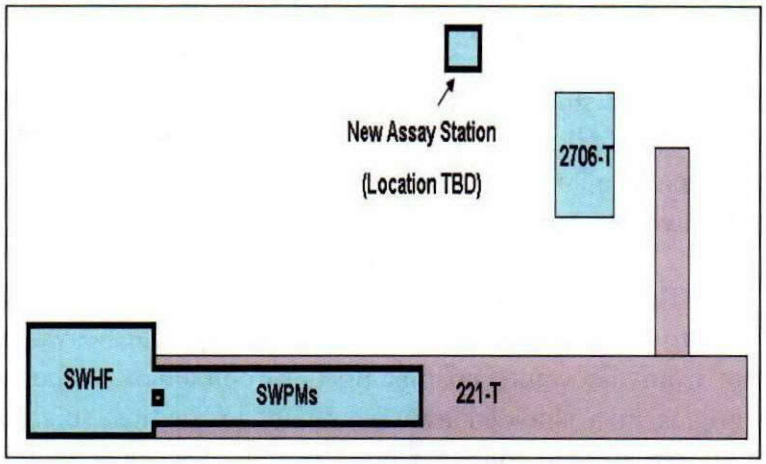


Figure 5.9. Location of New T Plant Complex Capabilities

canyon to process both MLLW and TRU waste and a Solid Waste Handling Facility (SWHF) added to the south end of the T Plant canyon. The old 221-TA inlet ventilation system will be removed to allow space for the SWHF. SWPMs will utilize remotely operated systems for: opening containers, removing non-conforming waste, size reduction, loading MLLW and TRU containers, and load-out of filled waste containers for disposal. A shielded manned processing module will be used to process small waste packages. MLLW and TRU waste will be size reduced for packaging in separate modules. The containers will be loaded-in to the SWPMs on transfer trays using a remote-operated rail system. The containers, loose shielding, and MLLW will then be separated from TRU waste and non-conforming items, size reduced, and placed in a 5 ft × 5 ft × 9 ft container for MLLW or a WIPP standard waste box (SWB). After load-out of MLLW, the containers will be assayed near T Plant and immobilized at 2706-T prior to disposal. TRU waste will be separated from non-conforming items, size reduced and placed into 55-gallon drums. CH TRU waste will be assayed at WRAP prior to shipment in a TRUPACT II to WIPP for disposal. RH TRU waste will be assayed in the SWPMs and loaded into RH-72B casks for shipment to WIPP. Nonconforming MLLW will be loaded-out and processed using existing capabilities (e.g., thermal treatment at commercial facilities), or treated in the SWPMs. Existing Hanford facilities (WRAP, CWC, 2706-T, MWT, and ERDF) will be utilized to support waste staging, processing, and disposal.

Figure 5.10 is an initial design concept, developed by PNNL, for processing in T Plant SWPMs. Pre-conceptual design layouts (Appendix H) of the SWPC were developed from knowledge of T Plant, waste feeds, LDR requirements, waste packaging alternatives, knowledge of existing remote processing systems, and existing processing facilities. Appendix I provides pre-conceptual design concepts for the SWPC heating, ventilation, and air conditioning. Airflow into the SWPMs will be from the airlocks toward the two major processing modules, the Primary Open Sort and Size reduction Module (POSSM) and the TRU waste Open Sort and Size reduction Module (TOSSM).

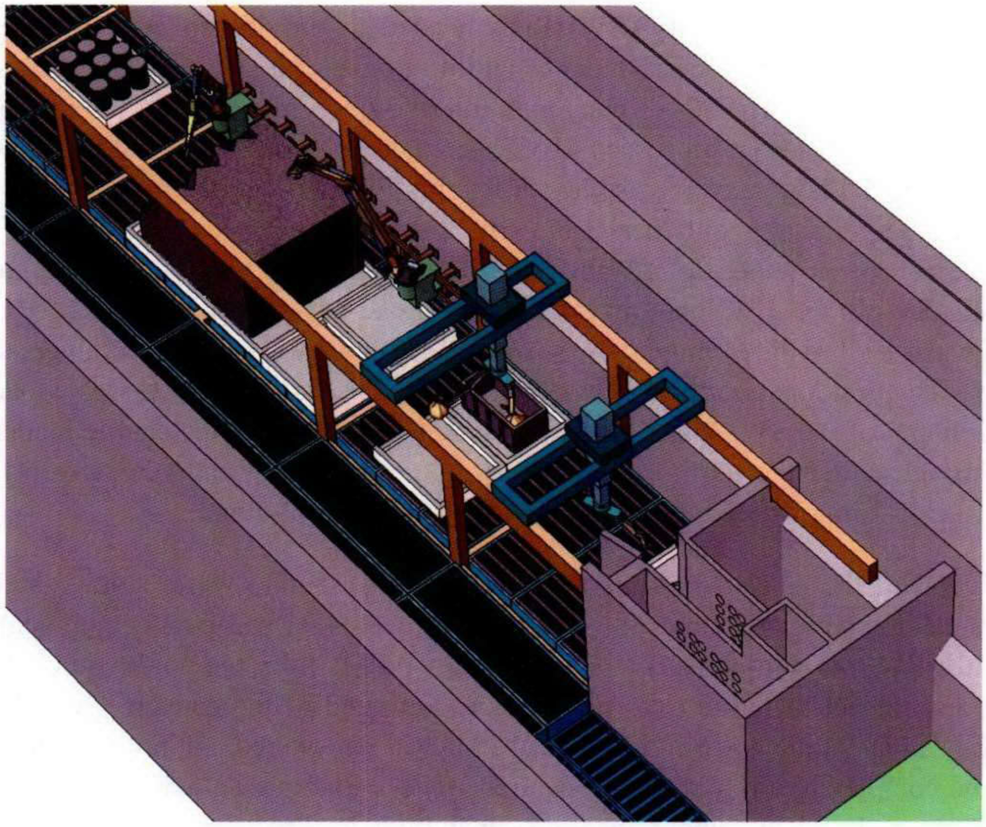


Figure 5.10. Initial Design Concept

5.7 Process Design Layout Considerations and Rationale

The current primary entry for waste containers and large equipment into or out of the 221-T canyon is by truck through a tunnel on the northwest side of T Plant. The tunnel was originally used for railcar access to the 221-T canyon. The rail system has been removed. A secondary small entry into the 221-T canyon is available through the old processing head-end on the northeast side of T Plant. The 221-T canyon is approximately 37 feet wide.

Processing of the MLLW and TRU waste identified in Chapter 2 requires space to load-in a wide variety (i.e., sizes, weights) of waste containers, space to load-in equipment and tools, space for decontamination of load-in/load-out airlocks, space to load-out LDR compliant MLLW containers, space for load-in of RH TRU waste drums that do not require processing for removal of non-conforming items or size reduction (these drums can be directly loaded-in to a RH-72B payload container), space to load-out CH TRU waste containers, space to load RH-72B containers of RH TRU waste, space to load-out RH-72B containers, and space to load-out non-conforming waste containers (e.g., reactor irradiated nuclear material). Additional space is needed to load-in materials, supplies, equipment and personnel during construction.

The new load-in/load-out facility (SWHF) is needed to provide space for receipt of trucks carrying waste feeds to be processed and capability to load-out some of the processed waste in containers for disposal. The 221-T canyon width of 37 feet makes it possible to load-in waste feed containers and load-out processed MLLW containers through one end of the facility. The south end of the T Plant canyon was chosen for this function because of the space it provided for unloading large/heavy containers from trucks and loading heavy RH MLLW containers. More space can be provided for SWPM load-in airlock operations, due to the smaller space required for SWPM MLLW load-out operations. Load-out of processed CH TRU waste and RH TRU waste will require comparable space to load-in of waste feed containers and load-out of MLLW. The best location for processed CH TRU waste and RH TRU waste load-out would be the north end of the SWPMs. CH TRU waste in 55-gallon drums can be loaded-out of the canyon through either the north-east side canyon entry or the west side canyon tunnel. The RH-72B truck loading would be through the west side canyon tunnel.

The north end of the canyon remains a viable option for future waste storage and processing tasks. A shielding wall that allows for T Plant crane access for waste and equipment transfers to and from the SWPMs will be used to separate the SWPMs from the north end of the canyon to minimize any impact to future operations in the north end of the canyon. Establishing a side entry to the canyon at the north end of the SWPMs was considered, but not recommended due to the size and complexity of the opening required. The T Plant tunnel will continue to be used to store waste (e.g., K-Basin sludge) awaiting capabilities to direct load RH drums into RH-72B payload containers. Integration of these operations with the new T Plant SWPC MLLW and TRU waste processing operations are manageable.

The old inlet ventilation system 221-TA is currently attached to the south end of the 221-T canyon. 221-TA will need to be removed to allow for the SWHF to be constructed. A remote-operated rail system will be used to transfer trays capable of holding multiple waste feed containers through a series of three airlocks into the primary open, sort and size reduction module (POSSM). The rail system will use a remote operated screw to transport the containers. Similar rail systems and trays will be used to load-out processed MLLW containers and processed TRU containers.

Available process knowledge of waste feeds will be used to segregate CH and RH waste feeds during processing. After un-packaging, a portion of waste in CH MLLW containers will be found to be RH. Dose rate measurement capability for the loading of MLLW containers will be required to assure that containers are CH at load-out. RH MLLW will require internal shielding to make the load-out container CH. Processed CH MLLW and RH MLLW can be loaded into containers with similar size for loaded-out onto trucks. By selecting similar sized containers the space requirements for MLLW container load-out airlock operations can be minimized. 5 ft x 5 ft x 9 ft containers and WIPP standard waste boxes were selected for MLLW rather than drums to reduce size reduction requirements. WIPP standard waste boxes will be used for TRU waste feed containers and shielding that should be MLLW, but could after assay be determined to be TRU. If found to be TRU, the waste would be in a container (WIPP SWB) that could be sent to

WIPP, via WRAP, in the TRUPACT II. Once approved for use, the 5 ft x 5 ft x 8 ft TRUPACT III container may be a better choice, based on its larger volume, than a WIPP SWB for this operation. Assay of these standard container sizes will be a simpler operation than a wider variety of sizes.

A portion of waste in CH TRU waste containers will be found to be RH after un-packaging. Determination of whether TRU waste product containers are CH or RH will not be known until the waste is loaded in a container and a dose measurement is taken. Loading TRU waste into 55-gallon drums allows for drums determined to be RH, after survey, to be separated for assay and future loading into a RH-72B payload container. The payload containers will be transferred using the existing crane through the T Plant canyon to the tunnel for final RH 72B loading and shipment to WIPP. Drums determined to be CH TRU waste will be transferred through the canyon to a truck for transfer to WRAP for future loading into a TRUPACT II. Capability to load-out non-conforming reactor irradiated nuclear material in containers compatible with storage at the Interim Storage Area (ISA) adjacent to the Canister Storage Building (CSB) will be provided through the north end of the process modules.

A shielded manned processing module will be placed adjacent to the POSSM and TOSSM on the east side of the canyon to process small waste packages (including non-destructive examination), load-out samples, to perform repairs on equipment and tools, and to provide added visibility for operations and maintenance. During processing of high activity RH waste, it may be necessary to halt manned access to the shielded manned processing module. Access to this module will be through the R-doors on the east side of the canyon. The R-doors will probably require widening for entry and exit. Small buildings will need to be added to the outside of the canyon for entry and exiting through the R-doors.

The control center for SWPC operations will be housed in the SWHF. The SWHF will be tied to the 271-T building to utilize existing T Plant capabilities when possible and practical. The SWHF will include a central room for controlling remote system operations and monitoring operations. The SWHF will include capabilities to house and ready personnel to perform SWPC tasks (i.e., decontamination of airlocks, processing waste using the manned processing module).

A new assay station will be constructed near T Plant in an area with a low radioactivity background. The station will be capable of non-destructively assaying product MLLW containers loaded on a truck trailer. A new immobilization capability will be established at 2706-T for product containers of MLLW. This operation could be performed off-site, but transport of CH and RH MLLW would add unnecessary and complicating steps. MLLW containers will need to have access ports (maybe the SWB vent port) for immobilization. 2706-T will continue its current multi-use support mission through 2028.

Over-pack containers will be used by generators to shield RH waste containers to CH prior to receipt at the SWHF. The over-pack containers will be removed in the second load-in airlock for load-out and reuse. Packaging of small waste containers in a thin insert container could make removal of the waste containers from the over-pack container easier. Load-in containers will be non-destructively examined in the second airlock to assist selection of container opening and size reduction tools, and to identify non-conforming items within the container.

Most non-conforming CH MLLW will be packaged and loaded-out in 55-gallon drums. The waste will be sent to the CWC for staging with similar waste streams (e.g., thermal treatment). Some of these wastes require establishment of treatment paths. Options include commercial and 2706-T. Some non-conforming CH MLLW (i.e., liquids) will require treatment in the SWPMs. Non-conforming MLLW could include reactive metals, shock sensitive material, dioxin waste, beryllium dust and will be handled on a case-by-case basis similar to existing commercial, T Plant or WRAP practices. Non-conforming waste that is TRU waste (assumed to be a small quantity) will require processing in the SWPMs. Waste processing will be managed to minimize cross contamination of waste codes. Examples of non-conforming liquids (discrepant material) found in containers processed at WRAP include:

- Acids, bases, neutral solutions, aerosol oven cleaners, oil/grease substances, aerosol spray paint cans, fire extinguishers, WD-40, hydraulic oils. Organics found range from C3 (aerosol with propane) to C50 (hydraulic fluid)

- Greatest documented volumes of one discrepant material in a drum include:

  - 11.4 liters of neutral solution
  - Six liters of aerosol containers
  - One liter container with very acidic solution
  - 7.6 liters of weak base
  - Five lead acid batteries
  - 85 milliliters of mercury

- Highest documented concentrations 4M HNO_3 (a number of entries state "very acidic") and greater than pH 12

5.8 Life-cycle Throughput

The 10,800 m^3 of waste plus the containers and shielding to be processed weighs approximately 6,300,000 kg. Approximately 60% of this weight is the waste container, loose shielding, and waste assumed to be MLLW at load-in. The remaining 40% of waste weight consists of approximately 1,400,000 kg of suspect TRU waste, 760,000 kg of CH TRU waste, 340,000 kg of RH TRU waste, and less than 30,000 kg of non-conforming waste (primarily MLLW). The TRU waste contains approximately 130 kg of plutonium.

The volumes for the retrievably stored waste from the LLBGs and waste in above-ground storage are based on internal container volumes. The volume for forecast waste is based on external container volumes. A volume increase of 10-25% can be expected in the conversion from internal to external container volumes. Figures 5.11 through 5.14 are processing flowcharts for CH MLLW, CH TRU waste, RH MLLW, and RH TRU waste, respectively.

Preliminary scheduling indicates the expanded capabilities would be available for use by 2016 to process a minimum of 600 m^3 per year of TRU waste and 300 m^3 per year of MLLW. Average annual generation rates from 2016 through 2028 are approximately 100 MLLW containers (48 in 5 ft × 5 ft × 9 ft containers and 52 in WIPP SWBs), 173 TRUPACT IIs, and 100 RH-72B casks.

Benefits to startup, as low as reasonably achievable (ALARA) concepts, and safe operations can be achieved by processing similar types of waste through the SWPC in campaigns. Processing during the first two years of operations should consist only of CH MLLW and direct loading of RH TRU waste drums into RH-72Bs for disposal. This allows for trouble-shooting, and optimizing container handling and waste processing. Years three through six should consist of CH only processing of MLLW and TRU, and continued direct loading of RH TRU waste drums into RH-72Bs for disposal. During this period, CH TRU waste containers with high concentrations of plutonium should be processed to reduce alpha inventory delays that could be impacted by high beta/gamma fields. A significant fraction of the plutonium inventory could be processed during this period. Over 54 kilograms of plutonium of the total 130 kilograms of plutonium to be processed through the SWPC are contained in 249 CH TRU waste containers. The remaining years should be used to process CH and RH waste. This processing strategy provides a steady waste disposal stream for CH and RH to WIPP. Figures 5.15 through 5.19 show inventory profiles for processing CH MLLW, CH TRU waste, RH MLLW, and RH TRU waste, respectively.

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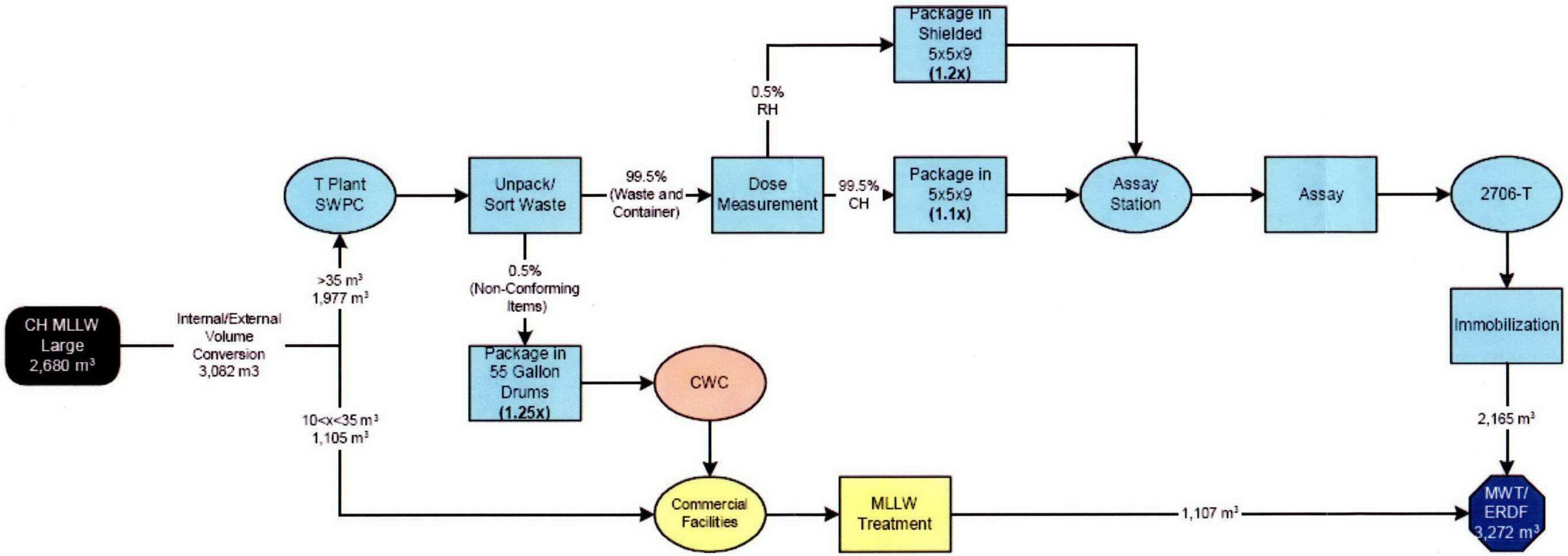

Figure 5.11. SWPC CH MLLW Processing Flowchart

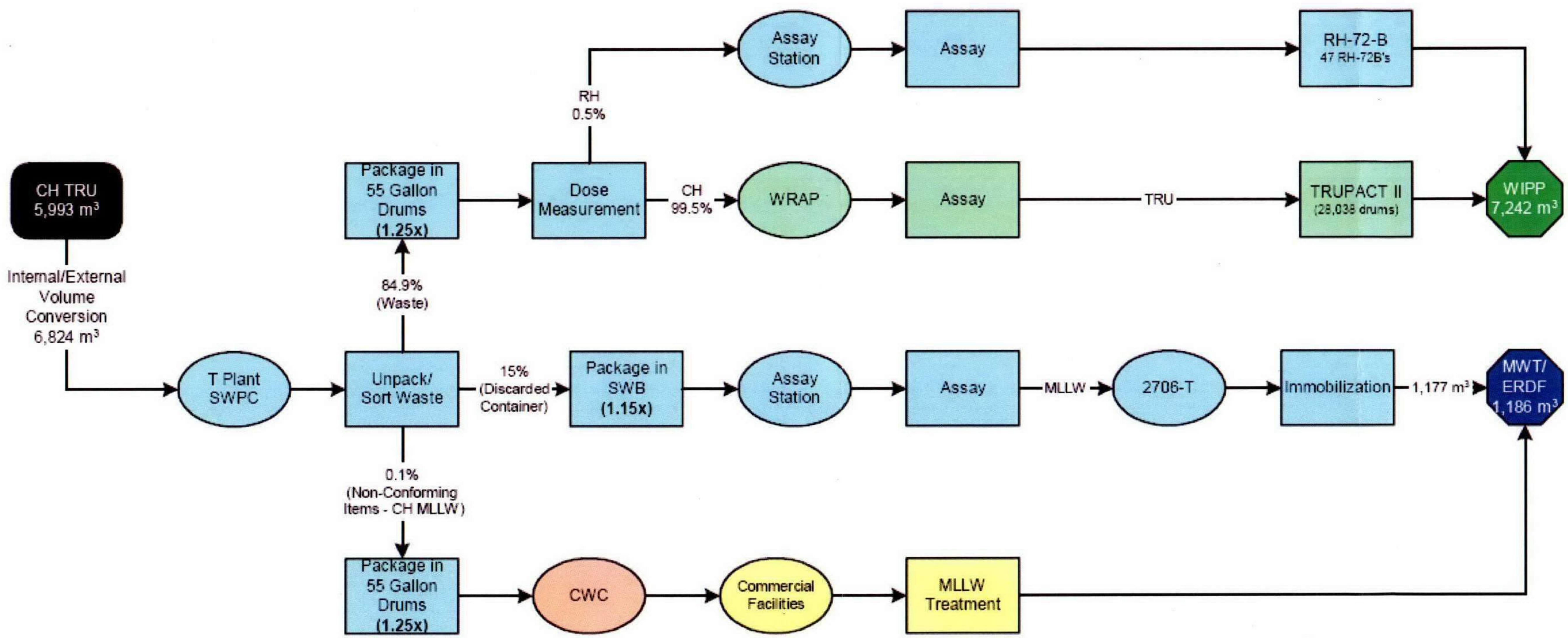

Figure 5.12. SWPC CH TRU Waste Processing Flowchart

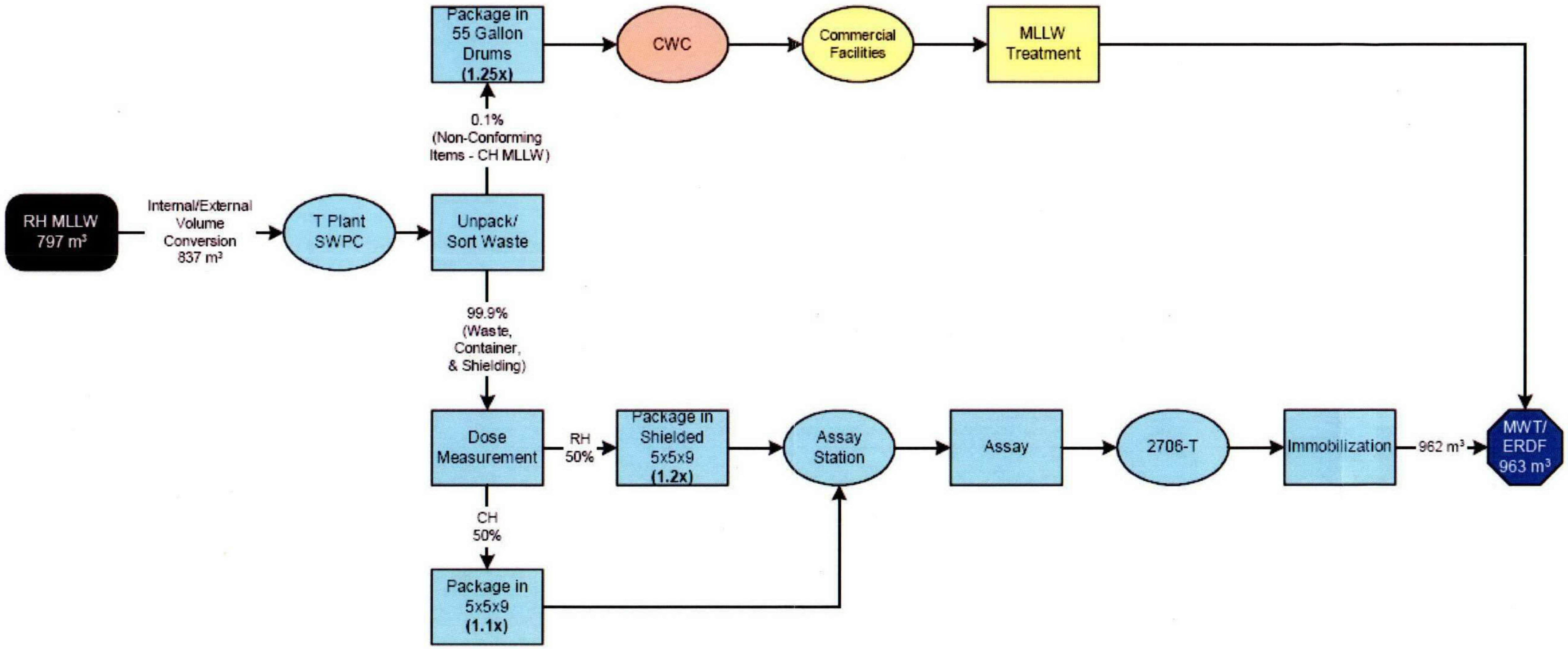

Figure 5.13. SWPC RH MLLW Processing Flowchart

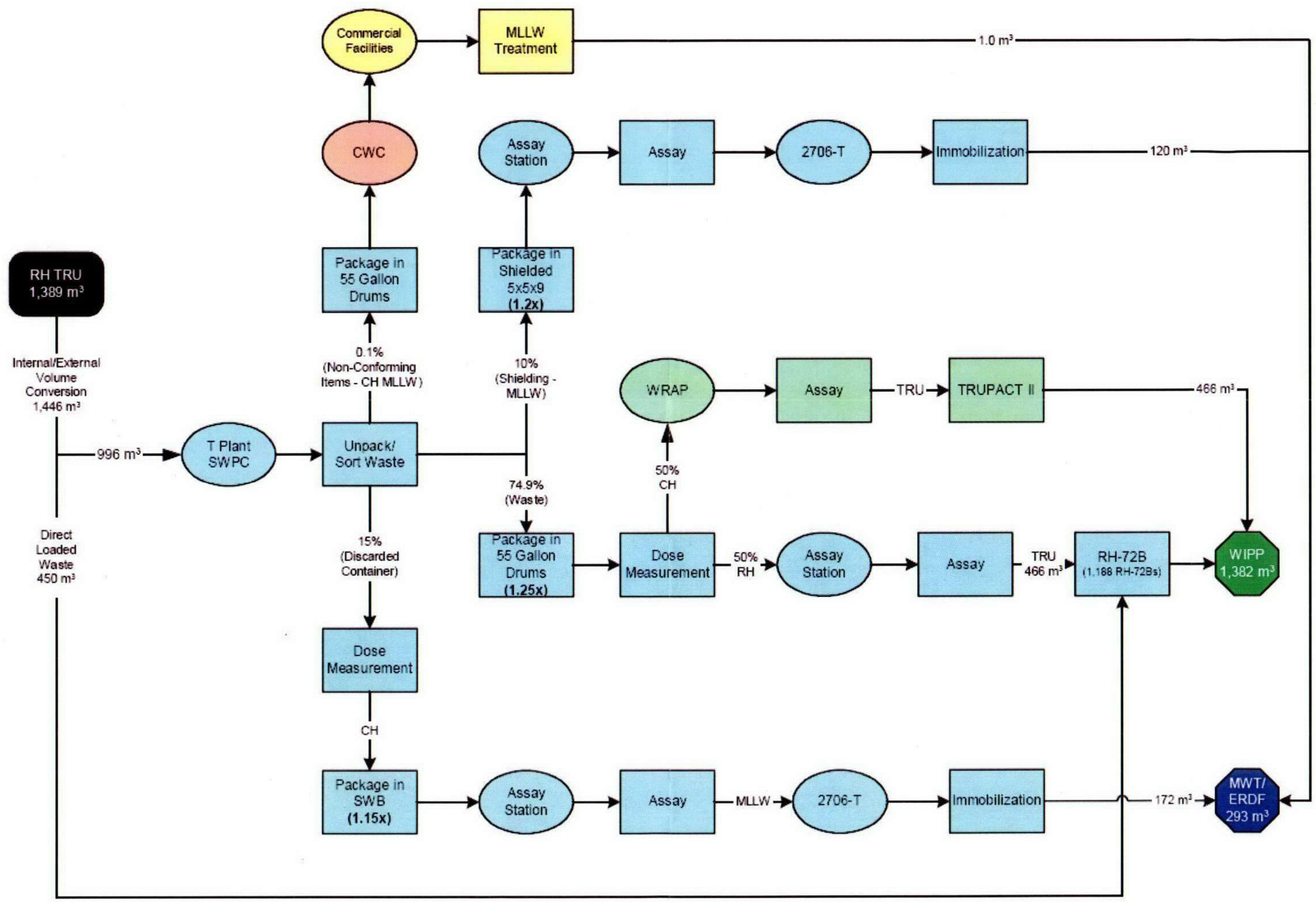

Figure 5.14. SWPC RH TRU Waste Processing Flowchart

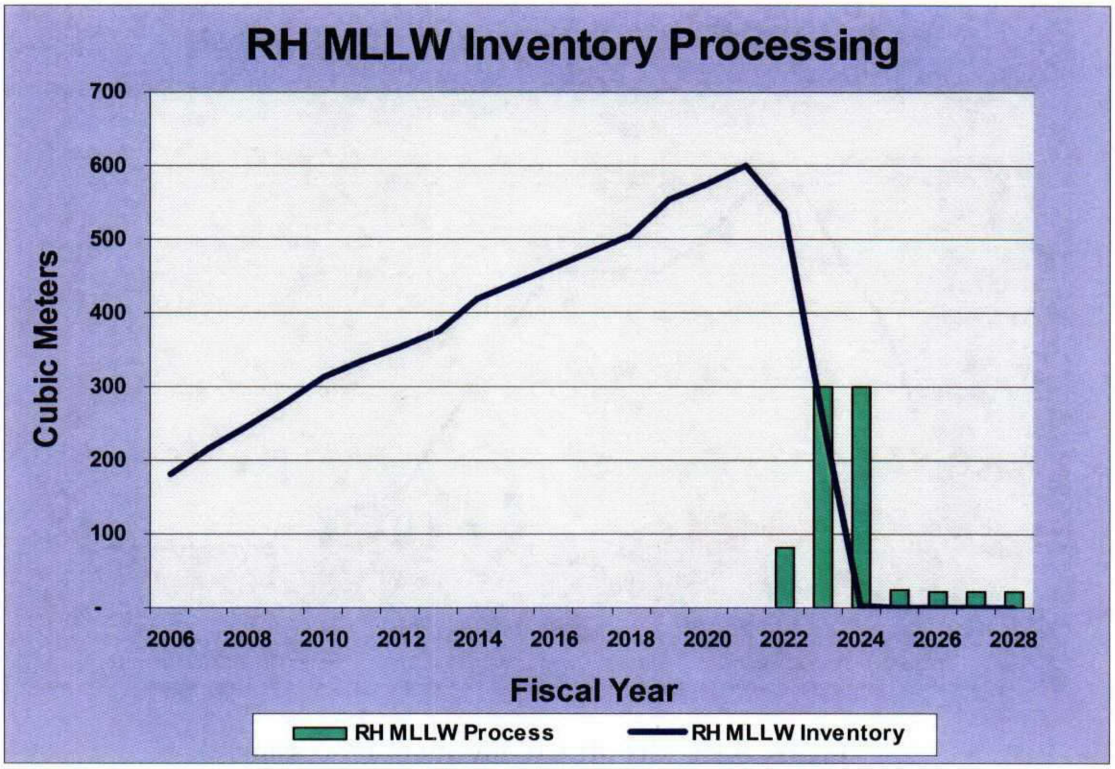

Figure 5.17. RH MLLW Inventory

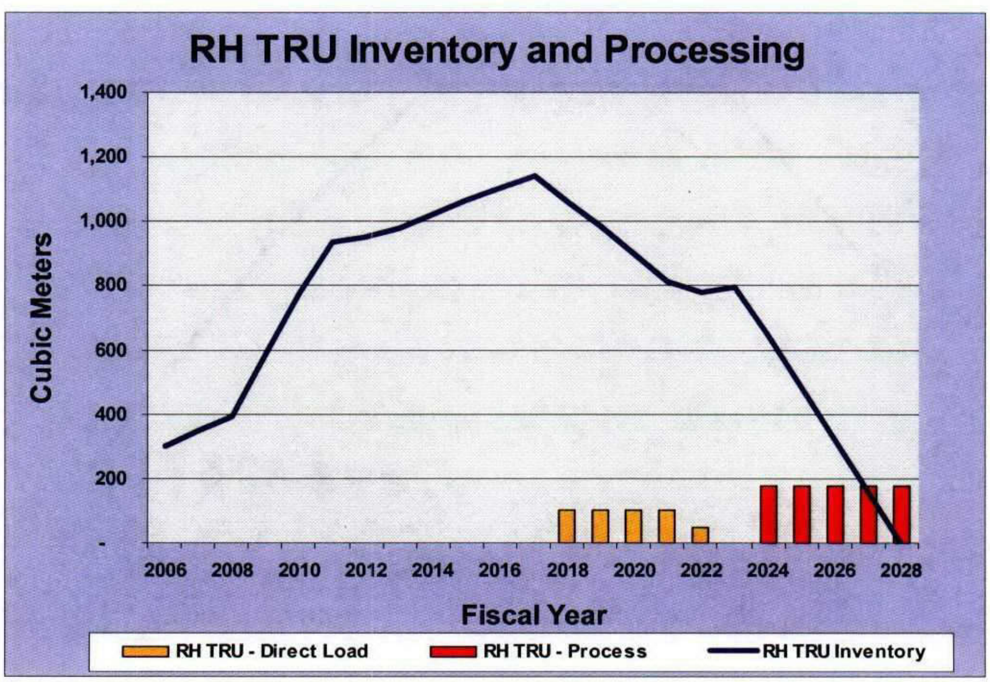

Figure 5.18. RH TRU Waste Inventory Processing

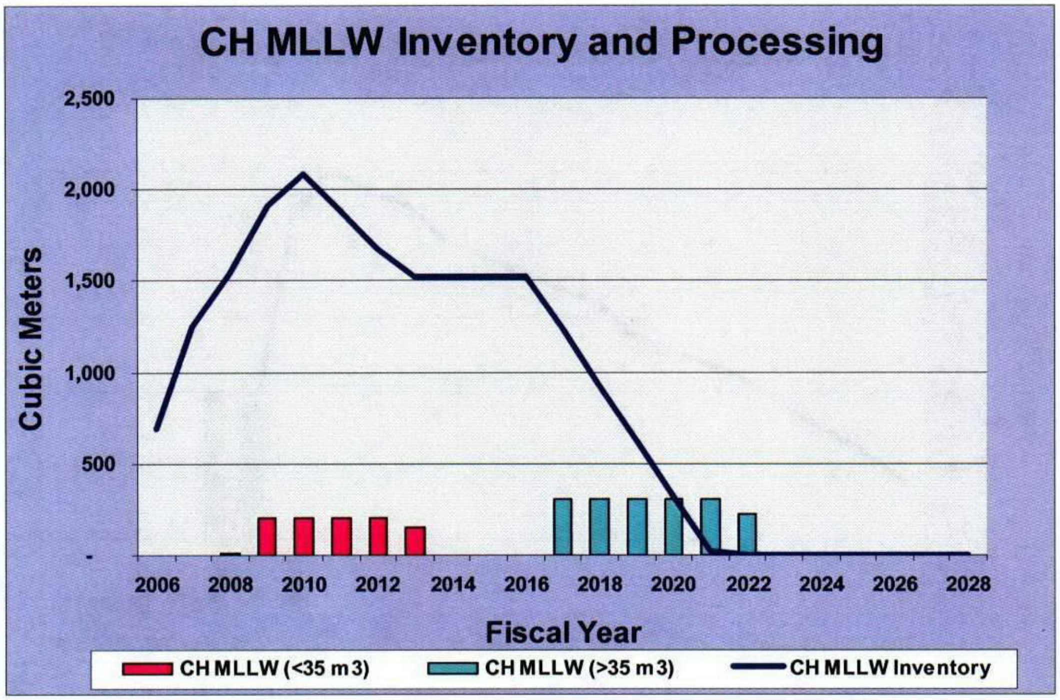

Figure 5.15. CH MLLW Inventory Processing

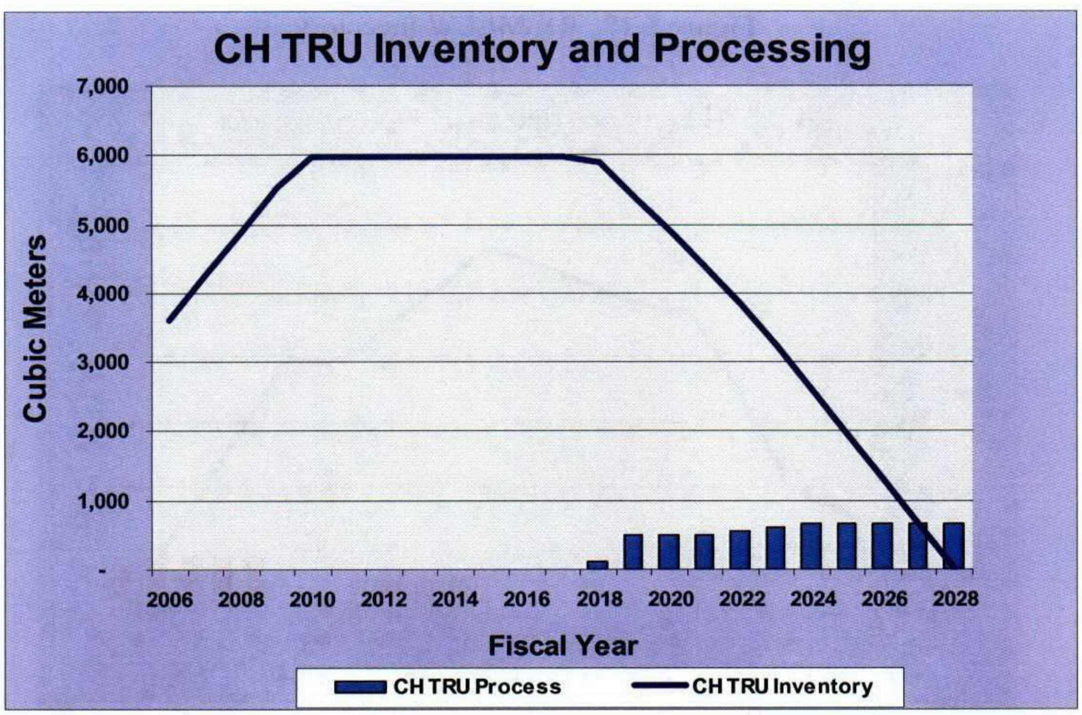

Figure 5.16. CH TRU Waste Inventory Process

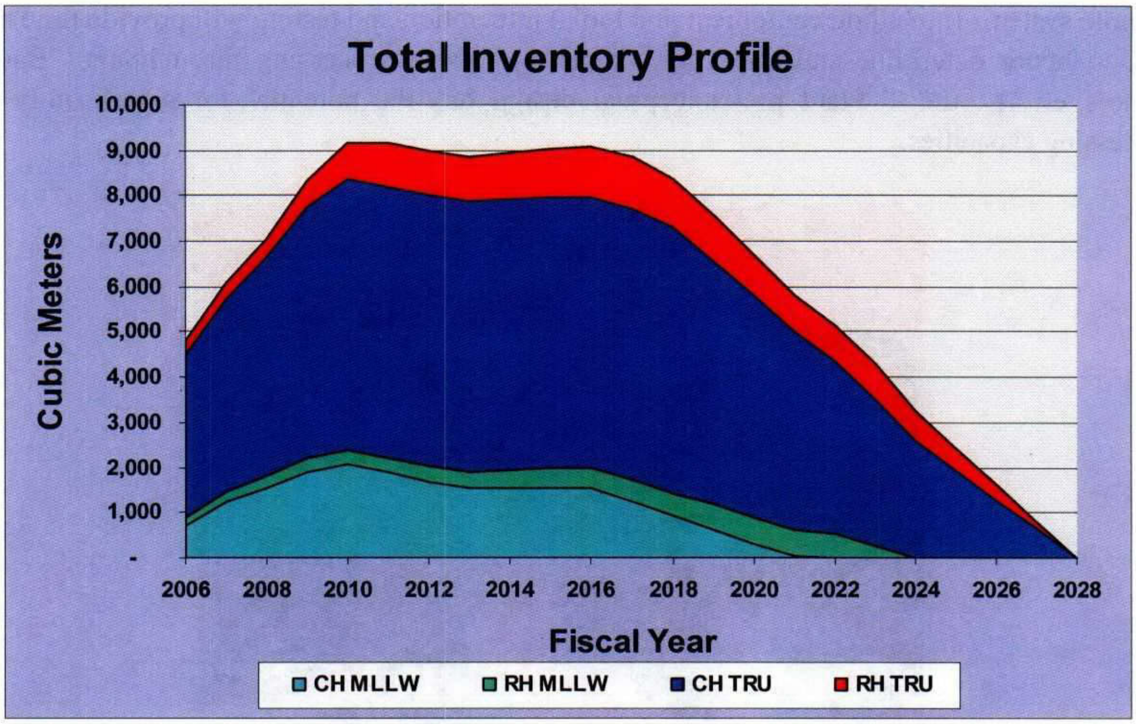

Figure 5.19. Total Waste Inventory

5.9 Technology Needs

Critical to the successful design, construction, startup and operation of the SWPC are the selection, adaptation, testing, and integration of systems, equipment and tools for the SWPMs. While many of the systems and equipment that will be used to process this waste are commercially available, they are almost all custom manufactured for the payload size, type, and motion required for the SWPMs and have not all been used in a similar integrated fashion. Selection of remote systems, equipment, and tools will require analysis of how a given system must interact with other systems and its mechanical, electrical/utility, vision, communications, and operator interfaces. An essential component of the SWPM's remote systems design will be the selection and/or development of a universal tool adaptor. The tool adaptor will enable remote equipment to easily attach and decouple tools. Figure 5.20 shows a remote tool rack and tool adaptor change plate. A cold mockup will be required for testing integrated systems, selection and testing of individual tools, operator training, and task/operational planning. Three-dimensional computer systems will support mockup and conceptual/definitive designs. Table 5.2 shows the risk/consequences of remote equipment failure. A remote system testing program should minimize repairs and problems during startup of the SWPC. Startup of the SWPC processing only CH MLLW during the first two years of operations will allow for easier man-entry for repairs and the work-in period will be beneficial in minimizing failures when handling alpha and RH waste.

Remote systems (including equipment and tools) integration and testing will provide time motion data to better determine staffing requirements and waste processing throughputs. Based on Idaho's efforts, the T Plant pre-conceptual design has the potential for significantly larger processing capacities.

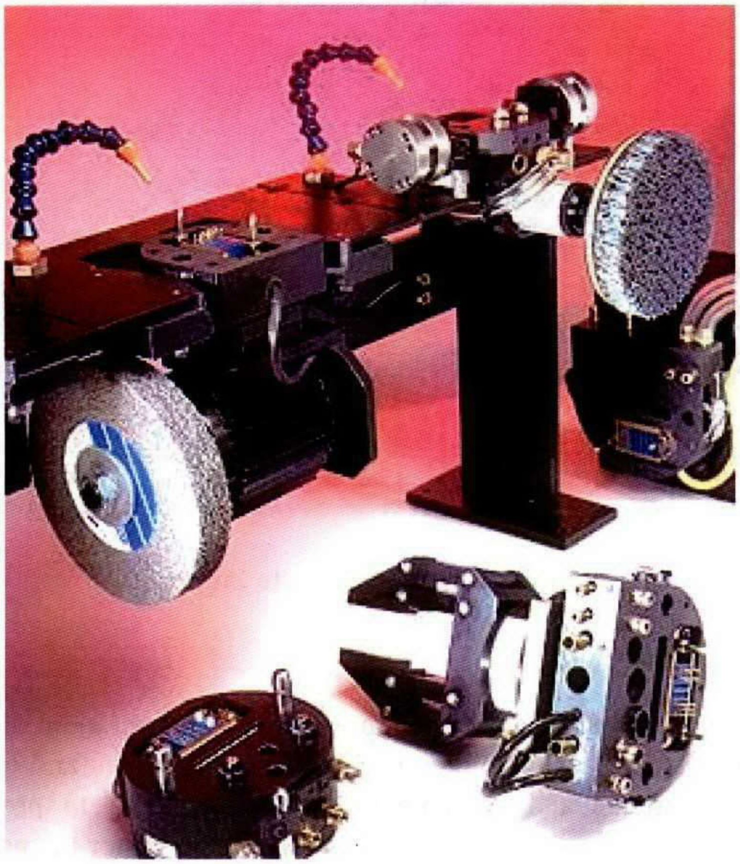

Figure 5.20. Remote Tool Rack and Tool Change Plates
(Photograph courtesy of NASA Spinoff)

Table 5.2. Remote Equipment Failure Risk/Consequence

	Gantry	Heavy Lift	Manipulators	Transport	Shredder	Hydraulic Boom	Cameras
Risk of Unexpected Failure by Type:							
Complete failure	Low	Low	Low	Low	Low	Low	Medium
Partial failure/slows operation	Low	Low	Medium	Low	Low	Low	Low
Misuse	Medium	Low	Low	Low	Low	Low	Low
Radiation related	Low	Low	Low	Low	Low	Low	Medium
$ Cost of complete failure (capital)	Very High	High	Low	Low	Medium	Low	Very Low
$ Cost of partial failure (parts)	Low	Medium	Low	Low	Low	Low	Low
Schedule penalty of complete failure	Very High	High	Low	Medium	Very High	Low	Low
Schedule penalty of partial failure	Medium	Medium	Low	Low	Medium	Low	Low
Repair/replace effort	Very High	Very High	Medium	High	Very High	High	Low
Required preventative maintenance	High	High	Low	Low	Low	Low	None

5.10 Integration with the T Plant Complex

- The T Plant Complex will be maintained and operated through FY 2028.

- Construction of the new T Plant capabilities (e.g., SWPMs, SWHF, new assay station, 2706-T) will require integration with ongoing T Plant Complex operations.

- T Plant Complex documentation will require updating to incorporate the addition of the new capabilities, including:

- Safety documents
  - Criticality control
  - Operating procedures
  - Training material
  - Seismic documentation review.

5.11 Life-cycle Cost and Schedule

The size and cost of the SWPC is driven by the capability to receive and process a wide variety (sizes of packages, waste materials [i.e., concrete, wood, plastic, metal]) of waste containers with high dose and/or high levels of plutonium. Key design considerations include seismic, fire protection, plutonium management, and heating ventilation and air conditioning. Processing capacity is a function of the ability to routinely load-in and load-out containers with minimal contamination issues, maintaining remote equipment in an operational condition, and staff for multi-shift operations.

The pre-conceptual design/construction cost estimate for the SWPC is $390 million (Appendix J). This estimate assumes that the SWPC design and construction is expense funded. The cost estimate includes 30% for contingency, 12% for escalation, and 17% for general and administrative overhead. The cost estimate includes 30% contingency, 12% escalation, and 17% general and administrative overhead. Elements of the estimate include conceptual design, detailed design, remote systems integration and testing, T Plant facility preparation, equipment procurement, off-site module fabrication, module assembly in the T Plant canyon, tie-in to T Plant systems, and construction of the SWHF/assay station, modification to 2706-T, readiness and startup, and project management. A $34 million remote systems integration and testing activity is included to reduce the risk of rework to the project. This allowed the contingency to decrease to 30%. A design/construction schedule based on expense project funding is shown in Appendix J.

Completion of other upgrades, previously planned for T Plant, is required for successful operations of the SWPC (i.e., roof upgrade, electrical upgrades). The SWPC is assumed to operate 24 hours per day, seven days per week, increasing T Plant staffing to an estimated

233 FTEs (currently 83 FTEs). The T Plant operations cost will increase from $13 million per year to $33 million per year (Appendix K). SWPC operations from June 2016 through 2028 are estimated to cost $320 million (with no escalation). The T Plant SWPC staffing is assumed to be a conservative estimate. Remote systems integration and testing will provide time/motion data to better refine staffing requirements.

Average unit cost for SWPC operations are estimated to be $82,000 per cubic meter of waste processed. Table 5.3 shows a comparison of average unit cost for processing different Hanford wastes.

Table 5.3. Average Unit Processing Cost (project cost + operational cost) per Cubic Meter for Processing Hanford Wastes

Processing Step	Hanford Waste	Average Unit Cost per Cubic Meter
LLBG Retrievably Stored Waste Removal	CH Suspect TRU Waste	$14,000
Commercial Treatment for LDR	CH MLLW less than 4 m^3	$7,000
Commercial Treatment for LDR	CH MLLW 4 m^3 to 15 m^3	$14,000
Commercial Treatment for LDR	CH MLLW 15 m^3 to 35 m^3	$24,000 (estimated)
WRAP Treatment for LDR	CH TRU in drums	$48,000
T Plant SWPC Treatment for LDR	CH MLLW greater than 35 m^3, RH MLLW, CH TRU waste (non-drums) and RH TRU waste	$82,000 (estimated)

5.12 Waste Retrieval Needs

Acquisition of capabilities and/or facilities will be required to remotely retrieve and package some suspect RH TRU waste (e.g., caisson waste) from the LLBGs. Retrieval of caisson waste will require a combination of soil excavation and placement of remote operated enclosures equipped with systems/equipment/tools to retrieve the waste. Testing of SWPC systems/equipment/tools will be useful in selecting systems for suspect RH TRU waste retrieval. Design of the SWPMs supports the development of field retrieval of RH TRU waste.

5.13 Integration with CERCLA Cleanup Needs

CERCLA integration needs are addressed in the implementation work plan submitted as part of Tri-Party Agreement Milestone M-16-93.

5.14 Assumptions

- WRAP will operate as long as necessary to perform NDE, NDA, and certification of CH TRU waste processed at T Plant.

- Assay and acceptable knowledge are sufficient to meet waste characterization requirements.
- RSW packages may require some over-packaging for transportation to T Plant.
- Transfer of most RSW CH MLLW containers to commercial facilities will require packaging to meet DOT requirements.
- The SWPMs will be designed for ease of disassembly and placement on or in the canyon cells for closure with T Plant. Some size reduction capability of the SWPMs may be required to allow access to the cells so that cell contents could be dispositioned prior to closure of T Plant.
- Cleanout of a minimum of two cells will be required to support SWPM installation. Additional cells may need to be cleaned out prior to SWPM construction to support facility closure.
- Shredding some TRU waste is acceptable.
- Assay of RH waste is viable.
- The T Plant complex upgrades planned for life extension and which are also required for SWPC operations are completed in a timely manner (i.e., seismic upgrades, electrical system, canyon crane).
- Required technology needs can be met to support SWPC startup and operations (i.e., assay of RH TRU waste; interface and communication between systems, equipment, and tools manufactured by multiple vendors; load-in/load-out systems).
- The T Plant permitting and operation documentation is completed to support SWPC startup and operations.
- Modifications to ready T Plant for SWPC are completed in a timely manner (i.e., cell cover block replacement or modification, removal of 221-TA, HVAC modifications).
- Expansion of commercial CH MLLW treatment capabilities to containers up to 35 m^3 is successful.
- Production quantities (waste feed and processed waste) are realized (e.g., retrieval of RSW suspect TRU waste from the LLBGs is 50% TRU and 50% MLLW by volume).
- WIPP accepts waste in a timely manner to support Hanford cleanup (e.g., RH-72Bs).
- MWT, ERDF and IDF are available for MLLW disposal.

5.15 Opportunities and Other Considerations

- Work with waste generators to ensure that RH MLLW is packaged such that it can be immobilized at 2706-T and never require processing through the SWPMs.

- Decontamination of entry airlocks can be minimized by reducing the number of waste package load-ins. This can be accomplished by placing multiple waste containers on transfer trays, within criticality control requirements, for load-in to the SWPMs.

- Some CH MLLW in containers larger than 35 m^3 could be processed on the canyon deck using a commercial approach prior to initiating construction of the SWPMs. The unit processing cost for the CH MLLW would be less, but would increase the unit processing cost for the remaining waste.

- CH TRU waste could be loaded into WIPP SWBs, which would reduce size reduction processing. Some packages may require rework if dose levels exceed CH. Additional fissile material control would be required.

- A new facility could be constructed to perform the new T Plant functions. The infrastructure requirements for the new facility would be significant cost (e.g., shielded facility, HVAC system with major stack, utilities, crane, procedures, closure costs for a new structure). These new costs out-weigh the reduced costs for installation of the modules in the canyon (i.e., worker time to install modules, replacement of cover blocks, cleanout of two cells, connecting to T Plant utilities) and any impacts to T Plant operations.

- 22% of the T Plant feed volume is RH waste. If the RH waste feed were eliminated from the scope of the new T Plant capabilities it would reduce the radiation shielding requirements and remove some system process requirements for the SWPMs. Approximately one-fifth of the T Plant RH waste does not require processing for size reduction or removal of nonconforming items and can be directly loaded in to a RH-72B. Capability to load RH-72Bs could be added and performed at some other T Plant or Hanford site location.

- After processing the majority of the CH MLLW during the first decade of operations of the SWPC, the POSSM could be used to load CH TRU waste and containers into a TRUPACT III (after its approval for use), rather than separating the CH MLLW container from the CH TRU waste. This would increase the SWPC TRU waste processing rate and increase the waste volume to WIPP (~1,200 cubic meters), and is consistent with processing at some other sites.

- Eliminating the requirement to remove non-conforming items would allow MLLW packages to be sent directly to immobilization and not require T Plant processing.

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Appendix A

M-91 TPA Milestones

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Appendix A

M-91 TPA Milestones

Number	Milestone	Due Date
M-016-67	SUBMIT A TECHNOLOGY DEVELOPMENT SUMMARY REPORT FOR PHASES I, II AND III, AN INTERMEDIATE DESIGN REPORT, A REMEDIATION SCHEDULE AND A TREATABILITY INVESTIGATION WORK PLAN FOR REMEDIAL ACTIONS AT THE 618-10 AND 618-11 BURIAL GROUNDS. THE TECHNOLOGY DEVELOPMENT SUMMARY REPORT FOR PHASES I, II AND III WILL DOCUMENT THE RESULTS OF THE EM-50 ACQUISITION STRATEGY RELATING TO THE IN-SITU DELINEATION AND WASTE REMOVAL OF RADIOACTIVE WASTE AT THE HANFORD 618-10 AND 618-11 BURIAL GROUNDS. THE INTERMEDIATE DESIGN REPORT SHOULD REPRESENT A 60% COMPLETE DESIGN REPORT AND SHOULD INCLUDE AT A MINIMUM, THE REMEDIATION APPROACH (i.e., PROCESS DEFINITION), EVALUATION OF INFRASTRUCTURE REQUIREMENTS [i.e., M-91 AND WIPP INTEGRATION PLANNING], AND UPDATED DRAWINGS/TECHNICAL SPECIFICATIONS. THE REMEDIATION SCHEDULE MUST IDENTIFY: 1) DATES FOR INITIATING AND COMPLETING INTERIM REMEDIAL ACTIONS AT WASTE SITES; AND 2) ANY DOCUMENTS REQUIRING EPA AND/OR ECOLOGY APPROVAL PRIOR TO INITIATING REMEDIAL ACTIONS (E.G., RD/RA WORK PLANS, ETC.). DEPENDING ON THE OUTCOME OF THE TECHNOLOGY DEVELOPMENT ACQUISITION STRATEGY, A TREATABILITY INVESTIGATION WORK PLAN FOR KEY ASPECTS OF THE FINAL REMEDIATION APPROACH WILL BE REQUIRED. THE TREATABILITY INVESTIGATION WORK PLAN MUST BE CONSISTENT WITH WIPP'S ACTUAL (OR, IF NOT YET APPROVED, ANTICIPATED) RH-TRU/TRUM WASTE ACCEPTANCE CRITERIA, INCORPORATE THE RESULTS FROM THE TECHNOLOGY DEVELOPMENT SUMMARY REPORT, AND WILL BE SUBMITTED AS A TRI-PARTY AGREEMENT PRIMARY DOCUMENT.	03/31/2007
M-16-93 LEAD AGENCY: EPA	SUBMIT AN IMPLEMENTATION WORK PLAN TO EPA FOR THE ACQUISITION OF CAPABILITIES NECESSARY TO PREPARE TRU AND TRUM WASTE GENERATED BY CERCLA CLEAN UP ACTIONS AT THE HANFORD SITE FOR DISPOSAL AT THE WASTE ISOLATION PILOT PLANT (WIPP). THIS WORK PLAN WILL REFLECT RETRIEVAL DECISIONS, PROJECTED WASTE VOLUMES, AND SCHEDULES FROM ALL CERCLA CLEANUP ACTIONS AUTHORIZED IN RECORDS OF DECISION AND ACTION MEMORANDA AT THE HANFORD SITE, AND WILL PROVIDE FOR UPDATES AND REVISIONS AS NEW INFORMATION BECOMES AVAILABLE (AT A MINIMUM, THE WORK PLAN MUST BE REVISED IN 2009 (AFTER ALL 200 AREA RODS ARE ISSUED) AND IN 2012). AS PART OF THE APPROVAL PROCESS, EPA WILL CONSULT WITH ECOLOGY TO ENSURE THAT WSTES FROM CERCLA OPERABLE UNITS FOR WHICH ECOLOGY IS THE LEAD REGULATORY AGENCY ARE PROPERLY PLANNED FOR. THIS WORK PLAN WILL PROVIDE A SCHEDULE FOR ACQUIRING THE CAPABILITIES FOR TRU AND TRUM MANAGEMENT NECESSARY TO SUPPORT ALL CERCLA CLEANUP ACTIONS.	09/30/2006

Number	Milestone	Due Date
	IN ORDER TO AVOID DUPLICATIVE REQUIREMENTS, THE M-16-93 WORK PLAN WILL INTEGRATE PLANS DEVELOPED PURSUANT TO THE M-91 MILESTONES TO PROVIDE CAPABILITIES FOR RCRA MIXED AND SUSPECT MIXED TRANSURANIC WASTE WHERE SUCH CAPABILITIES ALSO CAN BE USED FOR CERCLA TRU/TRUM WASTE. THE WORK PLAN WILL BE SUBMITTED PURSUANT TO SECTION 11.6 OF THE TRI-PARTY AGREEMENT.	
M-091-00	COMPLETE THE ACQUISITION OF NEW FACILITIES, MODIFICATION OF EXISTING FACILITIES, AND MODIFICATION OF PLANNED FACILITIES NECESSARY FOR RETRIEVAL, STORAGE, AND TREATMENT/PROCESSING, OF ALL HANFORD SITE RCRA MIXED AND SUSPECT MIXED LOW-LEVEL WASTE AND RCRA MIXED AND SUSPECT MIXED TRANSURANIC WASTE. DEFINITIONS THE FOLLOWING DEFINITIONS APPLY TO THIS SERIES OF MILESTONES. "BOXES AND LARGE CONTAINERS" AS USED HEREIN IS DEFINED AS WASTE CONTAINERS THAT ARE NOT 55-GALLON DRUMS AND THAT CANNOT BE PLACED IN SUCH DRUMS. "DESIGNATION" AS USED HEREIN IS DEFINED AS THE PROCESS FOR DETERMINING: (1) WHICH CONTAINERS OF LOW-LEVEL WASTE ARE MLLW; AND, (2) WHICH CONTAINERS OF TRANSURANIC WASTE ARE MIXED TRANSURANIC WASTE (CH-TRUM OR RH-TRUM). DESIGNATION OF WASTE WILL BE PERFORMED PURSUANT TO WAC 173-303-070 THROUGH 100. THESE REGULATIONS ALLOW THE USE OF "ACCEPTABLE KNOWLEDGE," SURROGATE SAMPLING AND OTHER MEASURES FOR DESIGNATION TO MINIMIZE WORKERS' RADIATION EXPOSURE AND TO REDUCE COSTS. WHERE APPLICABLE, DOE INTENDS TO USE INFORMATION GATHERED THROUGH THE CERTIFICATION OF TRANSURANIC WASTE IN SUPPORT OF ITS DESIGNATION OF RELATED LOW-LEVEL WASTE STREAMS. WHERE APPROPRIATE, DOE WILL USE MEASURES ALLOWED UNDER STATE AND FEDERAL REGULATIONS TO PERFORM ACCURATE AND COST EFFECTIVE DESIGNATIONS OF LOW-LEVEL WASTE. "LOW-LEVEL WASTE" AS USED HEREIN IS DEFINED AS RADIOACTIVE WASTE THAT IS NOT SPENT FUEL, HIGH-LEVEL WASTE, TRANSURANIC WASTE, BYPRODUCT MATERIAL, OR NATURALLY OCCURRING RADIOACTIVE MATERIAL. LOW-LEVEL WASTE INCLUDES BOTH "MIXED LOW-LEVEL WASTE" AND "NON-MIXED LOW-LEVEL WASTE." "MIXED LOW-LEVEL WASTE" (MLLW) IS LOW-LEVEL WASTE THAT IS SUBJECT TO RCRA OR 0.105 RCW. "NON-MIXED LOW-LEVEL WASTE" (LLW) IS LOW-LEVEL WASTE THAT IS NOT SUBJECT TO RCRA OR 70.105 RCW. LLW AND LLW CAN BE CONTACT-HANDLED (CH), I.E., CH-LLW OR CH-MLLW, OR REMOTE-HANDLED (RH), I.E., RH-LLW OR RH-MLLW. "CONTACT HANDLED" (CH) WASTE IS A WASTE PACKAGE WITH A	To Be Determined*

Number	Milestone	Due Date
	SURFACE DOSE RATE LESS THAN 200 MILLIREM PER HOUR. "REMOTE HANDLED" (RH) WASTE IS A WASTE PACKAGE WITH A SURFACE DOSE RATE EQUAL TO OR GREATER THAN 200 MILLIREM PER HOUR. "RETRIEVABLY STORED WASTE" (RSW) AS USED HEREIN IS DEFINED AS WASTE THAT IS OR WAS BELIEVED TO BE CONTAMINATED WITH SIGNIFICANT CONCENTRATIONS OF TRANSURANIC ISOTOPES WHEN IT WAS PLACED IN THE 218-W-4B, 218-W-4C, 218-W-3A AND 218-E-12B BURIAL GROUND TRENCHES AFTER MAY 6, 1970. DURING THE RETRIEVAL PROCESS, CONTAINERS OF RSW WILL BE SEGREGATED INTO TWO CATEGORIES: (1) CH RSW AND (2) RH RSW. SUBSEQUENT ANALYSIS AND CATEGORIZATION OF RSW PURSUANT TO RCRA, CH. 70.105 RCW, THE ATOMIC ENERGY ACT, AND THE WIPP LAND WITHDRAWAL ACT WILL RESULT IN MOST OR ALL OF THIS WASTE BEING CLASSIFIED AS ONE OF THE FOLLOWING TYPES OF WASTE: CH-LLW, RH-LLW, CH-MLLW, RH-MLLW, CH-TRU, CH-TRUM, RH-TRU OR RH-TRUM. RSW DOES NOT INCLUDE WASTE IN CONTAINERS THAT HAVE DETERIORATED TO THE POINT THAT THEY CANNOT BE RETRIEVED AND STABILIZED (E.G., PLACED IN OVERPACKS) IN A MANNER THAT WOULD ALLOW THEM TO BE TRANSPORTED AND DESIGNATED WITHOUT POSING SIGNIFICANT RISKS TO WORKERS, THE PUBLIC OR THE ENVIRONMENT. WITH RESPECT TO ANY SUCH CONTAINERS, AND WITH RESPECT TO ANY RELEASE OF RSW, THE DECISION AS TO HOW TO MOVE FORWARD WILL BE DETERMINED THROUGH THE CLEANUP PROCESS SET FORTH IN RCRA, CH. 70.105 RCW, AND/OR CERCLA AS APPROPRIATE. THOSE PROCESSES MAY RESULT IN ADDITIONAL REQUIREMENTS FOR THE REMEDIATION OF SUCH WASTES. "CAISSON WASTE" AS USED HEREIN IS DEFINED AS RSW IN THE 218-W-4B BURIAL GROUND CAISSONS ALPHA-1 THROUGH ALPHA-4. "TRANSURANIC WASTE" AS USED HEREIN IS DEFINED AS WASTE THAT MEETS THE DEFINITION IN SUBSECTION (18) OF SECTION 2 OF THE WASTE ISOLATION PILOT PLANT LAND WITHDRAWAL ACT, PUB. L. 102- 579. TRANSURANIC WASTE INCLUDES BOTH "MIXED TRANSURANIC WASTE" (TRUM) WASTE" AND "NON-MIXED TRANURANIC WASTE" (TRU), AND COMPRISES THE FOLLOWING CATEGORIES: CH-TRU, CH-TRUM, RH-TRU, AND RH-TRUM. "RETRIEVAL OF CH RSW" IS DEFINED AS UNCOVERING CH WASTES WITHIN DOE'S RSW TRENCHES, AND REMOVING SUCH CH WASTES FROM THE TRENCHES TO A PERMITTED AND COMPLIANT TREATMENT, STORAGE OR DISPOSAL FACILITY, THE ENVIRONMENTAL RESTORATION AND DISPOSAL FACILITY (ERDF) OR FOR WASTE DESIGNATED IN ACCORDANCE WITH WAC 173-303-070 THROUGH 100 AS NON-MIXED TO A STORAGE OR DISPOSAL FACILITY THAT DOE DETERMINES IS APPROPRIATE. STORAGE OF ANY RETRIEVED CH RSW THAT HAS NOT BEEN DESIGNATED AS NON-MIXED PURSUANT TO WAC 173-303-070 THROUGH -100 SHALL INCLUDE SECONDARY CONTAINMENT PURSUANT TO WAC 173-303-630(7).	

Number	Milestone	Due Date
	"RETRIEVAL OF RH RSW" IS DEFINED AS UNCOVERING RH WASTES WITHIN DOE'S RSW TRENCHES AND CAISSONS, AND REMOVING SUCH RH WASTES FROM THE TRENCHES TO A PERMITTED AND COMPLIANT TREATMENT, STORAGE OR DISPOSAL FACILITY, THE ENVIRONMENTAL RESTORATION AND DISPOSAL FACILITY (ERDF) OR FOR WASTE DESIGNATED IN ACCORDANCE WITH WAC 173-303-070 THROUGH 100 AS NON-MIXED TO A STORAGE OR DISPOSAL FACILITY THAT DOE DETERMINES IS APPROPRIATE. STORAGE OF ANY RETRIEVED RH RSW THAT HAS NOT BEEN DESIGNATED AS NON-MIXED PURSUANT TO WAC 173-303-070 THROUGH -100 SHALL INCLUDE SECONDARY CONTAINMENT PURSUANT TO WAC 173-303-630(7). * NOTE: THE M-91 SERIES MILESTONES (INCLUDING THIS NOTE) DO NOT INCLUDE ANY REQUIREMENTS TO ESTABLISH SCHEDULES FOR THE MANAGEMENT OF PRE-1971 TRU/TRUM. SCHEDULES FOR THE MANAGEMENT OF PRE-1971TRU/TRUM WILL BE ESTABLISHED, PURSUANT TO APPLICABLE PROVISIONS OF THE HFFACO OTHER THAN THE M-91 SERIES MILESTONES, FOLLOWING THE ISSUANCE OF OPERABLE UNIT RECORDS OF DECISION (RODS).	
M-091-01	COMPLETE THE ACQUISITION OF CAPABILITIES AND/OR ACQUISITION OF NEW FACILITIES, MODIFICATION OF EXISTING FACILITIES, AND/OR MODIFICATION OF PLANNED FACILITIES NECESSARY FOR RETRIEVAL, DESIGNATION, STORAGE, AND TREATMENT/PROCESSING PRIOR TO DISPOSAL OF ALL HANFORD SITE POST 1970 RH TRUM AND SUSPECT RH TRUM, TRUM IN BOXES AND LARGE CONTAINERS, AND SUSPECT TRUM IN BOXES AND LARGE CONTAINERS.	6/30/2012

Number	Milestone	Due Date
M-091-03	SUBMIT REVISION OF THE HANFORD SITE TRUM AND MIXED LOW-LEVEL WASTE PROJECT MANAGEMENT PLAN (PMP) TO ECOLOGY PURSUANT TO, AND IN COMPLIANCE WITH THE REQUIREMENTS OF AGREEMENT SECTION 11.5. REVISIONS OF THE PMP SHALL ADDRESS RCRA MIXED AND SUSPECT MIXED TRANSURANIC AND LOW LEVEL WASTE AND WILL CONSIDER AND EXPRESSLY EVALUATE THE IMPACT ON M-91 RETRIEVAL, TREATMENT AND PROCESSING CAPABILITIES, THAT MAY RESULT FROM RETRIEVAL, TREATMENT AND/OR PROCESSING OF ANY OTHER TRANSURANIC OR SUSPECT TRANSURANIC WASTE INCLUDING BUT NOT LIMITED TO OFF-SITE TRANSURANIC WASTE AND HANFORD SITE TRANSURANIC WASTE GENERATED AFTER 1/1/03. REVISIONS OF THE PMP SHALL BE SUBMITTED ON 12/31/2003, 3/31/2009 AND 3/31/2013. EACH REVISION IS A DISTINCT WORK REQUIREMENT INDEPENDENTLY SUBJECT TO THE ENFORCEMENT PROVISIONS OF THIS AGREEMENT. WITH RESPECT TO RH MIXED WASTE AND MIXED WASTE IN BOXES AND LARGE CONTAINERS, THE PMP SUBMITTED ON 12/31/2003 WILL SPECIFICALLY IDENTIFY MEASURABLE ACTIONS TO BE TAKEN BY DOE TO ACQUIRE CAPABILITIES TO MANAGE SUCH WASTES. THE PMP SHALL IDENTIFY SUCH MEASURABLE ACTIONS AT LEAST YEARLY. THE PMP SUBMITTED ON 12/31/2003 WILL NOT BE REQUIRED TO CONTAIN PLANS AND SCHEDULES FOR THE LDR TREATMENT (OR CERTIFICATION IN LIEU OF SUCH TREATMENT AS PROVIDED FOR IN M-91-42 AND M-91-44) OF TRUM WASTE. WITHIN SIX MONTHS OF ECOLOGY'S APPROVAL OF DOE'S PROPOSAL OR ECOLOGY'S ISSUANCE OF A DETERMINATION PURSUANT TO THE ACCOMPANYING SETTLEMENT AGREEMENT, FOLLOWING RECEIPT OF A FINAL APPEALABLE JUDGMENT ON THE MERITS OF THE LDR STORAGE AND TREATMENT CLAIM IN WASHINGTON V. ABRAHAM, NO. CT-03-5018-AAM, DOE SHALL REVISE THE PMP TO INCLUDE PLANS AND SCHEDULES FOR LDR TREATMENT (OR CERTIFICATION IN LIEU OF SUCH TREATMENT AS PROVIDED IN M-91-42 AND M-91-44) OF TRUM WASTE IN THE MANNER REQUIRED BY DOE'S APPROVED PROPOSAL OR ECOLOGY'S DETERMINATION. PMP REVISIONS WILL BE SUBMITTED TO ECOLOGY FOR REVIEW AND APPROVAL AS PRIMARY DOCUMENTS PURSUANT TO AGREEMENT ACTION PLAN SECTION 9.2.1. DOE SHALL IMPLEMENT THE PLAN AS APPROVED. ONCE APPROVED, THE PMP SUBMITTED ON 12/31/2003, IN ACCORDANCE WITH THIS MILESTONE SHALL SUPERSEDE THOSE PORTIONS OF PREVIOUSLY SUBMITTED DOE PMPS THAT CONCERNED RCRA MIXED WASTE, SUSPECT MIXED TRANSURANIC AND SUSPECT MIXED LOW LEVEL WASTE.	DUE DATES AS INDICATED IN THE DESCRIPTIVE TEXT OF THIS MILESTONE
M-091-05-T01	COMPLETE AND SUBMIT RH TRUM SUSPECT RH TRUM, TRUM IN BOXES AND LARGE CONTAINERS, AND SUSPECT TRUM IN BOXES AND LARGE CONTAINERS RETRIEVAL AND PROCESSING FACILITY(IES) ENGINEERING STUDY/FUNCTIONAL DESIGN CRITERIA STUDY TO ECOLOGY FOR FACILITIES REQUIRED BY M-91-01.	12/31/2007

Number	Milestone	Due Date
	THE TRUM ENGINEERING/FUNCTIONAL DESIGN CRITERIA STUDY WILL COVER ACTIVITIES/FACILITIES NOT CONSIDERED COMMERCIALLY VIABLE AS DOCUMENTED IN THE APPROVED TRUM PMP AND ASSOCIATED AGREEMENT CHANGE REQUESTS.	
M-091-12	COMPLETE THERMAL TREATMENT OF AN ADDITIONAL 360 CUBIC METERS OF CONTACT HANDLED MLLW. THIS BRINGS THE CUMULATIVE TOTAL TO AT LEAST 600 CUBIC METERS OF CONTACT HANDLED MLLW THERMALLY TREATED.	11/16/2007
M-091-12A	COMPLETE THERMAL TREATMENT OF AT LEAST 240 CUBIC METERS OF CONTACT HANDLED MLLW.	09/30/2005
M-091-15	COMPLETE ACQUISITION OF FACILITIES AND/OR CAPABILITIES AND INITIATE TREATMENT OF RH MLLW AND CH MLLW IN BOXES AND LARGE CONTAINERS.	06/30/2008
M-91-40	REGARDING THE RETRIEVAL AND DESIGNATION OF CONTACT-HANDLED (CH) RETRIEVABLY STORED WASTE (RSW) AND TREATMENT OF SUCH WASTES DESIGNATED AS MIXED TO MEET APPLICABLE FEDERAL AND STATE LAND DISPOSAL RESTRICTION (LDR) STANDARDS (ALL CH RSW WASTE REGARDLESS OF PACKAGE SIZE): 1. DOE SHALL RETRIEVE ALL CH-RSW WITHIN BURIAL GROUNDS 218-W-4C, 218-W-4B, 218-W-3A, AND 218-E-12B BY DECEMBER 31, 2010. IN ACHIEVING THIS RETRIEVAL REQUIREMENT, DOE SHALL FIRST INITIATE RETRIEVAL AT ITS BURIAL GROUND 218-W-4C NO LATER THAN NOVEMBER 15, 2003, AND SHALL RETRIEVERSW AT THE FOLLOWING RATES : • 1,200 CUBIC METERS (CUMULATIVE) BY 12/31/04, • 2,700 CUBIC METERS (CUMULATIVE) BY 12/31/05, • 4,700 CUBIC METERS (CUMULATIVE) BY 12/31/06, • 7,200 CUBIC METERS (CUMULATIVE) BY 12/31/07, • 9,700 CUBIC METERS (CUMULATIVE) BY 12/31/08, • 12,200 CUBIC METERS (CUMULATIVE) BY 12/31/09, • COMPLETE RETRIEVAL OF CH-RSW BY 12/31/2010. DOE SHALL CONTINUE RETRIEVAL ACTIONS IN 218-W-4C UNTIL ALL CH RSW IS RETRIEVED. SUBSEQUENT RETRIEVAL ACTIONS, SHALL BE UNDERTAKEN SEQUENTIALLY AT BURIAL GROUNDS 218-E-12B, 218-W-3A, AND 218-W-4B. RETRIEVAL OF WASTE OUT OF THE ORDERED SEQUENCE SHALL NOT BE COUNTED TOWARD THE MILESTONE REQUIREMENT UNLESS JOINTLY AGREED TO BY ECOLOGY AND DOE. DOE MAY REQUEST SUCH APPROVAL WITH RESPECT TO WASTE IN BOXES AND LARGE CONTAINERS. IN REVIEWING SUCH REQUEST, ECOLOGY WILL CONSIDER AMONG OTHER FACTORS; WHETHER THE WASTE CONTAINER HAS BEEN UNCOVERED, INSPECTED AND FOUND TO BE INTACT AND NOT POSING A THREAT TO HUMAN HEALTH AND THE ENVIRONMENT (OR RE-PACKAGED TO PREVENT RELEASE TO THE ENVIRONMENT) AND EXISTING DOCUMENTATION DOES NOT INDICATE THE PRESENCE OF FREE LIQUIDS. ECOLOGY MAY CONDITION ITS AGREEMENT ON A DOE COMMITMENT TO PERFORM ADDITIONAL SPECIFIED REQUIREMENTS (E.G., CONTAINER INSPECTIONS,	DUE DATES AS INDICATED IN THE DESCRIPTIVE TEXT OF THIS MILESTONE

Number	Milestone	Due Date
	COVERING CONTAINERS, ETC.) TO PREVENT RELEASES TO THE ENVIRONMENT. THE RETRIEVAL SEQUENCE IS PRIORITIZED BASED ON ENVIRONMENTAL RISK AND INTENDED TO ENSURE THAT DOE FIRST RETRIEVE WASTE FROM THE 218-W-4C BURIAL GROUND, WHICH HAS POTENTIAL CARBON TETRACHLORIDE CONTAMINATION ISSUES, AND TO SUBSEQUENTLY RETRIEVE WASTES FROM BURIAL GROUND 218-E-12B AND 218-W-3A WHERE CONTAINERS WERE PLACED IN CONFIGURATIONS THAT ALLOWED DIRECT CONTACT WITH THE SOIL. DOE SHALL CONCLUDE RETRIEVAL ACTIONS WITH BURIAL GROUND 218-W-4B. 2. AS RSW RETRIEVAL PROCEEDS, DOE SHALL SAMPLE AND ANALYZE TRENCH SUBSTRATES WITH THE PURPOSES OF DETERMINING WHETHER OR NOT RELEASES OF CONTAMINANTS TO THE ENVIRONMENT HAVE OCCURRED, AND, IF SO, THE NATURE AND EXTENT OF CONTAMINATION. SUCH SAMPLING AND ANALYSIS SHALL BE IN ACCORDANCE WITH ECOLOGY APPROVED SAMPLING AND ANALYSIS PLANS (SAP). THE SAP WILL BE DEVELOPED USING A DQO PROCESS TO ESTABLISH SAMPLING REQUIREMENTS FOR SAMPLING OF BURIAL GROUND VENT RISERS AND SUBSTRATE SOILS. DOE PROVIDED ECOLOGY WITH A DRAFT 218-W-4C SAP ON 8/12/03. ECOLOGY'S INTENTION IS TO ISSUE A FINAL SAP WITHIN 30 DAYS. WITH RESPECT TO THE REMAINING BURIAL GROUNDS, DOE WILL PROVIDE ECOLOGY WITH UPDATED SAPS, IF NEEDED, FOR REVIEW AND APPROVAL AT LEAST 45 DAYS PRIOR TO STARTING RETRIEVAL IN EACH BURIAL GROUND. DOE WILL IMPLEMENT APPROVED SAPS, AS A REQUIREMENT OF THIS MILESTONE, DURING RETRIEVAL OF ALL RSW. THE RESULTS OF BURIAL GROUND VENT AND SUBSTRATE SAMPLING AND ANALYSIS PURSUANT TO APPROVED SAPS SHALL BE SUBMITTED TO ECOLOGY BY LETTER REPORTS QUARTERLY. SUCH REPORTS SHALL DOCUMENT RESULTS AND METHODOLOGIES, SHALL ASSESS RESULTS AGAINST REGULATORY REQUIREMENTS, SHALL INCLUDE A DESCRIPTION (OR DESCRIPTIONS) OF DOCUMENTED CONTAMINANT RELEASES TO THE ENVIRONMENT, AND SHALL DESCRIBE PLANNED AND/OR SCHEDULED ADDITIONAL WORK. 3. WITHIN 90 DAYS OF RETRIEVAL, DOE SHALL DESIGNATE ALL CH RSW RETRIEVED FROM THE RSW TRENCHES PURSUANT TO WAC 173-303-070 THROUGH 100, AND SHALL SPECIFICALLY IDENTIFY INDIVIDUAL BOXES AND LARGE CONTAINERS THAT CANNOT BE DESIGNATED BASED ON AVAILABLE PROCESS KNOWLEDGE. FOR THE BOXES AND LARGE CONTAINERS DETERMINED TO BE LOW-LEVEL WASTE THAT CANNOT BE DESIGNATED BASED ON THE AVAILABLE PROCESS KNOWLEDGE, DOE SHALL DESIGNATE SAID WASTE ACCORDING TO THE REQUIREMENTS OF WAC 173-303-070 THROUGH 100, BY DECEMBER 31, 2008 (SIX MONTHS AFTER THE RH AND LARGE	

Number	Milestone	Due Date
	CONTAINER MLLW FACILITIES AND/OR CAPABILITIES ARE REQUIRED TO BE OPERATIONAL). FOR BOXES AND LARGE CONTAINERS DETERMINED TO BE TRANSURANIC WASTE THAT CANNOT BE DESIGNATED BASED ON THE AVAILABLE PROCESS KNOWLEDGE, DOE SHALL DESIGNATE SAID WASTE ACCORDING TO THE REQUIREMENTS OF WAC 173-303-070 THROUGH 100, BY DECEMBER 31, 2012 (SIX MONTHS AFTER THE RH AND LARGE CONTAINER TRANSURANIC FACILITIES AND/OR CAPABILITIES ARE REQUIRED TO BE OPERATIONAL). 4. FOR ALL RETRIEVED CH-RSW DETERMINED TO BE LOW LEVEL WASTE AND DESIGNATED IN ACCORDANCE WITH WAC 173-303-070 THROUGH 100, AS MIXED AND AS CONTAINING LDR RESTRICTED CONSTITUENTS, DOE SHALL TREAT SUCH WASTES TO MEET LDR REQUIREMENTS IN ACCORDANCE WITH THE SCHEDULE PROVIDED IN MILESTONE M-91-42(2) AND M-91-43(3). 5. IN REGARD TO THE CARBON TETRACHLORIDE VAPOR PLUME IN THE VADOSE ZONE IN THE VICINITY OF TRENCH 4 IN BURIAL GROUND 218-W-4C, DOE SHALL: START VAPOR EXTRACTION BY NOVEMBER 15, 2003, TO REDUCE CARBON TETRACHLORIDE VAPORS. START RETRIEVAL IN TRENCH 4 BY JANUARY 15, 2004 COMPLETE RETRIEVAL OF TRENCH 4 BY DECEMBER 31, 2006. (WITH THE EXCEPTION OF THOSE BOXES AND LARGE CONTAINERS THAT THE PARTIES HAVE AGREED, IN WRITING, MAY BE RETRIEVED OUT OF SEQUENCE.) RETRIEVAL WILL CONTINUE IN TRENCH 4 UNTIL IT IS COMPLETE. VAPOR EXTRACTION AND RETRIEVAL OPERATIONS IN TRENCH 4 WILL BE INTEGRATED BY DOE TO MINIMIZE POTENTIAL WORKER EXPOSURE TO CARBON TETRACHLORIDE VAPORS, AND TO MITIGATE ANY POSSIBLE RELEASES OF CARBON TETRACHLORIDE FROM TRENCH 4 CONTAINERS. 6. FOR ALL RETRIEVED CH-RSW DETERMINED TO BE TRANSURANIC WASTE AND DESIGNATED IN ACCORDANCE WITH WAC 173-303-070 THROUGH 100, AS MIXED AND AS CONTAINING LDR RESTRICTED CONSTITUENTS, DOE SHALL TREAT SUCH WASTES TO MEET LDRR REQUIREMENTS IN COMPLIANCE WITH THE SCHEDULE IN M-91-42(4) AND M-91-44(3). DOE MAY CHOOSE TO COMPLETE CERTIFICATION OF CH TRANSURANIC WASTE FOR DISPOSAL AT WIPP IN LIEU OF LDR TREATMENT, PROVIDED THAT ECOLOGY IS NOTIFIED IN WRITING OF SUCH COMPLETION OF CERTIFICATION, AND ONLY IF, AS OF THE TIME OF CERTIFICATION, SUCH WASTE IS EXEMPT FROM LDR TREATMENT REQUIREMENTS WHEN DISPOSED	

Number	Milestone	Due Date
	AT WIPP. IF DOE CHOOSES TO CERTIFY IN LIEU OF TREATMENT, IT MAY MEET THE VOLUME REQUIREMENTS SPECIFIED IN THIS MILESTONE FOR ANY GIVEN YEAR BY CERTIFYING CH TRU OR CH TRUM. EACH REQUIREMENT OF THIS MILESTONE IS CONSIDERED A DISTINCT WORK REQUIREMENT INDEPENDENTLY SUBJECT TO THE ENFORCEMENT PROVISIONS OF THE AGREEMENT.	
M-91-41	REGARDING THE RETRIEVAL AND DESIGNATION OF REMOTE HANDLED (RH) RSW (ALL RSW RH WASTE REGARDLESS OF PACKAGE SIZE, INCLUDING THE 200 AREA CAISSONS), AND LDR TREATMENT OF SUCH WASTES DETERMINED TO BE MIXED. 1. DOE SHALL INITIATE FULL SCALE RETRIEVAL OF RH RSW BY JANUARY 1, 2011. RETRIEVAL OF NON-CAISSON RH RSW SHALL BE COMPLETED BY DECEMBER 31, 2014. RETRIEVAL THE 200 AREA CAISSON RH RSW IN THE 218-W-4B BURIAL GROUND SHALL BE COMPLETED BY DECEMBER 31, 2018. 2. DOE SHALL DESIGNATE ALL RETRIEVED RH RSW PURSUANT TO WAC 173-303-070 THROUGH 100, WITHIN 90 DAYS OF RETRIEVAL. 3. FOR ALL RETRIEVED RH-RSW DETERMINED TO BE LOW-LEVEL WASTE AND DESIGNATED IN ACCORDANCE WITH WAC 173-303-070 THROUGH 100, AS MIXED AND AS CONTAINING LDR RESTRICTED CONSTITUENTS, DOE SHALL TREAT SUCH WASTE TO MEET LDR REQUIREMENTS IN ACCORDANCE WITH THE SCHEDULE PROVIDED IN MILESTONE M-91-43(3). 4. FOR ALL RETRIEVED RH-RSW DETERMINED TO BE TRANSURANIC WASTE AND DESIGNATED IN ACCORDANCE WITH WAC 173-303-070 THROUGH 100, AS MIXED AND AS CONTAINING LDR RESTRICTED CONSTITUENTS, DOE SHALL TREAT SUCH WASTES TO MEET LDR REQUIREMENTS IN ACCORDANCE WITH THE SCHEDULE PROVIDED IN MILESTONE M-91-44(3). DOE MAY CHOOSE TO COMPLETE CERTIFICATION OF SUCH WASTES FOR DISPOSAL AT WIPP IN LIEU OF LDR TREATMENT, PROVIDED THAT ECOLOGY IS NOTIFIED IN WRITING OF SUCH COMPLETION OF CERTIFICATION, AND ONLY IF, AS OF THE TIME OF CERTIFICATION, SUCH WASTE IS EXEMPT FROM LDR TREATMENT REQUIREMENTS WHEN DISPOSED AT WIPP. 5. EACH REQUIREMENT OF THIS MILESTONE IS CONSIDERED ADISTINCT WORK REQUIREMENT INDEPENDENTLY SUBJECT TO THE ENFORCEMENT PROVISIONS OF THE AGREEMENT.	DUE DATES AS INDICATED IN THE DESCRIPTIVE TEXT OF THIS MILESTONE
M-91-42	REGARDING: (1) NEWLY GENERATED CH WASTE; AND (2) CH WASTE CURRENTLY IN ABOVE-GROUND STORAGE (NOT INCLUDING CH WASTE CURRENTLY IN ABOVE-GROUND STORAGE IN BOXES AND LARGE CONTAINERS). 1. DOE SHALL DESIGNATE ALL NEWLY GENERATED CH WASTE AT	DUE DATES AS INDICATED IN THE DESCRIPTIVE TEXT OF

Number	Milestone	Due Date
	THE POINT OF GENERATION. SUCH DESIGNATION SHALL COMPLY WITH THE REQUIREMENTS OF WAC 173-303-070 THROUGH 100. 2. THERE ARE 5,066 CUBIC METERS OF CH-MLLW IN PERMITTED STORAGE AT DOE'S CENTRAL WASTE COMPLEX (CWC) AND ELSEWHERE AT HANFORD AS OF 12/31/02 (AS IDENTIFIED IN DOE HFFACO MILESTONE M-26-01 LDR REPORT MLLW TREATABILITY GROUPS MLLW-02 THROUGH MLLW-10, EXCLUDING MLLW-07) THAT HAS NOT BEEN TREATED TO MEET LDR REQUIREMENTS. (THIS VOLUME DOES NOT INCLUDE 600 CUBIC METERS OF WASTE REQUIRING THERMAL TREATMENT, AS THAT WASTE IS REQUIRED TO BE TREATED BY 2006 UNDER HFFACO MILESTONES M-91-12 AND M-91-12A). DOE'S 2002 LDR REPORT ESTIMATES THAT IT WILL GENERATE AN ADDITIONAL ANNUAL VOLUME OF APPROXIMATELY 330 CUBIC METERS OF CH-MLLW (AS WASTE TYPES IDENTIFIED IN DOE HFFACO MILESTONE M-26-01 LDR REPORT MLLW TREATABILITY GROUPS MLLW-02 THROUGH MLLW-10, EXCLUDING MLLW-07). DOE WILL RETRIEVE APPROXIMATELY 800 CUBIC METERS OF CH-MLLW BY 2010. IN ADDITION TO MEETING THE REQUIREMENTS OF M-91-12 AND M-91-12A, DOE SHALL TREAT THE WASTE DESCRIBED ABOVE TO MEET LDR REQUIREMENTS ON A SCHEDULE MEETING, AT MINIMUM, THE FOLLOWING: A. 1630 CUBIC METERS (CUMULATIVE) SHALL BE TREATED BY 12/31/04, B. 3260 CUBIC METERS BY (CUMULATIVE) SHALL BE TREATED BY 12/31/05, C. 4890 CUBIC METERS (CUMULATIVE) SHALL BE TREATED BY 12/31/06, D. 6520 CUBIC METERS (CUMULATIVE) SHALL BE TREATED BY 12/31/07, E. 8150 CUBIC METERS (CUMULATIVE) SHALL BE TREATED BY 12/31/08, AND F. COMPLETE TREATMENT OF ALL CH-MLLW (5066 CUBIC METERS IN STORAGE AS OF 12/31/02 AS DESCRIBED ABOVE, AND RETRIEVED CH-MLLW AND NEWLY GENERATED CH-MLLW IN THE TREATABILITY GROUPS DESCRIBED ABOVE, AS OF 6/30/09) BY 12/31/09 IF CH-MLLW IN THE TREATABILITY GROUPS SUBJECT TO THIS MILESTONE GENERATED DURING THE PERIOD FROM 12/31/02 THROUGH 6/30/09 IS TREATED TO LDR STANDARDS PRIOR TO DELIVERY TO STORAGE OR DISPOSAL, THE ORIGINAL PRE-TREATMENT VOLUME OF THAT WASTE SHALL BE COUNTED TOWARD MEETING THE VOLUME REQUIREMENTS OF THIS MILESTONE. EXCEPT FOR WASTE ALREADY IN PERMITTED STORAGE, TREATMENT OF CERCLA WASTE WILL NOT BE COUNTED TOWARD MEETING THE VOLUME REQUIREMENTS OF THIS MILESTONE. IF THE ACTUAL VOLUME OF NEWLY GENERATED OR RETRIEVED CH-MLLW COVERED BY THIS	THIS MILESTONE

Number	Milestone	Due Date
	MILESTONE IS LOWER THAN THE ESTIMATED VOLUMES ANTICIPATED BY THESE MILESTONES DOE WILL ONLY BE REQUIRED TO TREAT THE VOLUME OF WASTE GENERATED, RETRIEVED AND/OR IN STORAGE. IF THE ACTUAL VOLUME OF NEWLY GENERATED OR RETRIEVED CH-MLLW COVERED BY THIS MILESTONE IS SIGNIFICANTLY MORE THAN THE ESTIMATED VOLUMES THE PARTIES' MAY AGREE TO REVISE THESE REQUIREMENTS. 3. AFTER JUNE 30, 2009, DOE SHALL TREAT TO MEET LDR TREATMENT REQUIREMENTS ALL NEWLY GENERATED CH-MLLW CONTAINING LDR CONSTITUENTS IN COMPLIANCE WITH WAC 173-303-140 AND BY REFERENCE 40 CFR 268. 4. THERE ARE APPROXIMATELY 440 CUBIC METERS OF CH-TRUM IN PERMITTED STORAGE AT DOE'S CENTRAL WASTE COMPLEX (CWC) AND ELSEWHERE AT HANFORD AS OF 12/31/02. DOE'S 2002 LDR REPORT ESTIMATES THAT IT WILL GENERATE AN ADDITIONAL ANNUAL VOLUME OF APPROXIMATELY 220 CUBIC METERS OF CH-TRUM AND DOE ESTIMATES THEY WILL RETRIEVE APPROXIMATELY 1600 CUBIC METERS OF CH-TRUM BY 2010. CONSIDERING THESE ESTIMATES AND THE CONSIDERABLE UNCERTAINTY ASSOCIATED WITH THEM DOE SHALL TREAT THE WASTE CATEGORIES DESCRIBED ABOVE TO MEET LDR REQUIREMENTS ON THE FOLLOWING SCHEDULE: • 700 CUBIC METERS BY 12/31/04; • 1,800 CUBIC METERS (CUMULATIVE) BY 12/31/05; • 3,000 CUBIC METERS (CUMULATIVE) BY 12/31/06, • 4,200 CUBIC METERS (CUMULATIVE BY 12/31/07 • 5,400 CUBIC METERS (CUMULATIVE BY 12/31/08 • 6,600 CUBIC METERS (CUMULATIVE BY 12/31/09 • 7,600 CUBIC METERS (CUMULATIVE) BY 12/31/10; • 8,600 CUBIC METERS (CUMULATIVE) BY 12/31/11. IF THE ACTUAL VOLUME OF NEWLY GENERATED OR RETRIEVED CH-TRUM COVERED BY THIS MILESTONE IS LOWER THAN THE ESTIMATED VOLUMES ANTICIPATED BY THESE MILESTONES DOE WILL ONLY BE REQUIRED TO TREAT THE VOLUME OF WASTE GENERATED, RETRIEVED AND/OR IN STORAGE. IF THE ACTUAL VOLUME OF NEWLY GENERATED OR RETRIEVED CH-TRUM COVERED BY THIS MILESTONE IS SIGNIFICANTLY MORE THAN THE ESTIMATED VOLUMES THE PARTIES' MAY AGREE TO REVISE THESE REQUIREMENTS. 5. FOR CH TRANSURANIC WASTE NEWLY GENERATED ON OR AFTER 7/1/11 THAT IS DESIGNATED IN ACCORDANCE WITH WAC 173-303-070 THROUGH 100 AS MIXED AND AS CONTAINING LDR RESTRICTED CONSTITUENTS, DOE SHALL TREAT SUCH WASTES TO MEET LDR REQUIREMENTS PURSUANT TO WAC 173-303-140	

Number	Milestone	Due Date
	WITHIN ONE YEAR OF GENERATION. DOE MAY CHOOSE TO COMPLETE CERTIFICATION OF CH TRANSURANIC WASTE FOR DISPOSAL AT WIPP IN LIEU OF LDR TREATMENT, PROVIDED THAT ECOLOGY IS NOTIFIED IN WRITING OF SUCH COMPLETION OF CERTIFICATION, AND ONLY IF, AS OF THE TIME OF CERTIFICATION, SUCH WASTE IS EXEMPT FROM LDR TREATMENT REQUIREMENTS WHEN DISPOSED AT WIPP. IF DOE CHOOSES TO CERTIFY IN LIEU OF TREATMENT, IT MAY MEET THE VOLUME REQUIREMENTS SPECIFIED IN THIS MILESTONE FOR ANY GIVEN YEAR BY CERTIFYING CH TRU OR CH TRUM, PROVIDED THAT 1) ALL CH TRUM IN PERMITTED STORAGE AS OF 12/31/02 IS TREATED TO MEET LDR REQUIREMENTS OR CERTIFIED BY 12/31/2006 AND 2) ALL CH TRUM IN PERMITTED STORAGE AS OF 7/1/11 IS TREATED TO MEET LDR REQUIREMENTS OR IS CERTIFIED BY 12/31/2011. IN THE EVENT THAT ITEMS 4 OR 5 BECOME APPLICABLE, AMOUNTS OF CH TRUM CERTIFIED BETWEEN 12/31/02 AND THE DATE ON WHICH ITEMS 4 OR 5 BECOME APPLICABLE SHALL COUNT TOWARDS SATISFACTION OF THE OBLIGATIONS IN ITEMS 4 AND 5. 6. EACH REQUIREMENT OF THIS MILESTONE IS CONSIDERED A DISTINCT WORK REQUIREMENT INDEPENDENTLY SUBJECT TO THE ENFORCEMENT PROVISIONS OF THE AGREEMENT.	
M-91-43	REGARDING: (1) NEWLY GENERATED RH LOW-LEVEL WASTE; (2) NEWLY GENERATED BOXES AND LARGE CONTAINERS OF CH LOW-LEVEL WASTE; (3) RH LOW-LEVEL WASTE CURRENTLY IN ABOVE-GROUND STORAGE; AND (4) BOXES AND LARGE CONTAINERS OF CH LOW-LEVEL WASTE CURRENTLY IN ABOVE-GROUND STORAGE. THERE ARE 81 CUBIC METERS OF RH-MLLW IN PERMITTED STORAGE AT DOE'S CENTRAL WASTE STORAGE COMPLEX (CWC) AND ELSEWHERE AT HANFORD AS OF 12/31/02 (AS IDENTIFIED IN DOE HFFACO MILESTONE M-26-01 LDR REPORT MLLW TREATABILITY GROUPS MLLW-07) THAT HAS NOT BEEN TREATED TO MEET LDR REQUIREMENTS. DOE'S 2002 LDR REPORT CURRENTLY ESTIMATES THAT DOE WILL GENERATE AN ADDITIONAL YEARLY VOLUME OF 280 CUBIC METERS OF WASTE IN THIS TREATABILITY GROUP. IN ADDITION, DOE WILL RETRIEVE APPROXIMATELY 800 CUBIC METERS BY 2010. THIS INCLUDES VOLUMES OF RETRIEVED RSW. 1. DOE SHALL DESIGNATE ALL RH LOW-LEVEL WASTE AND BOXES AND LARGE CONTAINERS OF CH LOW-LEVEL WASTE CURRENTLY IN ABOVE-GROUND PERMITTED STORAGE (AS OF JUNE 30, 2003) ACCORDING TO THE REQUIREMENTS OF WAC 173-303-070 THROUGH 100, BY DECEMBER 31, 2008. 2. DOE SHALL DESIGNATE ALL NEWLY GENERATED RH LOW-LEVEL WASTE AND TRANSURANIC WASTE AND NEWLY GENERATED BOXES AND LARGE CONTAINERS OF CH-LOW-LEVEL WASTE AT THE POINT OF GENERATION. SUCH DESIGNATION SHALL COMPLY WITH THE REQUIREMENTS OF WAC 173-303-070 THROUGH 100.	DUE DATES AS INDICATED IN THE DESCRIPTIVE TEXT OF THIS MILESTONE

Number	Milestone	Due Date
	3. DOE SHALL BEGIN TREATING RH MLLW AND BOXES AND LARGE CONTAINERS OF CH MLLW TO MEET LDR TREATMENT REQUIREMENTS AT A MINIMUM RATE OF 300 CUBIC METERS PER YEAR BEGINNING NO LATER THAN JUNE 30, OF 2008. IF THERE ARE NOT 300 CUBIC METERS OF RH MLLW AND BOXES AND LARGE CONTAINERS OF CH MLLW IN STORAGE IN ANY GIVEN YEAR, THIS MILESTONE REQUIRES THAT DOE TREAT ONLY THAT AMOUNT THAT IS IN STORAGE. IF RH-MLLW IN THE TREATABILITY GROUPS SUBJECT TO THIS MILESTONE GENERATED DURING THE PERIOD FROM 12/31/02 THROUGH 6/30/09 IS TREATED TO LDR STANDARDS PRIOR TO DELIVERY TO STORAGE OR DISPOSAL, THE ORIGINAL PRE-TREATMENT VOLUME OF THAT WASTE SHALL BE COUNTED TOWARD MEETING THE VOLUME REQUIREMENTS OF THIS MILESTONE. EXCEPT FOR WASTE ALREADY IN PERMITTED STORAGE, TREATMENT OF CERCLA WASTE WILL NOT BE COUNTED TOWARD MEETING THE VOLUME REQUIREMENTS OF THIS MILESTONE. IF ACTUAL VOLUMES OF NEWLY GENERATED OR RETRIEVED RH AND BOXES AND LARGE CONTAINER MLLW ARE SIGNIFICANTLY MORE THAN THE ESTIMATED VOLUMES, THIS MILESTONE WILL BE REVISED TO REFLECT ACTUAL VOLUMES. 4. EACH ELEMENT OF THIS MILESTONE IS CONSIDERED A DISTINCT WORK REQUIREMENT INDEPENDENTLY SUBJECT TO THE ENFORCEMENT PROVISIONS OF THE AGREEMENT.	
M-91-44	REGARDING: (1) NEWLY GENERATED RH TRANSURANIC WASTE; (2) NEWLY GENERATED BOXES AND LARGE CONTAINERS OF CH-TRANSURANIC WASTE; (3) RH TRANSURANIC WASTE CURRENTLY IN ABOVE GROUND STORAGE; AND (4) BOXES AND LARGE CONTAINERS OF CH TRANSURANIC WASTE CURRENTLY IN ABOVE-GROUND STORAGE. 1. DOE SHALL DESIGNATE ALL RH TRANSURANIC WASTE AND BOXES AND LARGE CONTAINERS OF CH TRANSURANIC WASTE CURRENTLY IN ABOVE- GROUND STORAGE (AS OF JUNE 30, 2003) ACCORDING TO THE REQUIREMENTS OF WAC 173-303-070 THROUGH 100, BY DECEMBER 31, 2012. 2. DOE SHALL DESIGNATE ALL NEWLY GENERATED RH TRANSURANIC WASTE AND BOXES AND LARGE CONTAINERS OF TRANSURANIC WASTE AT THE POINT OF GENERATION. SUCH DESIGNATION SHALL COMPLY WITH THE REQUIREMENTS OF WAC 173-303-070 THROUGH 100. 3. DOE SHALL BEGIN TREATING RH TRUM AND BOXES AND LARGE CONTAINERS OF CH TRUM TO MEET LDR TREATMENT REQUIREMENTS AT A MINIMUM RATE OF 300 CUBIC METERS PER YEAR BEGINNING NO LATER THAN JUNE 30, 2012. IF THERE ARE NOT 300 CUBIC METERS OF RH TRUM AND BOXES AND LARGE CONTAINERS OF CH TRUM IN STORAGE IN ANY GIVEN YEAR, THIS MILESTONE REQUIRES THAT DOE TREAT ONLY THAT AMOUNT THAT IS IN STORAGE. IF ACTUAL VOLUMES OF NEWLY GENERATED OR RETRIEVED RH TRUM AND	DUE DATES AS INDICATED IN THE DESCRIPTIVE TEXT OF THIS MILESTONE

Number	Milestone	Due Date
	BOXES AND LARGE CONTAINER TRUM ARE SIGNIFICANTLY MORE THAN THE ESTIMATED VOLUMES, THIS MILESTONE WILL BE REVISED TO REFLECT ACTUAL VOLUMES. 4. AS TO NEWLY GENERATED RH TRUM GENERATED AFTER 12/31/18 THAT IS DESIGNATED IN ACCORDANCE WITH WAC 173-303-070 THROUGH -100 AS MIXED AND AS CONTAINING LDR RESTRICTED CONSTITUENTS, DOE SHALL TREAT TO MEET LDR REQUIREMENTS WITHIN ONE YEAR OF GENERATION. DOE MAY CHOOSE TO COMPLETE CERTIFICATION OF SUCH WASTES FOR DISPOSAL AT WIPP IN LIEU OF LDR TREATMENT, PROVIDED THAT ECOLOGY IS NOTIFIED IN WRITING OF SUCH COMPLETION OF CERTIFICATION AND ONLY IF, AS OF THE TIME OF CERTIFICATION, SUCH WASTE IS EXEMPT FROM LDR TREATMENT REQUIREMENTS WHEN DISPOSED AT WIPP. 5. EACH REQUIREMENT OF THIS MILESTONE IS CONSIDERED ADISTINCT WORK REQUIREMENT INDEPENDENTLY SUBJECT TO THE ENFORCEMENT PROVISIONS OF THE AGREEMENT.	
M-91-45	BY SEPTEMBER 30 OF EACH YEAR, DOE SHALL SUBMIT TO ECOLOGY A REPORT DESCRIBING COMPLETED AND SCHEDULED WORK RELATING TO RH WASTE AND BOXES AND LARGE CONTAINERS OF RH AND CH WASTE PERFORMED IN ACCORDANCE WITH THE REQUIREMENTS OF THIS MILESTONE SERIES. DOE'S REPORTS WILL DOCUMENT WORK COMPLETED DURING THE PREVIOUS FEDERAL FISCAL YEAR AND WORK SCHEDULED FOR THE COMING FISCAL YEAR. DOE'S REPORTS SHALL IDENTIFY BY CITATION ALL PUBLICLY AVAILABLE REPORTS DESCRIBING PERTINENT PROJECT ISSUES AND ACCOMPLISHMENTS, AND SHALL IDENTIFY ANTICIPATED PROJECTS FOR THE COMING YEAR.	09/30/2004 AND ANNUALLY THEREAFTER

Appendix B

Container Sizes in SWITS

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Appendix B

Container Sizes in SWITS

Several different types and sizes of waste containers were used to package the mixed low-level (MLLW) and transuranic (TRU) waste to be processed. A list of the number of containers as recorded in the Solid Waste Information Tracking System and Solid Waste Integrated Forecast Technical Report, along with the volume (m^3) by location, is shown in the following table. Dimensions shown in the container field are in feet.

Waste Type	Container Size	Storage	Retrievably Stored	Forecast	Grand Total
CH MLLW	17.7*9.7*13.6	66			66
	12*6*6	12			12
	10.1*7.3*5.6	12			12
	11*7.8*4.7	23			23
	5.6*7.4 11.3	13			13
CH MLLW Total		126			126
RH MLLW	9.7*8.6*6.2	15			15
	8*8*7.5	14			14
	8*7.8*7.5	13			13
	9.2*8.2*5.7	12			12
	9*8*5.7	12			12
	9.3*6.5*5.6	9.6			9.6
	9.7*5.7*5.6	8.7			8.7
	10.67*6.6*3.75	7.5			7.5
	9*5*5	25			25
	MB-VI (5x5x9)			194	194
	8.5*4.5*4.9	5.3			5.3
	8*5*4	4.6			4.6
	8*4*4	6.8			6.8
	6*4*4	2.7			2.7
	6*3*3	3.1			3.1
	7.7*2.6*2.4	1.1			1.1
	6.4*2.4*2.6	1.1			1.1
	6*2*2	2			2
	85 GALLON	1.6			1.6
	55 GALLON	2.9			2.9
	208 LITER	0.83			0.83
	208 L Drum (lead-lined)			6.4	6.4
	208 L Drum (1A2)			328	328

Waste Type	Container Size	Storage	Retrievably Stored	Forecast	Grand Total
RH MLLW Total		148		529	677
CH TRU	Concrete Monolith			90	90
	20*12.7*9		452		452
	20*11.6*9		393		393
	15.5*16.8*7.8	44			44
	20*10.67*9		925		925
	19.6*10.6*8.3		48		48
	16*10.67*9		965		965
	12.7*12*9		39		39
	12*10.7*10.5		190		190
	16*10*8		184		184
	20*8*8	11	36		47
	IP-2			321	321
	1250 CU FT	35	35		71
	12*10.7*9		555		555
	12*9.9*9.5		32		32
	16*10*7		32		32
	17.7*11.3*5.4	31			31
	18.5*8*6.5		81		81
	16.1*9.7*5.3	24			24
	14.6*8*6.5		194		194
	9.3*15.2*5.3	21			21
	14.7*8*6.3		22		22
	10.7*8*8		39		39
	13*10*5		18		18
	16.5*7.1*5.2		90		90
	10.8*9.7*5.7	17			17
	17*7*5	17	17		34
	9.2*10.7*5.3	15			15
	16*8*4		14		14
	12*7.1*6		43		43
	12*7*6	57			57
	10.7*8.1*5.7	14			14
	16*6*5		14		14
	12.7*8.8*4.1	15			15
	11*7.7*5.4	26	39		65
	10.1*7.3*5.6		175		175
	15.6*6.2*4.2		11		11
	11*7.8*4.7		101		101
	16.5*6*4		11		11
	10*7.1*5.5	55	33		88
	10.5*7.1*5.2		99		99
	9.3*9.7*4.2	19			19
	15*6*4		20		20
	10.6*5.8*5.8		20		20

Waste Type	Container Size	Storage	Retrievably Stored	Forecast	Grand Total
	16*5.5*4		10		10
	9.6*6.1*6		9.9		9.9
	11.2*5.7*5.5		29		29
	9*6.2*6.2		34		34
	9.3*5.7*6.4	281			281
	9.3*6.5*5.6	48			48
	11*6*5	19			19
	9.6*5.8*5.8		64		64
	10*8*4		9.1		9.1
	13.2*6.5*3.7		8.8		8.8
	Ion exchange module			35	35
	9.8*5.7*5.3		50		50
	7.2*5.8*6.7		16		16
	11.8*5.1*4.6		7.8		7.8
	10*6*4.5		7.6		7.6
	269 CU. FT.		7.6		7.6
	6.1*6.1*7	15			15
	13*4*5	7.4			7.4
	252 CU FT	21	7.1		29
	7*6*6	287	81		369
	9*7*4		14		14
	10*6*4	14	27		41
	6.9*6.7*5.1	6.7			6.7
	12.1*4.7*4.1	6.6			6.6
	12.1*4.6*4.1	6.4			6.4
	9*5*5	51			51
	7.3*5.7*5.3		19		19
	216 CU FT		12		12
	6*6*6		47		47
	6.8*5.6*5.4	23			23
	8*5*5	5.7			5.7
	197 CU FT		11		11
	8*5*4.83		11		11
	9*5*4		5.1		5.1
	7*5*5	39			39
	8*6*3.5		4.8		4.8
	10.3*5*3.17		4.6		4.6
	156 CU FT		13		13
	149 CU FT	4.2	4.2		8.4
	7.33*4.5*4.5	21			21
	7.3*4.5*4.5	25			25
	8*4*4	13	7.3		20
	MB-V (4x4x8)			7.9	7.9
	5.7*4.7*4.7	3.7			3.7
	5*5*5		3.5		3.5
	10*4*3		6.8		6.8

Waste Type	Container Size	Storage	Retrievably Stored	Forecast	Grand Total
	6*5*4	96	47		142
	8*5*3		6.8		6.8
	115 CU FT		3.3		3.3
	7*4*4	74	95		169
	108 CU FT		3.1		3.1
	6.7*4.5*3.2		2.7		2.7
	15*3*2		2.5		2.5
	3.08*5.92*4.54	7			7
	5.9*3.08*4.54	7.6			7.6
	5.9*4.5*3.1	73			73
	5.7*4.5*3.2	2.3			2.3
	6*4.5*3	2			2
	80.8 CU FT		2.3		2.3
	5*4*4		4.5		4.5
	5.7*4.3*3.1	8.2			8.2
	5.73*4.32*3.06	12			12
	6*4*3	1.9			1.9
	5.9*4*2.9	1.9			1.9
	4*4*4		18		18
	9*5	9			9
	8.75*8.75	15			15
	5*4*3	19			19
	6*3*3	1.5			1.5
	7*12	209	13		222
	3*3*4		4.1		4.1
	4*3*3		4.1		4.1
	5.7*2.3*2.3	2.5			2.5
	4.3*2.6*2.6		2.5		2.5
	3*3*3		7.8		7.8
	4*2.5*2.5		18		18
	5.6*7.4 11.3		26		26
	6*2*2		0.68		0.68
	2.5*2.5*2.5		2.3		2.3
	110 GALLON		23		23
	4*4	19			19
	4*5	8.9			8.9
	4*8	11			11
	2*2*3		6.2		6.2
	322 LITER	10	0.32		11
	85 GALLON	563	99		661
	POC (Pipe Overpack Container)			2.2	2.2
	55 GALLON	0.78	0.91		1.7
	1.8*1.38*0.94	17			17
	UNKNOWN		272		272

Waste Type	Container Size	Storage	Retrievably Stored	Forecast	Grand Total
CH TRU Total		2,473	6,129	457	9,058
RH TRU	20*8*8		36		36
	3*8.5*12	8.7			8.7
	9*5*5	19			19
	6.8*5.6*5.4	47			47
	8.3*5*4.25	50			50
	Metal box, Shielded, 4x4x8			359	359
	7*4*4		22		22
	7*4*3		2.4		2.4
	3.08*5.92*4.54	7			7
	5*4*4		6.8		6.8
	4*4*4		27		27
	9*5	27			27
	SWB			92	92
	5.7*2.3*2.3	2.5			2.5
	3*3*3		9.9		9.9
	322 LITER	1.6			1.6
	85 GALLON	3.2	0.32		3.5
	55 GAL LEAD LN	1.3			1.3
	55 GALLON	41	29		70
	208 LITER	1.5			1.5
	208 L Drum (lead-lined)			27	27
	208 L Drum (concrete-lined)			10	10
	208 L Drum (1A1)			33	33
	208 L Drum (1A2)			488	488
	30 GALLON		0.35		0.35
	1.37*1.52	50			50
	5 GALLON		1.5		1.5
	2 GALLON		0.03		0.03
	1 GALLON		22		22
	125 ML	0.01			0
	UNKNOWN	0.42	82		82
RH TRU Total		260	240	1,009	1,509
Grand Total		3,006	6,369	1,994	11,369

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Appendix C

New Processing Functions

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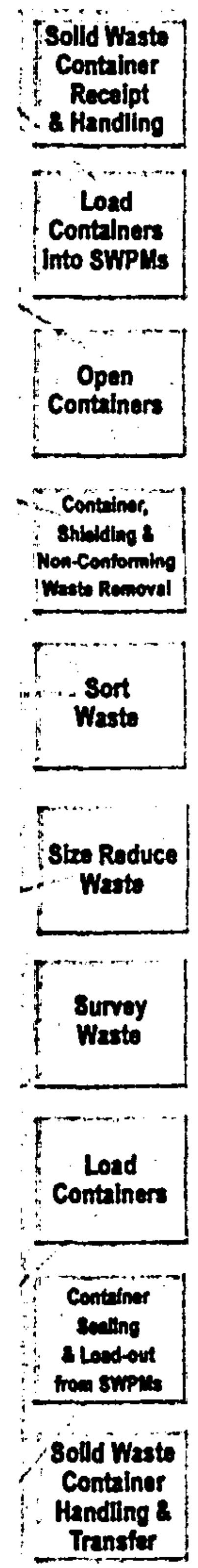
Appendix C

New Processing Functions



The T Plant Complex has been selected for the location to install the Solid Waste Processing Center (SWPC). The SWPC provides the capabilities to process MLLW and TRU Waste that is either CH in Boxes/Large Containers or RH Waste in Various Packages into LDR compliant waste packages. The SWPC is divided into four main segments. The segments include:

1. Solid Waste Handling Facility (SWHF)
2. Solid Waste Processing Modules (SWPM)
3. Assay Building for MLLW
4. MLLW Immobilization Module

In addition to adding the capabilities for the ten main functions, existing systems in the T Plant Complex (e.g., Ventilation, Electrical, Canyon Cranes, Sewer) will require modification.

Solid Waste Handling Facility:

The SWHF will be an addition to the south end of the 221-T Building. The SWHF will include a shipping and receiving area; airlocks that provide access to the 221-T Canyon and the solid waste processing modules; a storage area for waste containers, spare parts, and supplies; and the Process Control and Support Area (PCSA) for the SWPM. The SWHF will be built early in the construction schedule so the new airlocks can provide additional access to the 221-T Canyon for canyon construction activities, removal of debris from canyon clean up, and insertion of the SWPM.

Solid Waste Processing Modules:

The SWPM will be installed on the deck level of the south end of the 221-T Canyon. The SWPM includes the systems, equipment, and components necessary to load in, open, sort, reduce size, package, assay, and release waste containers. The modules will be designed for ease of decontamination. Ventilation will be connected to the main 221-T building stack and cascade air from areas of lower contamination to areas of higher contamination. The 221-T Canyon structure and equipment (e.g., cover blocks, crane maintenance platform, penetrations) will be modified as required to accommodate the SWPM. The modules include:

1. Main Transfer Module
2. TRU Waste Transfer Module

3. MLLW Transfer Module
4. Primary Open, Sort, Size Reduction Module POSSM
5. MLLW Dose Measurement and Container Packaging Module
6. TRU Waste Open, Sort, Size Reduction Module (TOSSM)
7. Manned Processing and Maintenance Module (MPMM)
8. TRU Waste Container Loading, Dose Measurement, and Airlock Module
9. TRU Waste Lag Storage and Assay Module
10. RH TRU 72-B Canister-Loading Module

Assay Building for MLLW

Waste containers loaded in the MLLW container loading module (5 ft x 5 ft x 9 ft or SWB) will be taken to a building on or near the T Plant Complex for assay. This assay will confirm that the container is MLLW or TRU. Containers that are MLLW will be transferred to the immobilization area for further processing. SWB containers that are TRU will be transferred to WRAP for further processing. 5 ft x 5 ft x 9 ft containers that are TRU will be reprocessed in the SWPC.

MLLW Immobilization Module

The MLLW requires macroencapsulation to meet LDR requirements prior to disposal. The system/equipment to perform the immobilization will be located at the 2706-T Complex.

The SWPC will be designed to provide the capabilities to perform the ten major functions. The functions (shown on the side bar on the previous page) are:

1. Solid Waste Container Receipt and Handling
2. Load Containers into SWPM
3. Open Containers
4. Container, Shielding and Non-Conforming Waste Removal
5. Sort Waste
6. Size Reduce Waste
7. Load Containers
8. Container Sealing and Load-out from SWPMs
9. Survey Waste
10. Solid Waste Container Handling and Transfer.

Potential remote equipment technologies, summarized in Appendix G, are discussed below for each of the functions.

C.1 Solid Waste Container Receipt and Handling

The primary path for receipt and handling both MLLW and TRU waste containers will be through the SWHF. Waste packages will vary in size and weight from a 1-gallon can weighing a few pounds to a container 13 ft wide x 20 ft long x 11 ft tall weighing 83,000 pounds. The incoming waste container will be shielded to CH levels. An overpack container will be supplied for waste containers that are damaged or require additional shielding.

The SWHF will have a 60-ton overhead bridge crane to unload and handle waste containers. The overhead crane will be radio-controlled from the shipping area floor or operated from a control room in the support area of the SWHF.

Product waste containers and associated equipment will be staged for use (WIPP SWBs, 5 ft × 5 ft × 9 ft containers, 55-gallon drums, and RH-72B containers).

C.1.1 Load Containers into SWPMs

MLLW and TRU waste container are loaded into the SWPM through the main transfer modules. The main transfer modules consist of three air locks. The airlocks are provided for contamination control. Container movement through the airlocks is by a conveyor system. The overhead crane in the SWHF places a container on a conveyor adjacent to the first airlock. Once placed on the conveyor the containers move without further assistance from the crane. The airlocks will be controlled from the main control room in the SWHF. If the waste container had to be over-packed, the over-pack will be unloaded in the second airlock. In the airlock before the POSSM the waste container will be x-rayed to determine if the contents present any unique challenges for lid removal.

Containers can be loaded into the SWPM through the TRU waste load-out modules on the north side of the SWPM (these modules are described in the Solid Waste Container Handling & Transfer Section, C.1.9). For this condition the waste container are brought into the 221-T Canyon through the train tunnel and placed on the TRU waste load-out module access conveyor by the 221-T Canyon crane. Containers load in this direction are limited in size to 5 ft x 5 ft x 9 ft and weight to 20000 lbs.

Approximate Space Requirements:

- 3 Transfer Module Airlocks – 21 ft x 30 ft each
- Container Load-In Staging Area – 21 ft x 35 ft

C.1.2 Open Containers

Containers are opened in the POSSM. This module contains an assortment of remotely operated systems, equipment, and tools to facilitate the opening of any size container from the anticipated waste inventory. The systems, equipment, and tools will be operated from the main control room in the SWHF. The POSSM is 35 feet wide and 110 feet long. The container opening area is large enough to stage two 13 ft x 20 ft waste boxes at a time. The height of the POSSM is 19 ft.

In the POSSM the primary system for container opening will be 10-ton bridge crane with a telescoping mast equipped with two manipulator arms. The crane also has a 10-ton cable hoist for heavy lifting. The crane will be approximately 35 feet wide and travel the full length of the POSSM. The POSSM will have two of these cranes.

The manipulator arms will be capable of operating different tools required for container opening. The manipulator arms will hold one tool at a time with the change of tools performed remotely.

Heavy lifting will be performed by the 10-ton lifting hoist. Below the hook lifting devises will be provided. These devices will be design for remote installation.

The discussion in this section applies to the opening of boxes/large containers. There will be smaller containers (e.g., 55-gallon drums, 5-gallon cans, 1-gallon cans) that will require opening. The system for opening the smaller containers will be included with the size-reduction equipment discussed in Section C.1.5.

Containers are opened in the SWPM container opening module. This module contains an assortment of tools and utilities to facilitate the opening of any size container from the anticipated waste inventory.

C.1.2.1 Container Opening Tools

These technologies range from systems that need design and development to simple industrial tools. Each has advantages and disadvantages depending on the application.

Heavy Lift Hook – The heavy lift and hook combination will be used for opening containers with a lifting bail. There are several large containers that have a lid simply set on the box. These may be opened and the lid transferred to size reduction while the rest of the box is sorted.

Circular Saw – A circular saw is a powerful cutting tool which can be used to cut a wide variety of material by using different types of cutting blades. In the POSSM there would be several circular saws equipped with the different types of blades. The appropriate saw would be remotely attached to the manipulator arm.

- Wood and plastic – This material would be cut using a carbide tipped blade. This type of saw cuts quickly and is very effective for this type of material.

Advantages:
- Common tool readily available
- Blades are common and easy to change
- Low vibration, lower stress on the manipulator

Disadvantages:
- The process generates sawdust that will have to be cleaned up
- The blade can bind and prevent the saw from cutting. Care must taken in how the cut is made to prevent binding.

- Concrete or Asphalt – This type of material requires a diamond tip blade for cutting. This is the only method for cutting concrete and asphalt. The standard circular saw used for cutting concrete and asphalt is larger and more powerful than the saw used to cut other materials.

  Advantages:
  - Common tool readily available
  - Blades are common and easy to change
  - Low vibration, lower stress on the manipulator

  Disadvantages:
  - The process generates dust that will have to be cleaned up
  - The blade can bind and prevent the saw from cutting. Care must taken in how the cut is made to prevent binding.
  - The cutting process creates heat that is usually cooled using water. Since water is not allowed in the SWPM, the cutting life of the blade will be reduced.

- Metals – This type of material can be cut using a carbide tip blade, a carborundum (abrasive) blade, or a diamond tip. This type of saw cuts quickly and is very effective for this type of material.

  Advantages:
  - Common tool readily available
  - Blades are common and easy to change
  - Low vibration, lower stress on the manipulator

  Disadvantages:
  - The process generates sparks which will create a challenge for fire protection.
  - This process generates dust that will have to be cleaned up
  - The blade can bind and prevent the saw from cutting. Care must taken in how the cut is made to prevent binding.

- ***Plasma Torch*** – A plasma torch uses a high voltage/current electric field between the head and the work piece to heat a fill gas (such as nitrogen). The ionized gas (plasma) is then forced through a vortex generator. The gas is then forced out of the generator at high speed.

The plasma eats through most electrically conductive materials rapidly. The high speed of the ejected plasma blows the molten fragments of the target out of the way of the cutting jet. Plasma torches are capable of quickly cutting though very thick metals. However, plasma torches are limited to conductive materials.

This mature technology approach is similar to laser cutting. An operator can select the best way to size-reduce individual items. A plasma torch may allow for separation of CH-TRU, RH-TRU, and MLLW by selective cutting. Using a plasma torch remotely requires a manipulator and a trained and dedicated operator. Commercial systems, including positioners, are available. Plasma cutting is not applicable to all waste types and requires treatment of fumes and off gases. Control of metal splatter must also be taken into account when using the plasma torch. Limitations of this technology include the consumable torch head, precise positioning between the head and the work piece, grounding the head to the work piece, and the high electromagnetic field generated by the process. Plasma torches cannot be used around combustible material or if there are combustibles in the associated waste.

- *Jackhammer* – A jackhammer is a portable, percussive-type tool that uses a jabbing motion (much like a hammer and chisel) to break up material, especially those that are brittle materials that break apart easily. Jackhammers rely on the inertia of the tool mass to break apart the material. Typically, this requires the tool to be operated in a vertical orientation such that gravity is aiding the tool motion. Jackhammers can be pneumatic, hydraulic, or electric powered.

  Commercial systems are available and are often used on demolition equipment such as backhoes. Disadvantages of this tool include its use only on brittle materials such as concrete, the amount of dust and debris generated, and the fierce vibration that must be supported by the tool holder. Deploying this type of tool on a bridge crane-type manipulator is not practical. A jackhammer would have to be deployed on an manipulator arm such as would be used on a backhoe.

- *Impact Wrenches* – An impact wrench can be mounted to the manipulator to provide a method to remove bolts securing a lid. Impact wrenches have been deployed in processing canyons (e.g., T Plant, U Plant, Purex) for years for installation of jumpers. The disadvantage to the wrench is difficulty in aligning it with the bolt and picking the bolt up after removal.

- *Abrasive Wheel* – An abrasive wheel mounted on a manipulator is a proven technology for opening containers made of metals and some other materials. Abrasive wheels have been deployed remotely many times. Decontamination and maintenance of the tool may be difficult. The potential for airborne materials and contamination spread is great due to the high velocity of the blade. An abrasive wheel can be slow in operation and is not suitable for flammable materials. Associated equipment to hold the cutting tool and waste item may be complex.

- *Reciprocating Saw* – A reciprocating saw could also be mounted to a manipulator or other positioning system to open containers. These are commonly used for cutting operation, and the initial cost of the equipment is low. A reciprocating saw can be difficult to operate using a remote manipulator, and it is not appropriate for all waste streams. It would not be suited for items with thick cross sections. Maintenance is an issue, depending on the material being cut. Frequent blade changing poses unique challenges. The method of cutting is also an issue.

C.1.3 Container, Shielding, and Non-Conforming Waste Removal

- Non-conforming waste and shielding are removed from the waste container in this module and transferred to the identified staging areas. The container pieces are also transferred to a staging area.
- Removal of waste items from the containers will entail the use of the gantry manipulator and heavy lift device. These items would be equipped with tools such as those described below.

C.1.3.1 Grippers, Hooks, and Clamshells

The primary method of material removal and sorting will be use of the manipulator grippers, heavy lift hook, and clamshells.

Grippers are good for picking up most items less than 200 pounds that are not fragile. Fragile items may require special tooling or force feedback, a technology that allows operators to gauge how tightly an object is grasped.

Hooks deployed by the heavy lift are efficient for removing objects with lifting bails, such as jumpers, or other items with bail-like features. Some heavy items may need rigging applied by the manipulator prior to lift. Rigging may be difficult to accomplish remotely.

Clamshells are robust technology for bulk items, such as piles of scrap metal or piles of bolts. Clamshell jaws are typically hydraulic or electric powered.

All of these technologies are fairly robust and effective when performed remotely, although none are high-throughput technologies because it is rather time-consuming to acquire items. Remote vision is a key enabling system for acquiring objects by one of these methods. Camera systems generally require the user to view multiple cameras from different views to ensure that an object has been grasped firmly. Acquiring objects is much easier if an operator can view the equipment operation through a window.

C.1.3.2 Scoops, Sweepers, and Vacuums

Small loose material such as dirt may best be captured by scooping, sweeping, or vacuuming. Liquids may also be captured in this method by first applying an absorbent to the liquid. Care must be taken when capturing liquids to avoid mixing non-compatible fluids.

Scoops are best used when the material is clumped together or near a wall. Scooping is a difficult task to accomplish remotely due to the complex motion required to scoop material effectively. Scooping also presents a contamination risk and possible criticality risk.

Sweepers are slightly easier to use remotely because the bristles provide some compliance. However, this task also requires a fair amount of practice to effectively acquire material. Sweeping will also require the positioning of a bin to collect the loose material. This bin must either be weighted or positioned such that it cannot be knocked over or moved while material is swept into it. Sweeping presents a contamination risk and possible criticality risk.

Vacuums are the easiest of these technologies and therefore require the least precision to acquire material. Numerous vacuuming technologies exist, including bagless and filterless vacuums that may be readily adaptable to a remote environment. Vacuuming does, however, present several hazards, including possible criticality due to the accumulation of material in the receptacle or filter media used with the system.

C.1.3.3 Other Tools

Some waste items will require the use of general equipment and/or specialized tools. The containers and shielding may best be sorted by intelligently laying out the conveyor system such that no other processing or tooling is needed to sort the waste prior to size reduction.

Some materials may be too small to sort/open efficiently with the gantry manipulator or heavy lift and must be transported to a manipulator station. The manipulator station may consist of two 6-degrees of freedom (DOF) hydraulic or electric manipulators mounted to a pedestal, table, or the module wall. The two manipulators would share a work table (with lip) and have overlapping work envelopes to allow coordinated effort. This station is most likely the destination of bagged waste, paint cans, small boxes, and items requiring disassembly. The manipulators likely will require tooling and fixtures such as socket sets, screwdrivers, and other standard tool sets. Fixed tooling such as spikes or utility knives would be helpful in opening bags.

Items such as paint cans and bags may need to be opened prior to sorting. Paint can opening may be performed with manipulators and tools such as screw drivers adapted for manipulator use. If enough paint cans (or other small containers) are expected, it may be advantageous to develop a fixed automation station to open these containers. This station would presumably be highly reliable and quick due to its limited functionality. Using manipulators for this type of work would be time-consuming and result in low throughput.

Bagged items may be opened by the manipulators either by tearing them apart or using a fixed spike or blade to breach the bag. Individual items could then be independently sorted according to waste stream.

Fragile items such as glass bottles or light bulbs may require force feedback or special tool development for the manipulators. Special tooling must limit the force applied to an object. An example of this type of tool would be a grappler with flexible fingers. If more than the minimally required force is applied, the fingers will bend yet maintain a grip on the object.

Biological waste such as dead mice may be removed and sorted using sweeping, scooping, gripping, or vacuuming. Electromagnets may be useful to remove and sort ferrous materials.

Additional end-effectors and tools for the manipulator or heavy lift may be required to solve tasks as they arise. For example, a portable camera and lighting system may be necessary to aid in the acquisition or identification of a waste item, or a specific waste item may prove difficult to acquire with an existing method or tool and require a specialized tool to be designed. This tool will need to be passed into the module and acquired appropriately.

Approximate space requirements: 36 ft × 75 ft (same as container opening space).

C.1.4 Sort Waste

Once the container is opened in the POSSM the waste must be sorted. Waste is divided into three categories: Non-conforming, MLLW, and TRU. Some of the waste will be in plastic bags. These bags will have to be inspected for non-conforming waste.

Non-conforming wastes (e.g., liquids, batteries, aerosol cans) will be separated from the conforming waste and placed into 55-gallon drums. The area developed for this separation will have several drums, placed on spill pallets, such that the non-conforming waste can be segregated for safety.

MLLW includes more than the waste from containers identified as MLLW. The containers and shielding from waste package identified as TRU will be considered as MLLW.

TRU waste will be removed from the container and placed on transfer trays for movement into the TOSSM for further processing. It is anticipated that a significant quantity of waste will be in heavy plastic bags. Non-conforming waste can be inside these bags. Once separated in to MLLW and TRU waste, the bags will be processed through an x-ray machine (one in the POSSM and one in the TOSSM). If the x-ray reveals non-conforming waste the bag will be opened and the non-conforming waste removed and separated.

C.1.5 Size Reduce Waste

MLLW is size reduced in the POSSM and TRU waste in the TOSSM. Waste is size-reduced to allow placement in the appropriate exit containers and/or to reduce output volume/void space. MLLW will be size reduced to fit into a 5 ft x 5 ft x 9 ft metal waste or a SWB. TRU waste will be size reduced to fit into a 55-gallon drum. There are numerous methods by which size reduction can be achieved (Bailey et al. 2001).

Fixed Automation Tools or Stations

In the areas used for size reduction, stations will be provided that perform a specific set of tasks. For example a fixed station would be used for the deployment of a jackhammer. This fixed station will require a more robust floor and fixed manipulator. Therefore, an area would be designed where material that requires a jackhammer for size reduction (e.g., concrete) would be taken. An example of a fixed tool station would be a tool that would just open a 5-gallon bucket. The station would be designed to secure the bucked and pop or cut the lid and dispose of it before ejecting the bucket for sorting of its contents. This fixed tool station could be secured to structure or designed to be picked up by the manipulator or heavy lift and set on top of the container.

C.1.5.1 Size Reduction Tools

These technologies range from very complex, expensive systems to simple industrial tools. Each has advantages and disadvantages depending on the application. Most of these tools are applicable to the inventory anticipated.

- *Shredder* – Materials are fed into a hopper and mechanically shredded. Throughput and reliability are very good, although most industrial shredders sized to handle the anticipated input waste containers will produce much more throughput (~30 tons/hour depending on make, model, and size) than will be required by the SWPMs. Shredders are constrained to waste streams without thick metallic pieces. Decontamination and maintenance of a shredder may be difficult. Material jams in shredders and shredded material conveyance systems could present exposure risks. The shredder size and tooth geometry should be optimized to the anticipated waste stream (WHC 1993).

  Waste items from the inventory that may be successfully size-reduced using an industrial shredder include:

  - Long, hollow objects such as jumpers, pipes, ducting, well casings, flanges, telescoping pipes, coil assemblies, tube bundles, and conductivity probes, especially after pre-size reduction using a shear

  - Paint cans

- Combustibles (paper, wood, cloth), foam, plastic, rubber, glass, small tools, construction debris, heaters
- Duct encased in concrete
- Process vessels, dissolvers, condensers, feed waste containers
- Lead blankets.

- *Shears* – Shears are used to cut long-length items into shorter, more manageable pieces. Industrial shears are simple and robust in design, and can be procured to handle very large components. Shears, usually hydraulically powered, generate local pressures in the material being cut greater than the ultimate strength of the material. The material being cut plastically deforms along the blade of the shear. The process is mechanical and the resulting thermal generation and airborne particulates are quite low. Care must be taken when performing shearing operations because the material being cut also elastically deforms. Once the shearing process if finished, the elastically deformed material may spring back to its original form. Hydraulic shears require a small hydraulic power unit (HPU).

  Limitations of the shearing process are the robust fixturing required to hold the material being sheared, the hydraulic requirements (pressures range from 3,000 to >10,000 psi), and blade life. The shear blades must be periodically replaced, which would be difficult should they become contaminated.

  Waste items from the inventory that may be successfully size-reduced using shear include:

  - Long, hollow objects such as jumpers, pipes, ducting, well casings, flanges, telescoping pipes, coil assemblies, tube bundles, and conductivity probes, which may then be post-processed using an industrial shredder.

- *Disassembly* – Disassembly is another method for size reduction that may be used regularly. The manipulators within the module may use specially adapted hand tools to size-reduce large items. For example, a collection of screwdrivers, sockets, and wrenches may be used by the manipulators to disconnect an electric motor from a pump assembly, allowing the pump assembly to be size-reduced in the shredder, while the electric motor can be placed directly in the waste container because it is too dense for a typical industrial shredder. Other items that may require disassembly include:

  - Centrifuges
  - Agitators
  - Pump assemblies
  - Other motor/equipment combinations.

- *Plasma Torch* – Plasma torches operate as described in Section C.1.2.1. Waste items from the inventory that may be successfully size-reduced using a plasma torch include:
  - Long, hollow metallic objects such as jumpers, pipes, ducting, well casings, flanges, telescoping pipes, coil assemblies, tube bundles, and conductivity probes
  - Metallic ducting
  - Metal waste boxes and other metal containers
  - Steel liners
  - Process vessels, dissolvers, condensers, feed waste containers
  - Metal plates.
- *Jackhammer* – Jackhammers operate as described in Section C.1.2.1. Waste items from the inventory that may be successfully size-reduced using a jackhammer include concrete containers.
- *Blade/Knife* – A blade or knife may be used to open plastic bags found within waste containers. The blade may be fixed while the material is moved past the blade or the material may be held and the blade may be moved through the material. Orientation of this tool is critical to efficiently open the bags. The blade will require periodic replacement. This tool can be easily deployed on a manipulator.
- *Baler* – A baler is essentially a trash compactor for metal salvage operations. Material is fed into a hopper and the baler compresses the materials into a relatively dense cube or cylinder. Compacted waste streams would not require other processing. Handling requirements for feeding are minimal, and packing density is relatively high for metallic components. A baler may not work well for springy, low-density materials such as plastics and paper. A baler will not work on thick-walled materials. Decontamination of a baler may be difficult; however, balers are proven technology operating in a vast number of salvage yards and recycling centers. A baler would be an effective tool used in conjunction with a shedder.

  Waste items from the inventory that may be successfully size-reduced using a baler include:
  - Long, hollow metallic objects such as jumpers, pipes, ducting, well casings, flanges, telescoping pipes, coil assemblies, tube bundles, and conductivity probes
  - Paint cans
  - Process vessels, dissolvers, condensers, feed waste containers, or other large metallic vessels.

- *Crusher* – A crusher can be used for items such as concrete boxes or other items that can be crushed to rubble or flattened. Crushers are simple in design, and adaptable for easy decontamination and maintenance. Crushers may not work well for springy, low-density materials such as plastics and paper. Crushers and balers handle similar waste items.

  Waste items from the inventory that may be successfully sized-reduced using a baler include:

  - Concrete casks
  - Concrete encased ducting
  - Concrete tank with steel liner
  - 55-gallon drums

- *Compactor* – A compactor is used to consolidate material inside of a container such as a 55-gallon drum. This tool most effective when compacting paper, plastic, or cloth that is compressive. For TRU waste, great care must taken in what waste is compacted due to criticality concerns. For MLLW, waste can be compacted into a drum and then the drum compacted to conserve space in the waste container.

- *Band Saw* – A horizontal or vertical fixed-location band saw is a proven technology for size reduction of metals and other materials. A band saw can be used on very thick cross sections and is extremely reliable. Binding of the blade may be problematic for size reduction of some components. Industrial band saws can be operated with or without a cutting fluid/coolant. Computer-controlled material positioning and cutting operations are available in standard saws. Low band speed can reduce the potential for airborne contamination; decontamination and maintenance may be difficult. Band saws and shears handle similar waste items.

  Waste items from the inventory that may be successfully size-reduced using a band saw include:

  - Long, hollow metallic objects
  - Metallic ducting
  - Metal lathes.

- *Abrasive Wheel* – An abrasive wheel operates as described in Section 8.1.2.1.

  Waste items from the inventory that may be successfully size-reduced using an abrasive wheel include:

  - Jumpers, pipes, ducting, well casings, flanges, telescoping pipes, coil assemblies, tube bundles, conductivity probes

  - Process vessels, dissolvers, condensers, feed waste containers.

- *Reciprocating Saw* – Reciprocating saws operate as described in Section C.1.2.1.
- *Size-Reduction Bypass* – Some waste items may already be compact or, for other reasons, not require further size reduction. There should be provisions for bypassing the size-reduction equipment and sending items directly to waste loading.

C.1.6 Survey Waste (including RH TRU 55-gallon drum assay)

After loading and sealing TRU waste containers, the containers will be surveyed to determine whether they are RH or CH. RH TRU drums will be assayed in the SWPMs. CH TRU waste drums will be shipped to WRAP for final assay and shipment to WIPP.

The assay of RH TRU drums will be done in the 221-T Canyon. The assay will provide the waste acceptance data required for shipment to WIPP.

MLLW waste containers will be surveyed as the container is loaded. The container must be below CH levels for the container to be released from the SWPM. Lead shielding will be used as needed to lower the dose levels.

C.1.7 Load Containers

MLLW waste will be loaded in the POSSM using 5 ft x 5 ft x 9 ft or SWB containers. TRU waste will be loaded into 55-gallon drums in the TOSSM.

MLLW waste will reduced in size to load in a 5 ft x 5 ft x 9 ft or SWB containers. A real-time dose measurement of the outside of the container will be made to assure that the CH dose levels are maintained. Lead shielding will be used to maintain CH levels.

TRU waste will be loaded into 55-gallon drums. Dose rate from the drum is not important. The weight of the drum is important and will be measured during loading.

C.1.8 Container Sealing and Load-Out from SWPMs

MLLW waste containers will be moved away from the loading area into a separate module where a lid will be secured to the container. This will be done remotely using bridge-type crane manipulators and impact wrenches. Special bolts will be developed to work with the impact wrench. Once the lid is secured the container is moved out of the SWPM through three airlocks equipped with a conveyor system for movement. This first airlock will be equipped with a system that can spray the container with contamination fixodent. The last airlock is connected to the SWHF where the container can be shipped to the MLLW assay station and then to the MLLW encapsulation station.

TRU waste containers will be moved away from the loading area into a separate module where a lid will be secured to the container. This will be done remotely using a bridge-type crane and special equipment designed to seal the lid on a 55-gallon drum. Once the lid is secured the container will be surveyed as discussed in Section C.1.7. CH TRU drums will be loaded out through air locks to the 221-T Canyon where they will be staged for shipment to WRAP.

TRU waste containers that are RH will be staged and loaded into 72B Payload containers in preparation for shipment to WIPP. The station for loading the 72B Payload container will be in the 221-T Canyon immediately adjacent to the SWPM. The RH TRU container will be removed from the SWPM through an air lock. Loading of the 72B payload container will be with the 10-ton 221-T Auxiliary Canyon Crane. Three RH TRU drums are placed in the 72B payload container and then the lid is welded in place. The completed payload container can be stored in a modified canyon cell until shipment to WIPP.

The RH-TRU material will require additional steps to certify the container for WIPP, including inspecting the weld on the metallic payload canister, inserting the payload into the inner vessel, sealing the inner vessel, leak testing the inner vessel, inserting the inner vessel into the outer container, sealing the outer container, and leak testing the outer container.

C.1.8.1 Container Loading Tools and General Transport Equipment

These technologies range from systems that need design and development to simple industrial tools. Each has advantages and disadvantages depending on the application (DOE/EIPP 2003a, 2003b, 2004, 2005b).

Conveyors – Conveyor systems are a useful tool to transport material around the module. These systems must be implemented intelligently to avoid material loss and minimize paths between equipment. Containers can be filled easily with size reduced material by using a conveyor directly from the size-reduction equipment to the container loading station.

Grippers, Hooks, and Clamshells – Loading or unloading of waste items may require manipulator grippers, heavy lift hooks, and/or clamshells, which operate as described in Section C.1.3.1. Occasionally, material may need to be recovered due to overfilling or exceeding the dose limits of a partially loaded container.

C.1.9 Solid Waste Container Handling and Transfer

- MLLW in 5 ft × 5 ft × 9 ft containers will be staged on the T Plant canyon deck, loaded-out of the canyon using the canyon crane, and transferred to a T Plant complex assay station. After assay, the MLLW will be immobilized in 2706-T prior to disposal.
- Non-conforming MLLW in 55-gallon drums will be staged on the canyon deck and transferred to the CWC for staging prior to treatment and disposal.

- Suspect CH TRU waste WIPP SWBs will be staged in the SWHF awaiting load-out and transfer to WRAP for assay. Suspect CH TRU waste determined to be MLLW will be transferred to 2706-T for immobilization prior to disposal.

- RH TRU waste casks will be staged in the SWHF awaiting transport to WIPP.

Appendix D

Remote Manipulator and Gantry Systems

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Appendix D

Remote Manipulator and Gantry Systems

D.1 Hydraulic Manipulators

Hydraulic manipulators (Figure D.1) are complex and expensive but have a high payload capacity (typically 200 to 250 lb) and considerable dexterity. Hydraulic manipulators require a hydraulic power unit (HPU). The fluid must be kept relatively clean (no particulates larger than 3 microns). These systems require product-specific trained operators, of which there will be only few, if any, on-site.

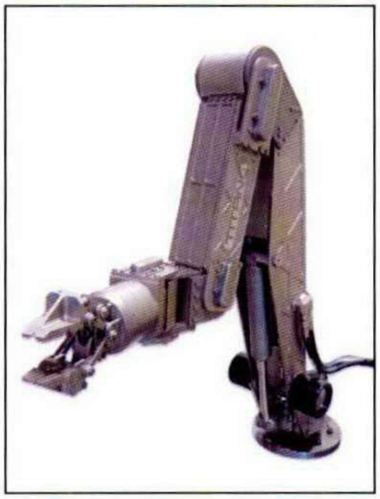

Figure D.1. Hydraulic Manipulator

6-DOF Hydraulic Manipulator – General Information regarding maintenance for hydraulic manipulators (based on one manufacturer's recommendations):

- Daily – check for collision damage, loose screws, hydraulic leaks, damaged hoses, loose connectors, etc.
- 100 hr – retorque all external fasteners (could avoid by applying lock-tite before initial deployment), check hydraulic reservoir for particulates (replace if contaminated).
- 500 hr – check HPU fluid level, clean/replace HPU filters (upper slave arm filter too; should not need cleaning unless your post filter indicates problems).
- 2000 hr – replace worn/damaged actuator pins and bushings, drain and replace fluid.

- 3 yr/2000 hr – replace all actuator O-rings and seals, replace all slave arm O-rings and seals, clean all O-ring grooves and surfaces (involves complete dismantlement of the manipulator).

Parts – A company that has 1000 or more manipulators in service will usually have good availability of spare parts at all times.

Critical Failure Points – Generally seem to be the servos and resolvers. Servo failure rates can be reduced by maintaining good fluid filtration/cleaning. Replacement of these items would require pulling the arm out of service and dismantling a portion of it (usually a single joint).

Uses

- Gross positioning, tool positioning and handling, handling up to 200-pound pieces of material.

- Not suited well for working within small space requirements.

Gantry Robots – Gantry robots, also referred to as Cartesian robots, provide flexible and efficient solutions for a wide range of applications, including pick and place, machine loading and unloading, stacking, unitizing, and palletizing. Gantry robots typically have three degrees of freedom (DOF) along the X, Y, and Z coordinate system. Most gantry robots allow teach and repeat motions to allow them to perform repetitive tasks efficiently. End-effectors may be designed to be interchangeable to allow the use of different tools from a single gantry robot. The use of tool change plates is encouraged when utilizing multiple tools.

Gantry robots may also be used as the base platform for deploying other manipulators. The gantry acts as a gross positioning system and the manipulator can perform the fine work. Several companies, most notably PaR Systems Inc., have developed combined gantry robot and manipulator systems that are used in module environments. Gantry systems may be driven electrically or hydraulically; electrically driven systems are the most common commercial systems.

To return to a specific point in space, the system must have precision orientation sensors. These sensors may require special maintenance to keep them free of debris and from damage.

Other Manipulator Systems Considered but Likely Not Applicable

Mechanical – Mechanical master slave manipulators are simple and fairly inexpensive systems (Figure D.2). They have a high component failure rate, and their payload/lifting ability is limited to operator strength, typically no more than 40 pounds. Some newer mechanical manipulators are power assisted. Mechanical manipulators have limited DOF and work envelopes. There are many personnel trained to use these types of manipulators on-site.

Electric – Electric manipulators are less expensive than hydraulic manipulators, have good dexterity, and usually have mid-level payload ranges (20 to 100 lb). These systems require product-specific trained operators; there will be few, if any, on-site. Electric manipulators are used in manufacturing industries where high precision and repeatability are important (Figure D.3).

Electric manipulators are generally not suited for tele-operation (man in the loop) and generally are not set up for the types of tasks that may be done in a nuclear waste handling and repackaging facility. Installation and programming of electric systems can be expensive (three times the price of the hardware).

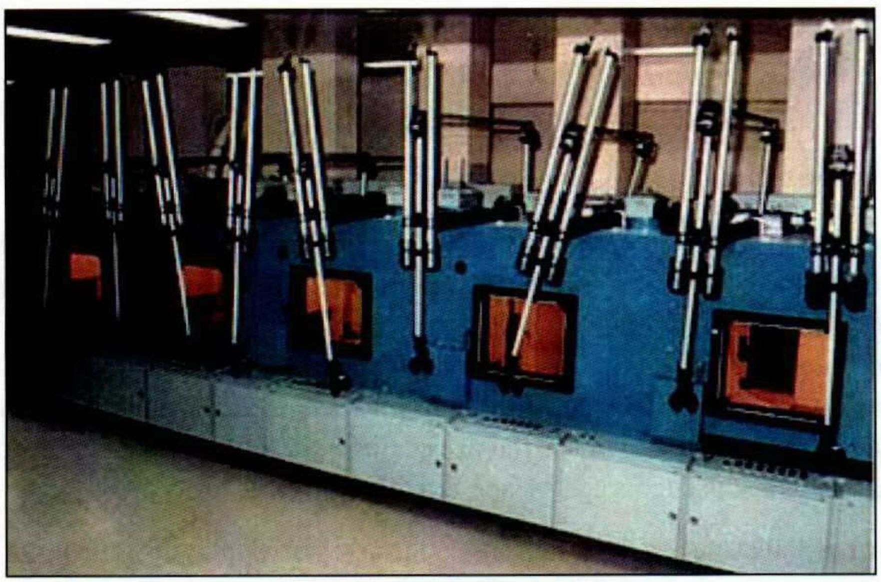

Figure D.2. Mechanical Master Slave Manipulators

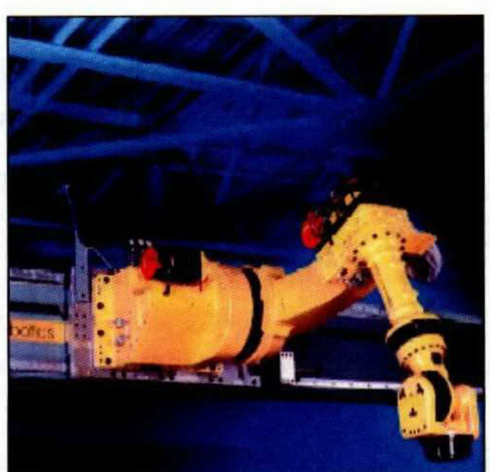

Figure D.3. Electric Manipulator

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Appendix E

General Remote Systems Process Information

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Appendix E

General Remote Systems Process Information

E.1 Vision and Lighting

Vision systems are key aspects of remote operations. Correctly located and selected cameras and appropriate lighting are essential for successful remote operations. Conventional camera views do not provide the depth of field information required for efficient remote operations. While stereoscopic vision systems can provide this information, all of the display methods available have shortcomings. A remote system of this type will require a large number of cameras, some in fixed locations and others mounted to moving elements of the systems such as the gantry and articulated manipulators. Managing the information from all of these cameras becomes a task-loading issue for the operator.

Camera location is a key determinant of camera usefulness. Cameras need to be situated where they provide useful information to the operators. It is important to have a view that is perpendicular to the direction of motion as a manipulator attempts to pick up an object. To aid in picking up objects from the sorting table, for example, it will be necessary to have a camera that looks out across the table. As the manipulator moves down to acquire an object, the camera will be able to present a view that allows the operator to judge the distance between the gripper and the object. In some cases, it will be desirable to have cameras that can be relocated (moved up and down or back and forth along a rail).

Stereoscopic vision systems can provide the depth of field information that operators need when picking up and placing objects. However the displays used pose a number of human factors issues. Goggles that display one camera image to each eye are a common approach. These goggles generally preclude use of other video displays and obscure the operators' view of the system controls. In addition, spatial disorientation often results in operator nausea. Systems that use a double-scanned image to alternate display of the left and right cameras on a display are also used. These work in conjunction with liquid crystal display (LCD) glasses that alternately block the left and right eyes so that each eye sees the appropriate image. The glasses are expensive and fragile, and the viewing angle is limited. Operator headaches can result from extended use of this system. Some newer displays promise to produce the three-dimensional effect without these issues. These displays may hold substantial promise for this type of application.

It may be possible to mount some of the cameras outside the containment enclosure. These cameras can view the enclosure through small view port windows. They may still be subjected to a high dose from the waste material, but they should remain uncontaminated. When they fail, repair or replacement should be relatively straightforward. Other cameras will need to be mounted inside the enclosure. Appropriate shielding and camera- and waste-management methods can be used to reduce exposure to the cameras, but the cameras will be considered disposable items. Some provision for replacing them remotely will be required.

Managing the images from multiple cameras is also an issue. The operator requires a few high-quality views of the work he is performing, but will need to be able to easily select those from perhaps dozens of available camera views. It is important to design this system so that it does not overwhelm the operator.

Strategically placed lighting will also be required; the ability to move, dim, aim, and turn individual lights on and off is important. This will allow the lighting to be customized to accommodate the work flow. Again, it is important that the operator be able to manage the lighting without distraction from the main task.

We have found that having operators work in pairs can be of substantial benefit. One operator can drive the manipulator and remain focused on the detail task of picking up objects, cutting things, opening things, etc. The other operator can select and adjust camera views so that they evolve appropriately as the task progresses. This operator can also watch the overall environment for potential collisions between the machines and the work and for other potential issues.

E.2 Remote Use of Standard Tools and Equipment

A number of commercially available standard tools will be used in the module to perform various operations. Examples are listed in the sidebar. These tools are already proved in commercial use for exactly the types of tasks required. However, they are not often used in remote applications and the tools must be modified to allow them to function properly in this environment.

Candidate Remotable Tools

- Bolt cutters
- Concrete saw
- Nibbler
- Plasma torch
- Liquid nitrogen cutter
- Clamshell
- Vacuum
- Scoop
- Shear
- Shredder
- Jackhammer

Areas of modification include grasping, power source control, and maintenance. Another issue that must be dealt with is the services required by the tooling. It is not practical to provide all services required by all tools to the end of the manipulator arm, where they are needed.

Many tools that are ordinarily hand-held (such as a nibbler or vacuum cleaner) can be readily modified for remote use by adding a T-handle or other grip designed for use by a manipulator gripper. Others (such as a plasma torch) may be more easily dealt with by a near-complete redesign of the tool. Much of the grip of a plasma torch is designed for operator comfort and convenience and (for remote use) can be replaced by a simple fixture. Another class of tool would include the bolt cutter. Here it is probably best to design almost a completely new tool, although parts from a commercial tool could (and likely would) be used. The remote bolt cutter would probably be built on a quick-change plate. In use, it would replace the gripper and be powered by the manipulator hydraulic system.

An issue with these remote tools is the logic of powering them on and off. Tools powered by draped cables are connected to their power source continuously, and it is possible to (potentially inadvertently) turn them on when they are in a storage area. Other tools powered by end-of-arm services may turn on and off in different ways, as they may use different services. A relatively simple system would use a series of toggle switches to turn different tools on and off. However, this allows the operator to turn on tools that are not currently in the gripper. It also makes it difficult to distinguish between two tools that use the same end-of-arm service. Significant design work needs to be done in this area to ensure that appropriate safety interlocks are in place and that the operator can easily and accurately activate the desired tool.

Some services (such as hydraulic power) may be readily available at the gripper end of the manipulator arm. Other services (such as vacuum or electrical power as required by the plasma arc cutter) are unlikely to be available at end-of-arm. These kinds of services are often best dealt with by draping the required service lines to the tool from a wall- or ceiling-mounted fixture. While this requires the operator to manage the lines without having them damaged or interfere with the task, this is not too onerous compared with permanently routing these lines along the manipulator arm. Routing heavy, bulky lines along the manipulator reduces the range of motion and payload and adds unacceptably to the bulk of the arm.

Some kinds of tools lend themselves to remote operation. Largely, these are non-contact tools such as water jet or plasma arc cutters. These tools are tolerant of slight misalignment and do not bind up when slightly out of alignment with the cut. Contact cutting tools are, in contrast, substantially more difficult to operate remotely. Generally, tools with a long contact with the material being cut (such as rotary saws) are not tolerant of misalignment. To prevent tool failure, the tooling must be designed with compliance that can allow the tool to align itself correctly. Alternatively, force feedback can be incorporated into the system (manipulator) to prevent misalignment. This is a challenging and not necessarily effective approach. Other types of contact cutting tools, such as reciprocating saws, share this issue but to a lesser degree.

E.3 Tool Staging and Acquisition

A very time-consuming aspect of remote work is acquisition of objects in an unstructured environment. An operator may make several attempts to pick up an object that has dropped to the work table surface. Remote tooling must be picked up in much the same way as other objects, although it is more difficult due to the precise orientation requirements. Acquisition of tooling constructed on a quick-change plate is somewhat different, but substantially similar to gripper held tooling. To avoid the potentially large consumption of time associated with tool acquisition, tools should be stored in fixed, known locations. This will allow pre-programmed algorithms to be used for tool acquisition and replacement. Each tool will be stored in a specific location on a tool rack that is fixed in the module. This will allow the manipulator to move directly to the required tool storage location without time wasted in trying to locate and acquire the tool.

An important aspect of this interchangeable tooling concept is the use of quick-change tool plates. This system consists of mating pairs of plates, one permanently mounted to the manipulator, and the other permanently mounted to the tool. A latching mechanism allows the manipulator to acquire a plate (and hence the tool mounted to it), while service pass-throughs and electrical connections allow hydraulic, pneumatic, and electrical signals to pass between the manipulator and the tool. The tool may be quite complex, possessing multiple degrees of freedom and passing sensor information back through the manipulator to the operator.

E.4 Problematic Waste Forms

It is possible that some of the inventory consists of intractably challenging waste forms. An example would be a TRU-contaminated air filter encased in concrete. Such a filter might be too large to fit into a Waste Isolation Pilot Plant-approved container and not amenable to size reduction due to the likely release of highly mobile contamination. It may be possible to minimize the contamination release by using a concrete saw or other cutter to minimize the number of resulting pieces. Another approach would be to perform the size reduction underwater or in some other entraining fluid that would capture any particles released by the size reduction process. Problematic waste forms will be dealt with on a case-by-case basis.

E.5 Maintenance/Repair/Upset Recovery

All remote systems will have maintenance issues. Remote maintenance is very difficult and time consuming. Remote problem identification is even more difficult. If there are ways to decontaminate a process module well enough to allow personnel entry, then maintenance and repair becomes easier. Another option is to make replacement of equipment easy such that the broken equipment can be replaced, decontaminated, and moved to another area, either outside the process module or in a designated low hazard area for repair. Once the equipment is repaired, it can be held in the repair area until needed as a service replacement. The approach for maintenance/repair of remote systems is something that will need to be carefully planned for.

One method to alleviate the challenge of remote equipment repair is to treat small equipment as disposable. To facilitate replacement, use quick change plates where possible. These quick change plates would include all necessary utility contacts/connections required to power and operate the equipment. When equipment fails, it will be processed as waste (or sent to a repair module/facility), and a replacement will be sent into the module for quick remote installation.

Large equipment such as the gantry, shredder, and conveyers require advance recovery design. The module may require access to facilitate replacement of the entire piece of equipment if catastrophic failure occurs. In addition, large equipment should be as modular as possible so that components can be replaced more easily. For example, the conveyor system should be divided into sections such that a failed section can be easily replaced.

Vision system components should be mounted within enclosures that are easily decontaminated and changed remotely. In addition, camera change out should be regularly scheduled to avoid burn out of all vision components simultaneously (thus leaving you blind for camera change out).

Provisions for upset recovery must be present within the module. Any time there is an inspection (e.g., welding inspection, radiological survey, leak tests), there is a possibility of a need for rework. Additional instances might come after preliminary size reduction (i.e., if size reduced, but not quite enough to get the piece into the waste container). In addition, upset recovery may be required due to the failure of process equipment, such as a jammed shredder or broken conveyor system.

E.6 Technology Trade-offs

An important issue to be decided when dealing with remote equipment is the trade-off between having expanded capability through new technologies versus the maintenance or replacement problems required to keep them operational. This process line should be designed either in the traditional way with no intelligence (all mechanical hardware using optics for vision) or to try to update waste processing with new technologies (computer controlled equipment and digital vision systems).

For example, gantry systems exist that have less precision positioning feedback and depend solely on operator vision. These systems lack the capability to automate certain tasks, such as "Go to X position for tool change out" or "Take this part to the shredder," which may greatly increase productivity. However, the lack of positioning feedback results in fewer components that may fail and need replacement. Replacing linear encoder positioning systems within the module will be a very difficult and time intensive task.

One way to help alleviate maintenance/repair problems would be to have redundant process lines. In the event of a catastrophic failure, waste streams could be diverted to the redundant line while the original process equipment was decontaminated and repaired.

E.7 Staging Areas

Staging areas are required for numerous objects within this process line. Staging and insertion areas will be needed for bagless transfer blanks waiting to be filled, final containers (55-gallon drum, WIPP SWB, 5 ft × 5 ft × 9 ft, Big Box, etc.), payload canisters for WIPP containers, the WIPP inner vessel and lid, the WIPP outer vessel and lid, as well as all the tools and survey equipment required to certify containers prior to release from the module. Staging may also be required for waste items prior to container loading and for output containers awaiting release.

E.8 Decontamination

Remote decontamination may be required to keep the process modules as clean as possible. High contamination levels will affect the ability to survey, maintain, and operate equipment within the module. Good housekeeping habits will reduce the spread of contamination.

Appendix F

Potential Remote Equipment by Process Function

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Function	Tool	Level of Confidence	Testing Requirements
		Successful Task Completion Confidence - H = high, M = medium, L = not confident	1 = Post Install Acceptance Test/Training, 2 = Mockup Functional Testing (integration, interfaces, etc), 3 = Individual Equipment Functional Testing (buy equipment, remotize it, & test it), 4 = Equipment Design/Develop (not currently off the shelf)
Feed Container Handling (SWH)			
	Heavy lift	M	1
Load into SWPM			
	Conveyors	H	1
	Airlock & crane	H	2
Container Opening			
Fixture to hold any container smaller than 4x4x4 box	Two or three arms (clamshell) to handle all shapes	H	4
Fixed automation systems to open common container types (set of fixtures used by manipulator or gantry for 55-gallon drums, SWB, 4x4x8 boxes, etc):	Cut ring off drums, unbolt box lids, etc, Lid cutter, concrete saw, nibbler	H	4, (3 - individual tools)
Other:	Bolt cutter	M	3
	Plasma torch or other hot cutter	H	3
	Liquid nitrogen cutter	L	3
Container & Shielding Removal/Container Emptying			
Removing items	Gripper	H	1-2
	Hook	H	1-2
	Clamshell	H	3
	Vacuum	H	3
	Scoop	M	3
Empty container & shielding handling/transfer	Conveyor	H	1
	Heavy lift	H	1
Lead blankets	Manipulators	H	2
Sorting			
Liquids, contained and loose	Vacuum post absorb	H	3
	Sweep/scoop post absorb	H	3
Dirt, absorbents	Vacuum	H	3
	Sweep/scoop	H	3
Non-conforming waste	Manipulator	H	2
Conveyor size waste	Conveyors	H	1
	Roller devices	H	2
Large items	Heavy lift	H	1
Heavy items	Heavy lift	H	1
Paint cans	Paint can opener station	H	4
	Manipulators & tools	H	3
Fuel rod hulls, fuel pieces	Vacuum	H	3
	Scoop/sweep	H	3
Biological	Manipulators & tools	H	3
	Scoop/sweep	H	3
	Vacuum	H	3
Bagged items	Manipulators & tools	H	3
	Sharp spike attached to manip table	H	2
	Utility knife	H	2

Figure F.1. Potential Remote Equipment by Process Function

Function	Tool	Level of Confidence	Testing Requirements
Waste Item Size Reduction			
Plastic sheeting	Sharp knife or paper cutter/shear device	H	2
Jumpers, pipes, ducting, well casings, flanges, telescoping pipes, coil assemblies, tube bundles, conductivity probes	Shear	H	3
	Shredder	H	3
Paint cans	Shredder	H	3
Combustibles (paper, wood, cloth), foam, plastic, rubber, glass, small tools, construction debris, heaters	Shredder if necessary	H	3
Duct encased in concrete	Shredder	H	3
	Concrete saw	M	3
	Jack hammer	H	3
Concrete containers	Jackhammer	H	3
	Shredder	M	3
Concrete tank w/ steel liner	Jackhammer	M	3
	Shredder	H	3
	Plasma cutter	M	3
Pump assemblies, centrifuges, agitators	Plasma cutter	H	3
	Manipulator & tools	M	3
	Shredder	M	3
Process vessels, dissolvers, condensers, feed waste containers	Shredder	H	3
	Plasma cutter	H	3
Lead blankets	Shredder	H	3
Assay/Survey			
	Fixed automation stations	H	4
	Manipulator portable instruments	H	4
Waste Container Loading **RH-TRU Waste Container Loading**			
Empty RH payload cannister loading into SWPMs	Conveyor	H	1
	Manipulator	H	2
	Heavy lift	H	1
Move & manipulate empty RH payload cannister	Automated transport system	H	4
Fill RH payload cannister	Conveyor	H	1
	Heavy lift	H	1
	Gantry/manipulator	H	2-3
	Clamshell	H	3
Item removal (too much material, too much dose, etc)	Gantry/manipulator	H	2-3
	Vacuum	H	3
	Clamshell	H	3
Weld lid onto payload cannister	Automated weld station	M	4
Inspect weld	Inspection station	H	4
Move & manipulate empty inner vessel into cell	Fixed automation	H	4
Load payload into inner vessel	Fixed automation	H	4
Place gaskets and lid on inner vessel	Fixed automation, w/ alignment tools	M	4
Secure lid to inner vessel	Fixed automation	H	4
Leak test inner vessel	Fixed automation, w/ special leak test tool	M	4
Move & manipulate empty outer vessel into cell	Fixed automation	H	4
Load payload into outer vessel	Fixed automation	H	4
Place gaskets and lid on outer vessel	Fixed automation, w/ alignment tools	M	4
Secure lid to outer vessel	Fixed automation	H	4
Leak test outer vessel	Fixed automation, w/ special leak test tool	M	4

Figure F.1. Potential Remote Equipment by Process Function (contd)

Function	Tool	Level of Confidence	Testing Requirements
SWB Container Loading			
Load empty SWB into cell	Fixed automation	H	4
Move & manipulate empty SWB	Fixed automation	H	4
Fill SWB	Conveyor	H	1
	Heavy lift	H	1
	Gantry/manipulator	H	2-3
	Clamshell	H	3
Item removal (too much material, too much dose, etc)	Gantry/manipulator	H	2-3
	Vacuum	H	3
	Clamshell	H	3
Put on & secure lid	Fixed automation	H	4
(Shielded & Unshielded) MLLW Container Loading			
Load empty container into cell	Fixed automation	H	4
Move & manipulate empty container	Fixed automation	H	4
Fill container	Conveyor	H	1
	Heavy lift	H	1
	Gantry/manipulator	H	2-3
	Clamshell	H	3
Item removal (too much material, too much dose, etc)	Gantry/manipulator	H	2-3
	Vacuum	H	3
	Clamshell	H	3
Put on & secure lid	Fixed automation	H	4
55 Gallon Drum Loading			
Load empty drum into cell	Fixed automation	H	4
Move & manipulate empty drums	Fixed automation	H	4
Fill drum	Conveyor	H	1
	Heavy lift	H	1
	Gantry/manipulator	H	2-3
	Clamshell	H	3
Item removal (too much material, too much dose, etc)	Gantry/manipulator	H	2-3
	Vacuum	H	3
	Clamshell	H	3
Put on & secure lid	Fixed automation	H	4
Output container handling			
	Conveyor	H	1
	Heavy lift	H	1
	Forklift	H	1
	Drum dolly	H	1
Container Transfer			
	Trucks	H	1
Component			
Vision systems		H	4
Deconamination systems		L	4
Lighting		H	4
Tool change plates		H	4

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Appendix G

Solid Waste Processing Center Primary Opening Cell Remote Equipment Report (PNNL-15779) Summary

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Appendix G

Solid Waste Processing Center Primary Opening Cell Remote Equipment Report (PNNL-15779) Summary

The *Solid Waste Processing Center Primary Opening Cell Remote Equipment* report (PNNL-15779) issued in April 2006 addresses the remote systems and design integration aspects of the development of the Solid Waste Processing Center (SWPC), a facility to remotely open, sort, size reduce, and repackage mixed low-level waste (MLLW) and transuranic (TRU)/TRU mixed waste that is either contact-handled (CH) waste in large containers or remote-handled (RH) waste in various-sized packages.

The vast and varying waste stream that is anticipated to enter this facility makes this an extremely complex challenge. In addition to the issues associated with handling RH-TRU waste, the SWPC will encounter containers sized anywhere from 1 gallon cans to 20 ft x 13 ft x 11 ft boxes. The waste containers can be as heavy as 83,000 pounds, and the radiation levels can be as high as 20,000 rem/hr at the container surface.

Another aspect that makes this project complex is the remote environment, where tasks are inherently more difficult. Seemingly easy everyday tasks can be quite problematic or impossible to achieve remotely. Operator vision is limited to two dimensions (no depth of field), audio feedback is limited to what microphones and noise canceling technology can provide, and the sense of physically feeling motions or forces is absent without extensive sensor technology.

The authors have considerable background in the development and deployment of remotely operated systems for radioactive waste retrieval, inspection and surveillance, and decontamination and decommissioning of equipment and facilities. Pacific Northwest National Laboratory (PNNL) was tasked with assessing and providing general guidance on the following issues:

- Project feasibility
- What remote equipment would be required, and to what extent is that equipment available commercially off-the-shelf
- Extent to which technology development is required
- Feasibility of siting the proposed facility within T Plant.

PNNL's assessment is based on a review of summary tabulations of the waste inventory, a preliminary list of processing requirements, and uses knowledge of other projects with related challenges. Based on analysis of this limited and preliminary information, the project appears to be technically feasible. All the tasks identified in the proposed process description can probably be performed using remotely operated equipment. Some technology development will be required, mostly at the tool/waste interface, and a significant design integration effort will be required.

PNNL's experience suggests that successfully processing waste in this facility will require more effort than simply buying equipment and installing it in T Plant. Each element of the system must interact with many others, and these interfaces will include mechanical, electrical/utility, vision, communications, and operators. Each of these interface points must be carefully managed by a systems integrator to ensure that the systems can work together effectively when finally installed. While many of the systems are found as commercially available "catalog" items, they are almost all custom manufactured for the payload size, type, and motion required.

The systems integrator will be involved in all aspects of the project, including development of the functions and requirements and the specification and selection of equipment. A highly qualified integrator will have the ability to understand the SWPC challenges, will be good at matching the SWPC needs with technology, and approach the project with a structured systems engineering perspective. Systems integration requires inductive reasoning and knowledge of a large number of topics/technologies gained through research and experience.

It will be critical that the project not underestimate the challenges of developing this facility. Key aspects in effectively succeeding at this effort and controlling costs include:

- Clearly defining scope and requirements with the involvement of users and stakeholders.
- Understanding the need for process design and tool flexibility to counteract the extensive uncertainties that will be encountered.
- Completing thorough design integration efforts up front.
- Paying significant attention to tool development, testing and validation for all process tasks. Commercial off-the-shelf tools are not designed for remote deployment and operation and will require adaptation.
- Being cognizant of the human-machine interface complexities associated with the deployment of numerous remote systems in one space.
- Utilizing discrete event simulation to focus on the logical structure of the facility and the movement of material through it.
- Understanding maintenance requirements.

- Evaluating the risk and consequences of equipment failures.
- Establishing and maintaining a cold mock-up for testing, operator training, and operational task planning prior to and during operation of the plant.

- Establishing a relationship with Labor for the development of the SWPC's own specialist operators to perform all remote tasks and maintenance.

In performing this assessment, information was gathered on other remote facilities across the Department of Energy complex including the West Valley Remote-Handled Waste Facility, the Idaho Advanced Mixed Waste Treatment Project, and the Oak Ridge Spallation Neutron Source Target Facility. Experts in the fields of hot cell operation, TRU assay, and criticality safety were interviewed, and detailed discussions were conducted with major equipment vendors.

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Appendix H

Pre-conceptual Design Layouts of the Solid Waste Processing Center

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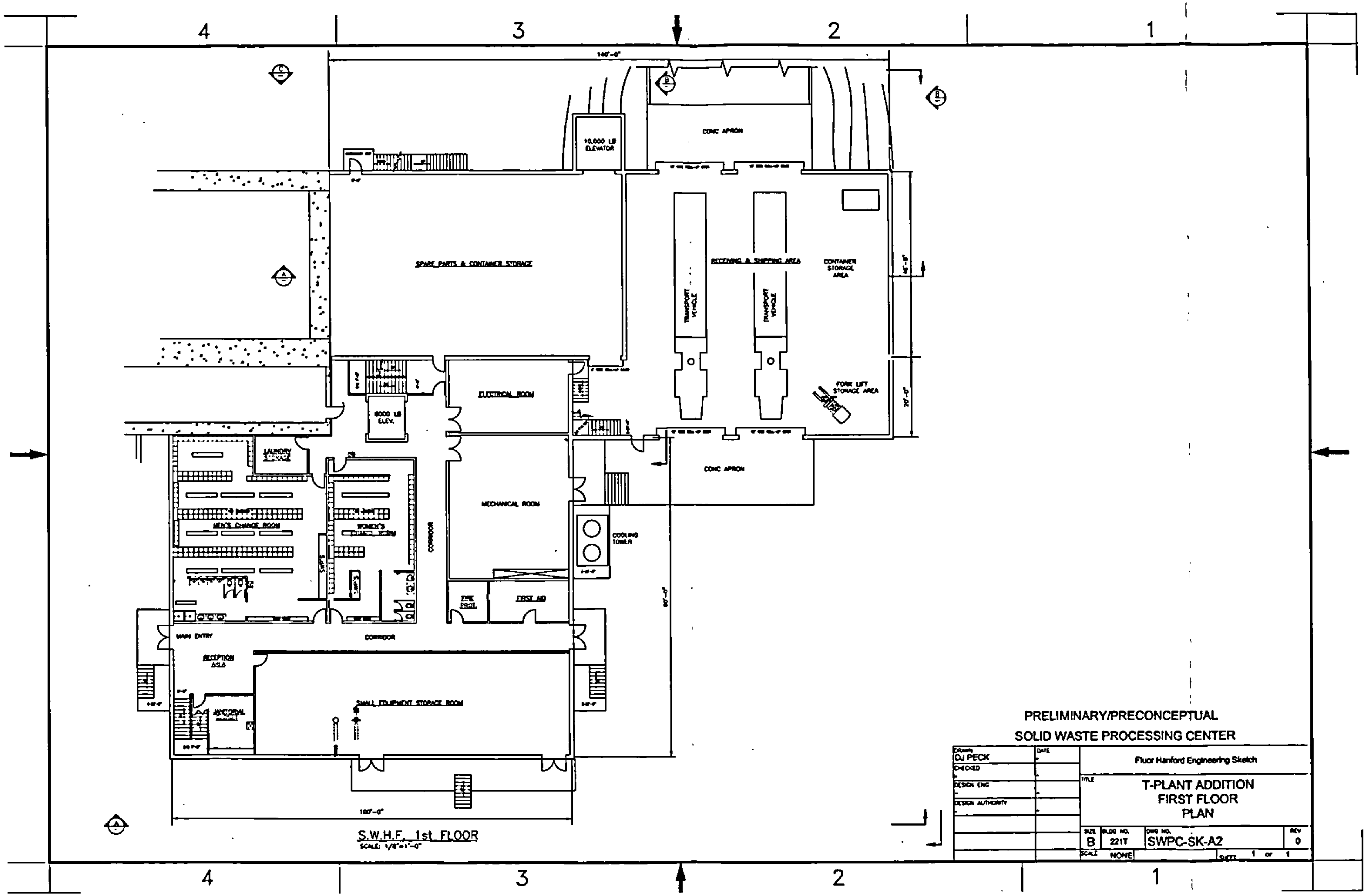

Figure II.1. T Plant Addition First Floor Plan

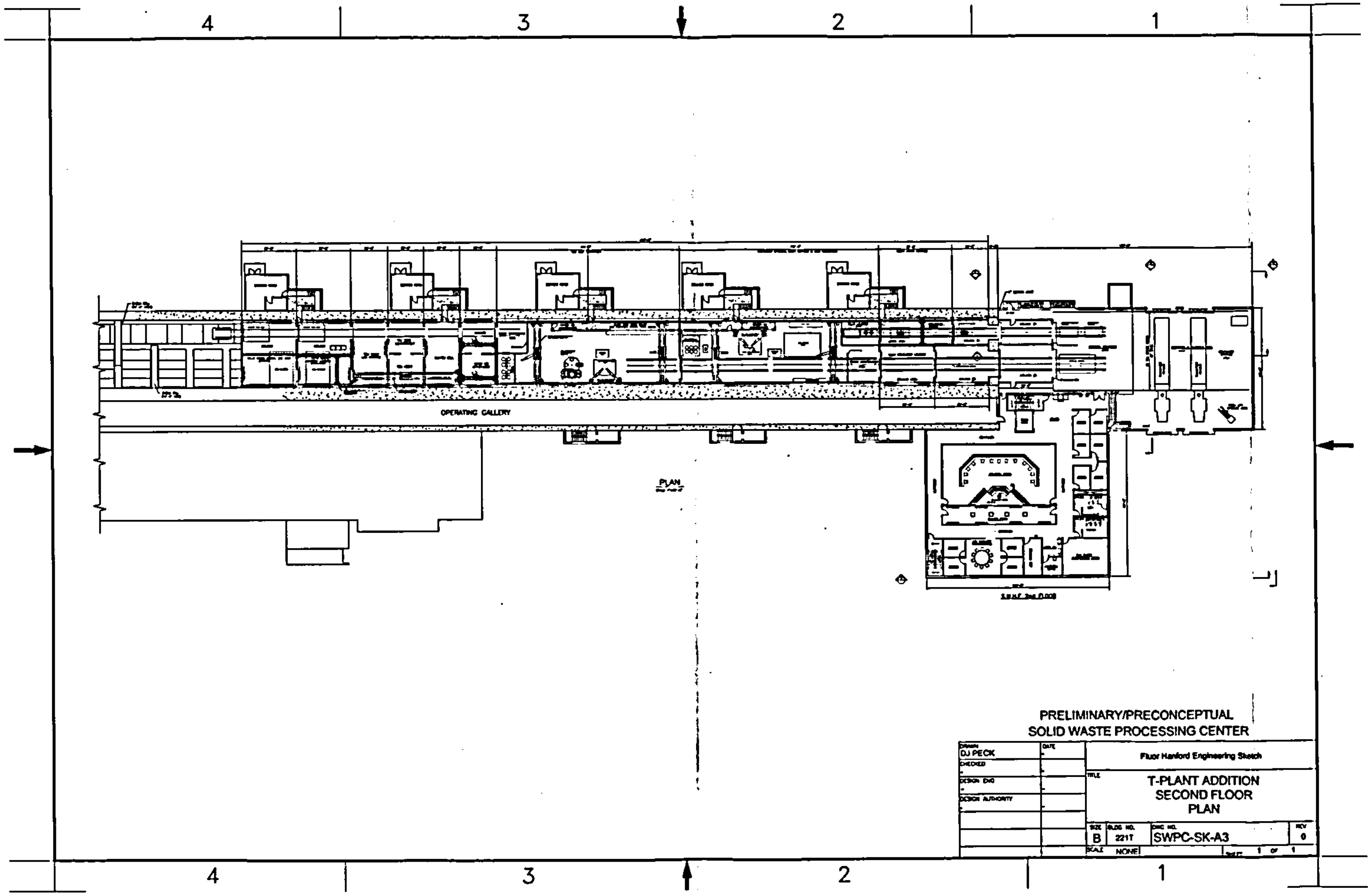

Figure H.2. T Plant Addition Second Floor Plan

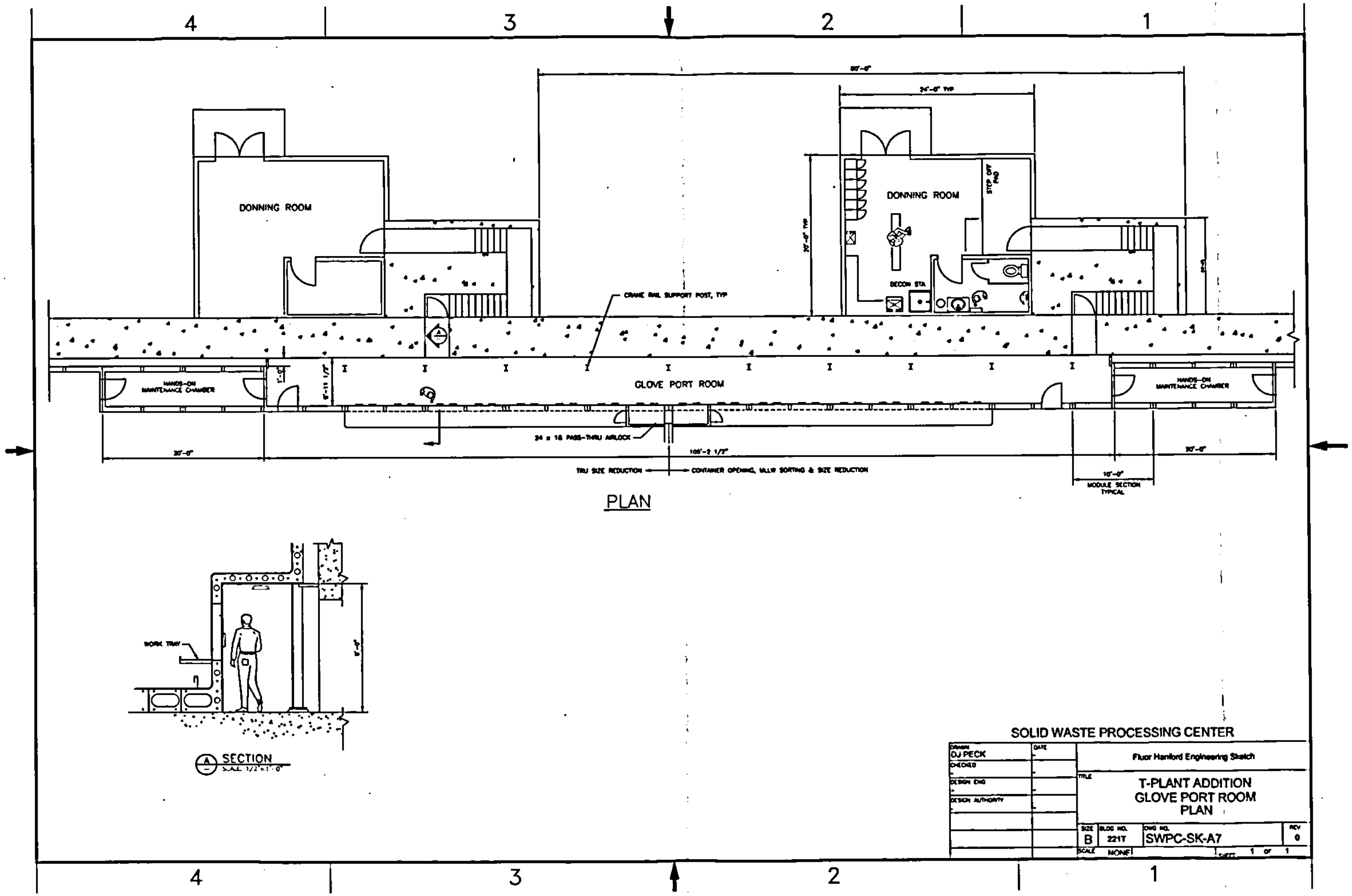

Figure H.3. T Plant Addition Glove Port Room Plan

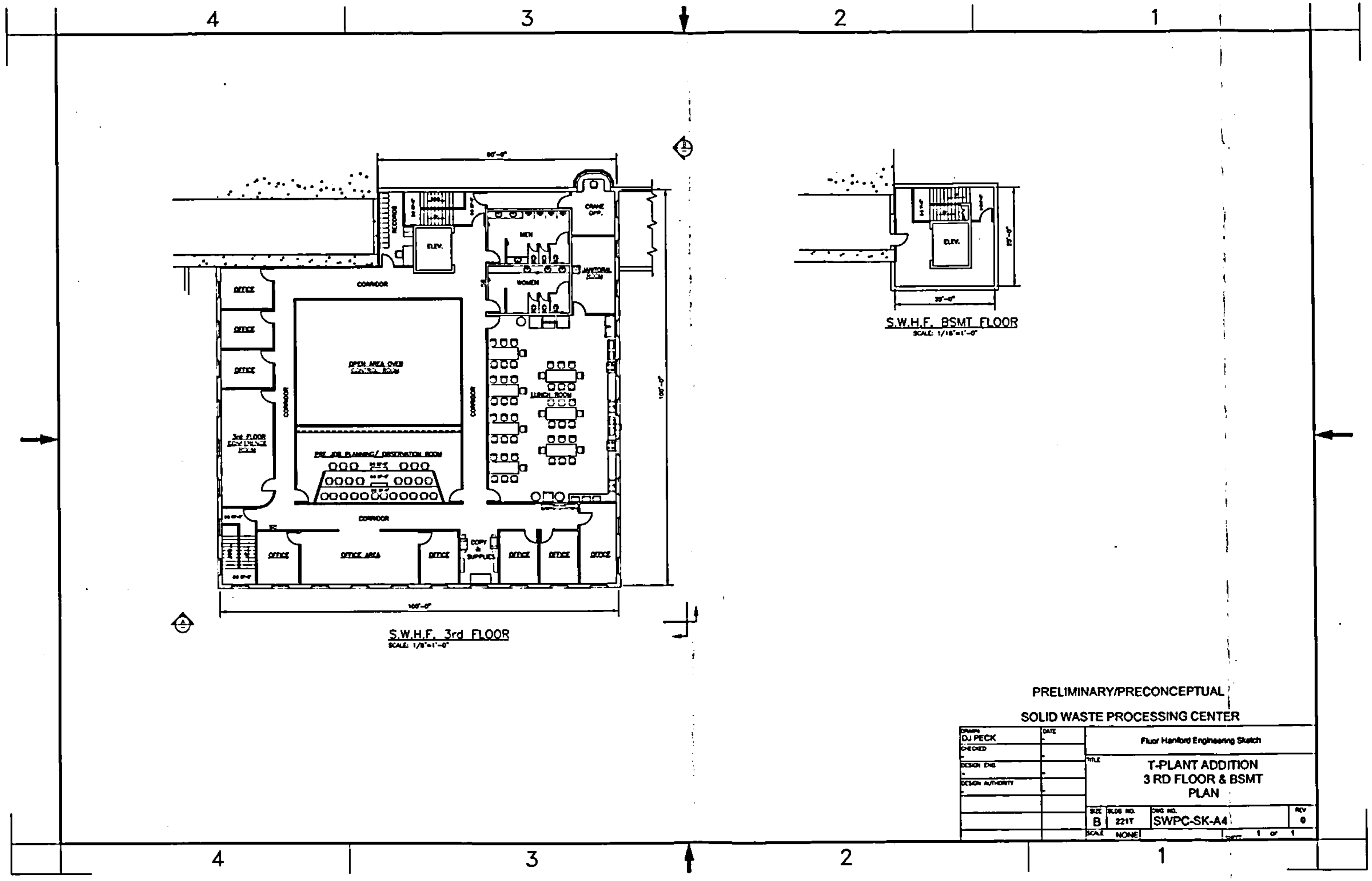

Figure H.4. T Plant Addition Third Floor and Basement Plan

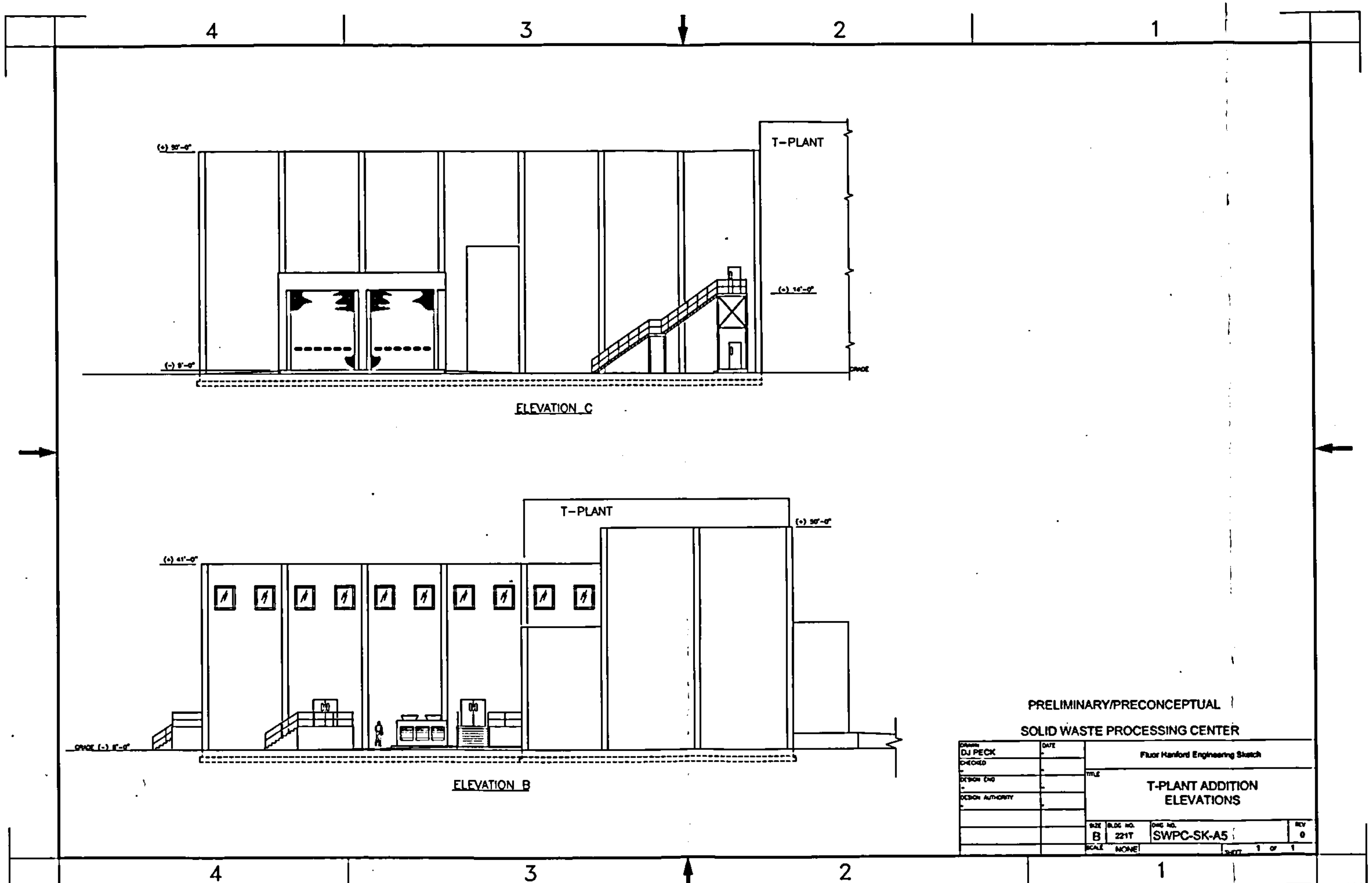

Figure H.5. T Plant Addition Elevations

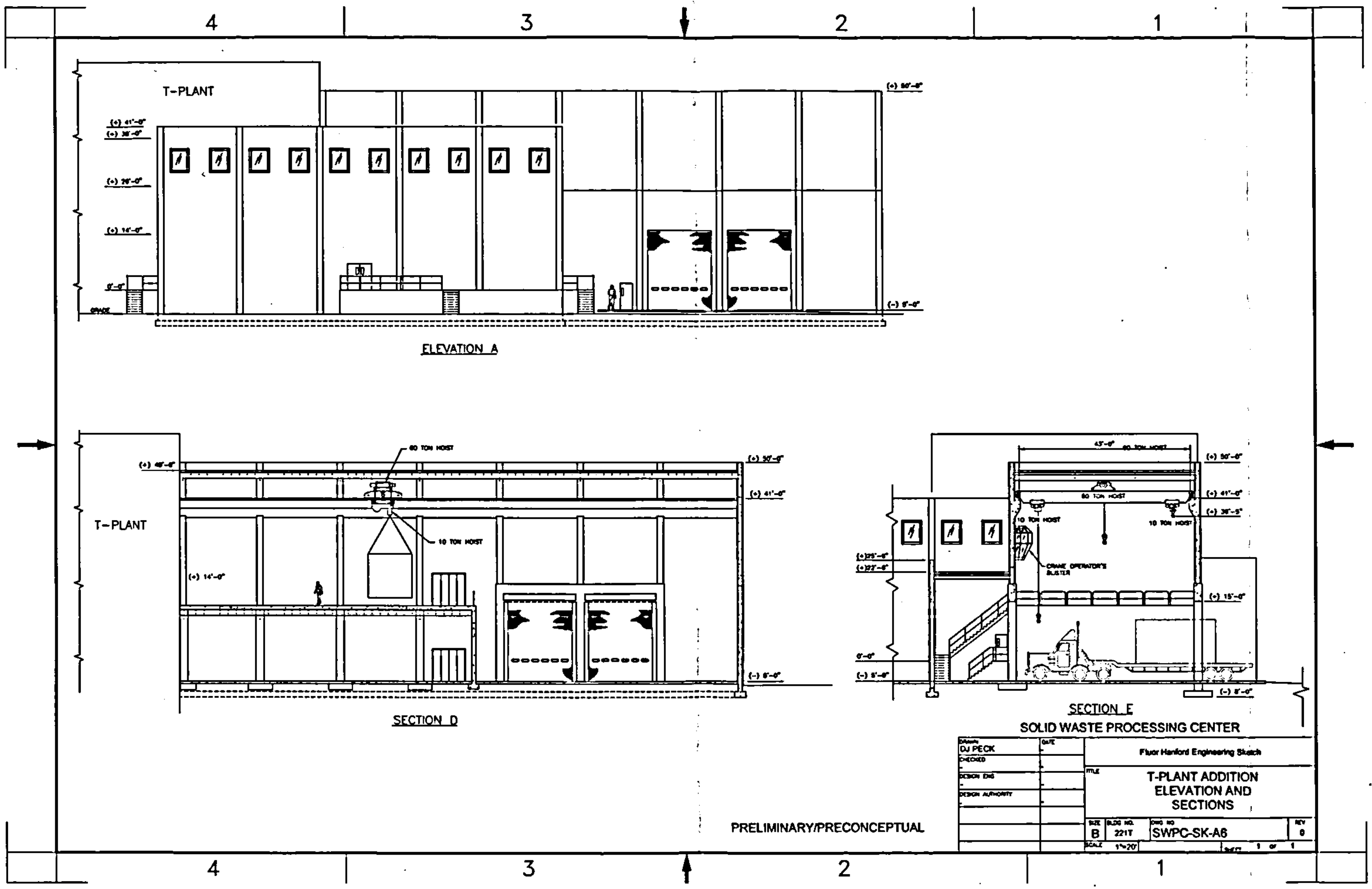

Figure H.6. T Plant Addition Elevation and Sections

Appendix I

Pre-conceptual Design Heating, Ventilation, and Air Conditioning

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Appendix I

Pre-conceptual Design Heating, Ventilation, and Air Conditioning

VENTILATION SYSTEM FOR SWPC

The Solid Waste Processing Center (SWPC) will consist of two connected facilities, the Solid Waste Processing Modules (SWPM) and the Solid Waste Handling Facility (SWHF). The SWPM spaces will generally be contaminated, and the SWHF spaces will generally be free of contamination. Two separate ventilation systems will be provided for the two facilities.

SWPM Ventilation

The process modules will be located inside the T Plant canyon, situated immediately above the existing process cells. The modules will be connected end-to-end in such an order that the ventilation air will cascade from relatively clean modules toward the most contaminated process modules. The two most contaminated modules will be the TRU Waste Open, Sort and Size reduction Module (TOSSM) and the MLLW Primary Open, Sort and Size reduction Module (POSSM).

Assuming that the two process modules will circulate air at the rate of 10 air changes per hour, the TOSSM will circulate approximately 11,000 cfm and the POSSM will circulate approximately 14,000 cfm, based on interior volume. The proposed relative locations of all the modules and the recommended air flows and pressures are shown in Figure I.1.

The current exhaust flow in the double-HEPA-filtered T Plant exhaust system is approximately 31,000 cfm. The source of make-up air for the exhaust consists of approximately 10,000 cfm at the rail tunnel door in addition to an approximately 21,000 cfm infiltration through the existing canyon supply plenum and miscellaneous other drainage and abandoned equipment penetrations. A certain percentage of this infiltration is suspected of entering the exhaust ventilation tunnel directly without passing through the canyon. Actual minimum airflow available must be confirmed by measurement of current infiltration rates.

It will be desirable to condition most of the canyon supply in order that the process modules will have relatively clean air and operate in a reasonable temperature range (40°F to 90°F). As shown in Figure I.1, the modules will require approximately 14,000 cfm supply air from the canyon. It is estimated that approximately 20,000 cfm of conditioned air could be supplied to the canyon through new A/C units located at each end of the canyon, one near the 221 TA and the other at the rail tunnel door. Each unit would supply 10,000 cfm and would have electric resistance heating (approximately 140 kW) and chilled water cooling (approximately 20 ton).

Supply air to each module will be controlled through an adjustable orifice plate or valve. Backflow from the modules to the canyon will be prevented with back-draft dampers. All air supplied to the TOSSM and POSSM will be cascaded from adjacent modules at lower contamination potential. Pressure differentials between modules will normally be in the range of 0.05 in.wc., and the differential between the canyon and the TOSSM or POSSM will be approximately 0.5 in.wc. Local HEPA filtered exhaust units (or vacuums) will be situated to control particulate at size reduction stations. The total exhaust from the modules (14,000 cfm) will be discharged to a new 16-inch round duct located in the hot pipe trench, approximately 220 feet long. The duct will require four vertical legs (16 feet dia.) that penetrate the floor of the trench and extend to the exhaust tunnel below.

Four new change rooms will be located along the South wall of the 221-T, situated at four existing access stairways. Each of the four change rooms will require approximately 1.5 tons of cooling. Two of the rooms will utilize split system heat pumps. HVAC for the other two change rooms located near the POSSM and TOSSM will receive coolant from a small 5-ton chiller that will also supply cooling for the Manned Process Maintenance Module (MPMM). Cooling air to the MPMM will be through an 8-inch duct penetrating the south canyon wall.

SWHF Ventilation

The Solid Waste Handling Facility has two distinctly different functional areas: the Shipping and Receiving Area and the Control Room Support Building.

Shipping and Receiving Area:

The Shipping and Receiving Area has accommodations for two semi-trucks to park inside. The total interior volume of open space is over 200,000 ft^3, and includes a large open storage area. It is intended that the large truck doors would be left open whenever the truck engines are running. In addition, four roof exhaust fans rated at 5000 cfm each will purge the area of exhaust fumes at the rate of approximately 5 air changes per hour. Actual ventilation requirements will depend on allowable carbon monoxide levels as defined by ASHRAE Std. 62.

Heating will be provided by electric unit heaters totaling 80 kW, which will maintain 50°F inside temperature with the doors closed. In addition, portable infrared spot heaters will be provided. Cooling will be provided by portable spot coolers, either refrigerated or evaporative units.

Control Room Support Building:

The Control Room Support Building is treated as an office facility and is provided with standard commercial HVAC, including computer room air conditioning for the control room. Each of the three floors in the building will have a mechanical area to house HVAC equipment (heat pumps). The total airflow will be approximately 25,000 cfm, and the total cooling required will be approximately 70 tons.

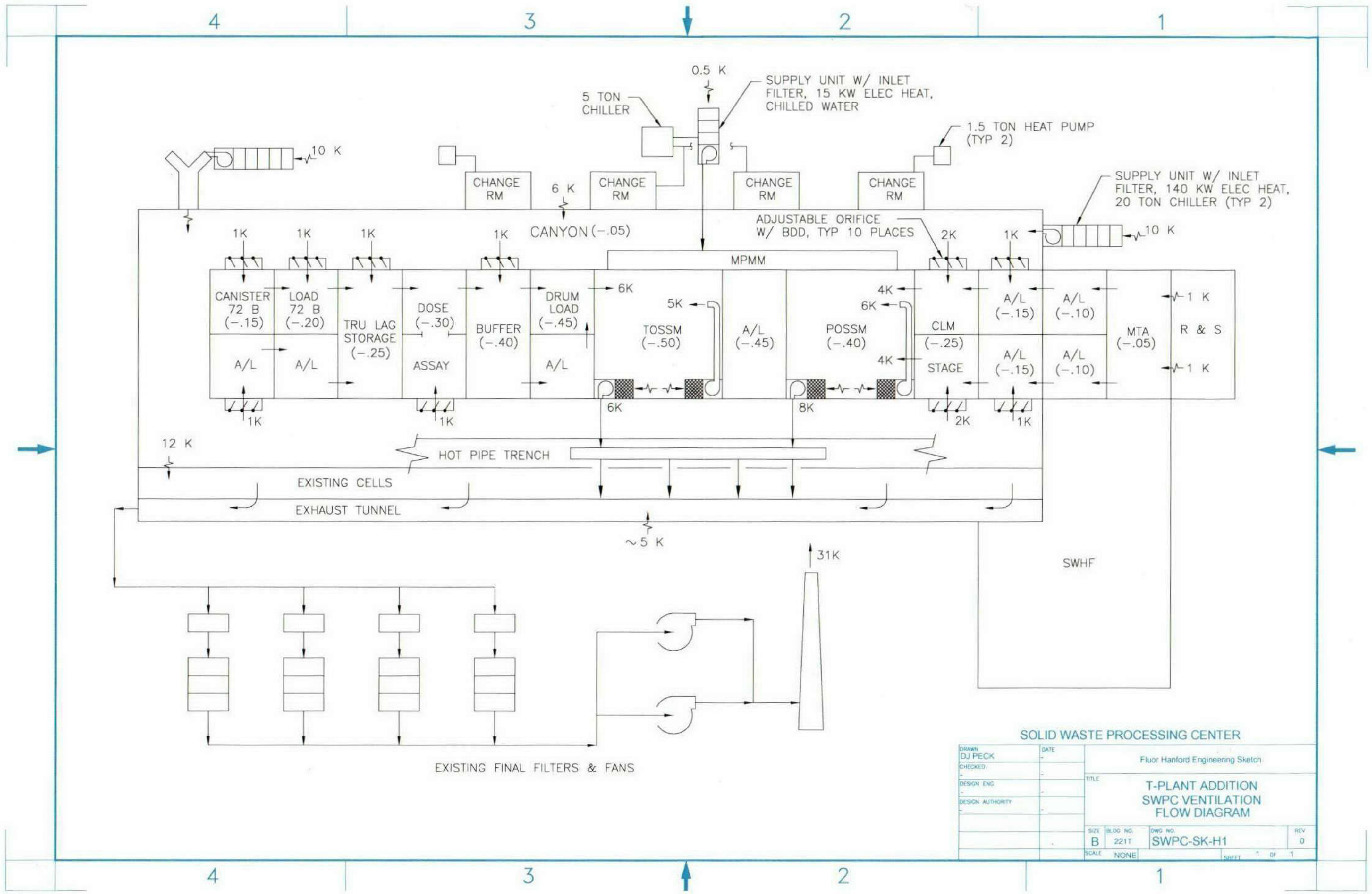

Figure I.1. T Plant Addition SWPC Ventilation Flow Diagram

Appendix J

Pre-conceptual Design/Construction Cost Estimate

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Activity ID	Activity Description	Orig Dur	Early Start	Early Finish
0005	CD-0 PREPARATION	65	02OCT06	29DEC06*
0007	PRE CONCEPTUAL DESIGN	195	01JAN07	28SEP07
0010	CD-0 JUST. OF MISSION NEED SUBMIT TO HQ	0		06JUL07*
0015	APPROV. OF MISSION NEED; START OF CDR	0		01NOV07*
0020	CDR PHASE I & II	589	01OCT07	31DEC09
0026	CD-1 SUBMIT CD-1 / START CD-2	0		31DEC09
0027	REMOTE SYSTEMS INTEGRATION & TESTING	1,045	01OCT07	30SEP11
0040	DRY RUN PRESENTED FOR VALIDATION	88	01DEC09*	01APR10
0045	VALIDATE FOR CAP $	0		01APR10*
0055	DD PHASE I & II	586	01JAN10	30MAR12
0056	CD-2 SUBMIT	0		30MAR12
0057	BID & AWARD PHASE I & II	131	30MAR12	28SEP12
0067	CD-2 APPROVAL/START CD-3	0		29JUN12*
0070	CONSTRUCTION PHASE I & II	783	01OCT12	30SEP15
0080	CD-3 COMPLETE	0		30SEP15
0085	OPS STARTUP	588	01APR14*	30JUN16
0090	CD-4 START OF OPS	0		30JUN16
0095	CLOSEOUT	66	01JUL16	30SEP16
0105	POST CD-4 COMPLETION	0		30SEP16

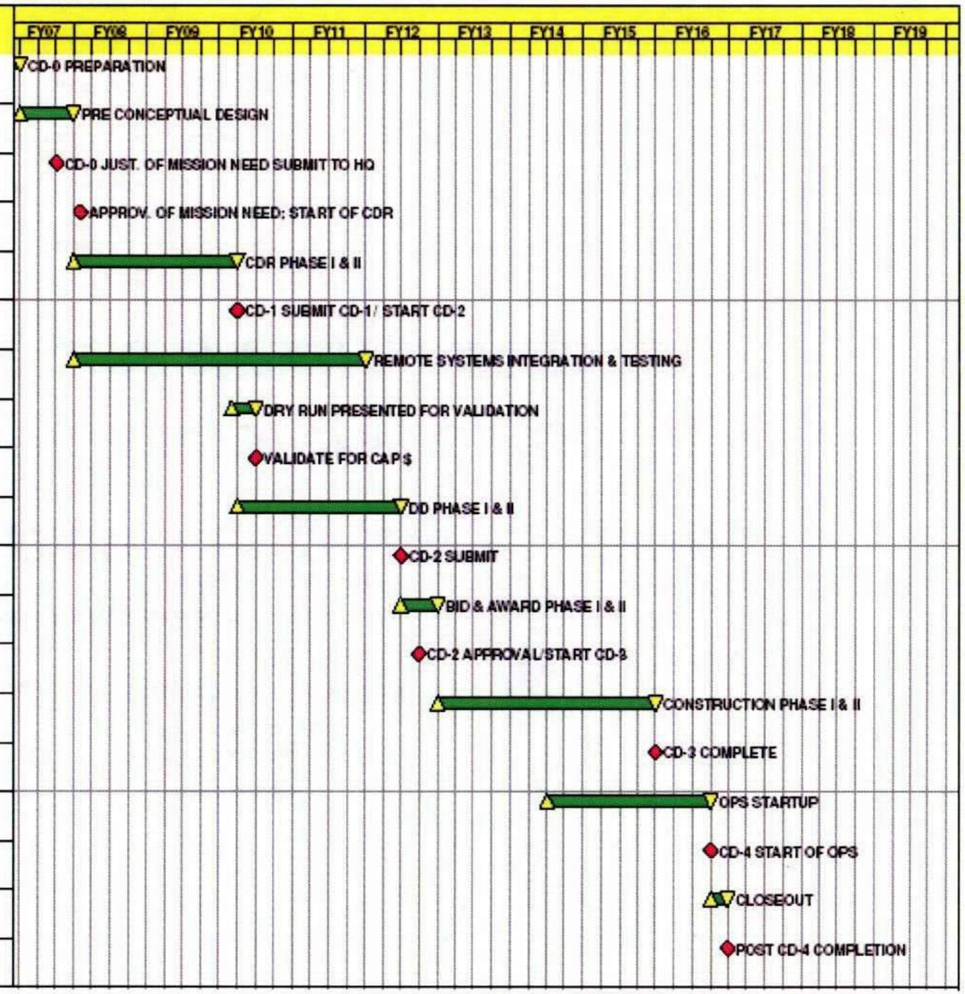

Figure J.1. Project Schedule

M-91 ACTIVITY BY FY W/O ADDERS OR CONTINGENCY	FY 07 1 M	FY 08 1 M	FY 09 1 M	FY 10 1 M	FY 11 1 M	FY 12 1 M	FY 13 1 M	FY 14 1 M(b)	FY 15 1 M	FY 16 1 M	FY 17 1 M	DIRECT SUM	ESCALATED W/SITE ADDERS	CONTINGENCY ADDED @
Fiscal Year														
CRITICAL DECISIONS SUPPORT	0.1	0.1		0.1	0.1							0.40	0.75	0.97
PROJECT DOCUMENTATION	0.8	1.4	1.45	0.7	0.3				0.05			4.70	6.35	8.26
PRE-CONCEPTUAL (Q2)	1.0											1.00	1.35	1.76
CONCEPTUAL P1/P2														
PHASE 1 (Q3-Q2) FY08-09		1.00	0.2									1.20	1.62	2.11
PHASE 2 (Q3-Q4) FY 08-09		0.25	1.3									1.55	2.10	2.72
ADVANCED CONCEPTUAL (Q1)														
FY 10				0								0.00	0.00	
DEFINITIVE DESIGN P1/P2														
PHASE 1 (Q2-Q1) FY 10-11				4.8	1.6							6.40	8.65	11.25
PHASE 2 (Q2-Q3) FY 10-11				4.6	4.6							9.20	12.44	16.17
REMOTE SYS INTEG/TESTING														
(CDR Q4- DD Q2) FY 07-11	0.5	5.4	5.6	4.0	2.0							17.50	23.66	30.75
PROCUREMENTS														
(Q1-Q3) FY 11-14					20	12	12	7.9				51.90	70.16	91.20
CONSTRUCTION														
Phase 1 (Q3-Q4) FY 12-15						5.00	6.20	6.10	1.20			18.50	25.01	32.51
Phase 2 (Q3-Q4) FY 12-15						13.00	10.00	10.00	6.00			39.00	52.72	68.53
T3 E&I														
(Q4-Q4) FY 12-15						1.75	1.75	1.75	1.75	0.2		7.20	9.73	12.65
START-UP/TESTING														
(Q3-Q4) FY 14-16							1.7	5.5	10.6	17.0		34.80	47.04	61.15
OPERATIONAL SUPPORT														
FY 07-16	0.1	0.25	0.5	0.5	0.8	0.8	1.4	1.5	2.0	2.6		10.45	14.13	18.36
PROJECT SUPPORT														
FY 07-16	0.8	2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	0.2		18.40	24.87	32.33
MILLION $ / FISCAL YEAR (TOTALS W/O ESC & CONT)	3.3	10.4	11.25	16.90	31.60	34.75	35.25	34.95	23.80	20.00		222.20	300.36	390.47
ESCALATION 16.0% BASIS (compounded from FH table)	1.00	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16				
SITE ADDERS 16.53% (maintained at current rate)	1.165	1.165	1.165	1.165	1.165	1.165	1.165	1.165	1.165	1.165				
FY MILLION $ (W/ESCLATION AND SITE ADDERS)	3.85	14.06	15.21	22.84	42.72	46.97	47.65	47.24	32.17	27.03			300.36	
CONTINGENCY (30% Average)	1.00	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30				
PROJECT COST TOTALS W/ADDERS & CONT	3.85	18.28	19.77	29.70	55.53	61.07	61.94	61.42	41.82	35.15				390.47

NOTES: ACQUISITION STRATEGY ASSUMES FUNDING AND CONTRACTING OF MULTIPLE YEAR CONTRACTS AND SUPPORT PROJECTS WILL BE FUNDED

1. CD-0 FUNDING NEEDED IN FY07 TO SUBMIT CD-0 2 JAN 08
2. PRECONCEPTUAL FUNDING NEEDED FROM 2 JAN 08 UNTIL APPROVAL OF CD-0.
3. APPROVAL CYCLES BASED ON 3 MONTH TURN AROUND FROM SUBMITTAL TIME
4. ADVANCED CONCEPTUAL MAINTAINED FOR CONTINUITY OF RESOURCES
5. PE&D FUNDS USED UNTIL CONSTRUCTION STARTS BASED ON VALIDATION IN 2010

Legend: Expense Funds (green); PE & D Funds (yellow); Capital Funds (blue)

CD0 PROJECT >$100 M <$750 M REQUIREMENTS NON-MSA	Reference Document: Draft Program and Project Management for The Acquisition of Capital Assets DOE 413.3X 6/29/2006
*Mission need statement prepared to document Project and risk	(Parameters, benefits, final review needed)
**Mission validation Project Review	(Limited review or Value Engineering Study)
***Tailoring Strategy	(Project Execution Plan Initiated)
****Approval Request of PED funds	(Baseline development, Preliminary Design, Final Design)
*****Pre-Conceptual Planning	(Funding breakdown and resource loading)
******NEPA Strategy	(Permitting and environmental plan)
*******Quality Assurance Program Plan	(QA plan outlined or in place)

Figure J.2. Pre-conceptual Design/Construction Cost Estimate

Appendix K

Pre-conceptual SWPC Operations Cost Estimate

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OPERATIONS

Work Package OPERATIONS	Cost Center	P3 Res	Res Desc	$K	Hrs	FTEs		ESTIMATE RATE	ESTIMATE COST
	Operations Total		$10 513 420						
FY17	Total	$12,887,300							
Operations								Total	$12,887,300
The MLT Facility will require 97 personnel to operate on the ABCD shift. These people are broken down as follows Plant Engineers (Ops Sup) 8, Ops Engineers 4, Analysts 2, Manipulator Operator 24, NPO 24, RCT 24, Crane Operator 2, Teamster 4, Rigger 6. NPO, RCT, and Manipulator Operators have a 1.25X multiplier to compensate for training, PTB and Sick			Operations Supervisor		8980	8.0	Provide supervision to Operations staff during Operations. Trained and qualified for all functions of Operations including BED. Receive facility training Waste Handling training and training certification on new systems of SWPC. Four Supervisors are required to operated the facility ABCD Shifts. During absences or training, other supervisors fill in. Day shift has two persons assigned, other shifts have one. Ops Engineer assists with routine duties and fills position as Assistant BED/Communicator during emergencies	$75	$673 50[illegible]
			Ops Engineer		7184	4.0	Provide supervision to Operations staff during Operations. Trained and qualified for all functions of Operations including BED and Communicator. Receive facility training Waste Handling training and training certification on new systems of SWPC. Four Engineers are required to operated the facility ABCD Shifts. During absences or training other Engineers fill in. All shifts have one person assigned	$75	$630 80[illegible]
			NPO		53880	30.0	Operate the SWPC inside and perform necessary tasks to keep facility operation, moving full containers, moving empty containers, maintaining inventories, marking containers assisting with routine maintenance and maintaining cleanliness functions. 24 Operators are required to maintain the anticipated schedule. Six additional NPOs are added to staff to allow for Sick, PTB and Training requirements	$56	$2 963 400
			RCT		53880	30.0	Operate the SWPC inside and perform necessary tasks to keep facility operation, surveying full containers, Surveying entry points, assisting with inventories, assisting with marking containers performing routines assisting with routine maintenance and maintaining cleanliness functions. 24 RCTs are required to maintain the anticipated schedule. Six additional RCTs are added to staff to allow for Sick, PTB and Training requirements	$56	$2 963 400
			Manipulator Operator		53880	30.0	Operate the SWPC inside and perform necessary tasks to keep facility operation, moving full containers, moving empty containers, maintaining inventories, marking containers assisting with routine maintenance and maintaining cleanliness functions. 24 Manipulator Operators are required to maintain the anticipated schedule. Six additional Manipulator Operators are added to staff to allow for Sick, PTB and Training requirements	$55	$2 963 400
			Rigger		17960	10.0	Riggers are on staff to receive packages that require external rigging and rigging plans. Riggers will rig equipment off of trucks and onto the rails for reception into the SWPC. This activity includes four Riggers	$55	$987 800
			Crane Operator		3592	2.0	Crane Operators operate cranes for the receipt of containers on trucks both in the Tunnel and the Solid Waste Handling Facility. Crane Operators are assigned on Days and one other shift	$55	$197 560
			Teamster		7184	4.0	Truck Drivers are utilized to move containers in and out of the tunnel and the SWHF. Two drivers are assigned	$55	$395 120
			Rad Analyst		3592	2.0	Provide supervision to RCT Staff and provide guidance on Rad issues. Develop RWPs, AMWs and other documentation required to receive, open and repackage containers. Two Analysts are assigned on four shifts	$85	$305 320
			Material	$400			Operational Material based on 5% of Operations cost. Includes cost of Protective clothing, masks, containers tools bags and other consumables		$400 000
Maintenance								Total	$4,776,440
Maintenance is performed as Preventative, routine and corrective. It is anticipated that all components will be replaced once every four years and will be accomplished in outages. Outages will require more staff than budgeted here. An electrician, Instrumentman, and Millwright are kept on each shop for repairs. It is anticipated that each craft will rely on the other for routine repairs			Supervisor		3592	2.0	Maintenance Supervisors will supervise maintenance staff on two shifts. He will ensure safety of workers and approve all work packages. Will review PM schedules and ensure maintenance is kept current	$75	$269 400
			Electrician		10776	6.0	Performs electrical work on all shifts	$55	$592 680
			Millwright		10776	6.0	Performs Millwright work on all shifts	$55	$592 680
			Instrument Tech		10776	6.0	Performs Instrument work on all shifts	$55	$592 680
			Pipe Fitter		3592	2.0	Performs Fitter work on two shifts	$55	$197 560
			Tool Room		3592	2.0	Mans the Tool Room on two shifts	$40	$143 680
			Material Costs Robotics	$2 600			Robotics will be replaced four times during the lifetime of the system. The full cost ($32.5M) is divided over each operating year (15 yrs). A 1.2 X multiplier is added for escalation and other costs		$2 600 000
			Material Costs Other	$263			Material Costs for repair parts, special tools and test equipment estimated at 5% of annual Maintenance Costs		$263 000
			PO Contracts	$626			An Open contract for repairs on Robotics. Anticipated a 10% of annual Maintenance costs		$626 000
Planning								Total	$1,149,440
Each Waste Package Record is reviewed by the planning team and a Work Package/Procedure is prepared that gives Operations direction for receiving, opening, sorting, repackaging and shipping the waste package. The review is explicit and includes rigging instructions, survey points, ALARA Plans and other pertinent instruction to fully treat the package			Planner		3592	2.0	Convenes planning sessions. Maintains records. Records decisions and drafts package. Operates on two shifts	$75	$269 400
			Engineer		1796	1.0	Participates in all planning sessions and initiates USQ on package. Approves all packages	$85	$152 660
			Ops Sup		1796	1.0	Participates in all planning sessions and approves all packages	$55	$98 780
			NPO		1796	1.0	Participates in all planning sessions and applies experience gained in operations in the planning of new packages	$55	$98 780
			Analyst		1796	1.0	Participates in all planning sessions and approves all packages. Develops RWP and AMW for each package	$85	$152 660
			RCT		1796	1.0	Participates in all planning sessions and applies experience gained in operations in the planning of new packages	$55	$98 780
			Manip Operator		1796	1.0	Participates in all planning sessions and applies experience gained in operations in the planning of new packages	$55	$98 780
			Nuc Eng		1796	1.0	Participates in all planning sessions and approves all packages. Validates that package is within the MDSA bounds	$100	$179 600

Shift Breakdown						
Shift Compliment		Days	Swing	Graves	Other	Total
OPERATIONS						
Supervisors		2	1	1	1	5.0
Ops Engineer		1	1	1	1	4.0
NPO		8	8	8	6	30.0
RCT		8	8	8	6	30.0
Manipulator Operators		8	8	8	6	30.0
Riggers		5	5			10.0
Crane Operator		1	1			2.0
Teamsters		2	2			4.0
Analyst		1	1			2.0
				Total Operations		117.0
MAINTENANCE						
Supervisor		1	1			2.0
Electrician		3	1	1	1	6.0
Millwright		3	1	1	1	6.0
Instrument Tech		3	1	1	1	6.0
Pipe Fitter		1	1			2.0
Tool Room		1	1			2.0
				Total Maintenance		24.0
PLANNING						
Planner		1	1			2.0
Engineer		1				1.0
Ops Sup		1				1.0
NPO		1				1.0
Analyst		1				1.0
RCT		1				1.0
Manip Operator		1				1.0
Nuc Eng		1				1.0
				Total Planning		9.0
Total Personnel		56	42	29	23	150.0