LOW-LEVEL AND TRU WASTE MANAGEMENT AT WEST VALLEY

J. C. Cwynar, L. R. Eisenstatt, J. Goodman, P. M. Petrone
West Valley Nuclear Services Co., Inc.
West Valley, NY 14171-0191

ABSTRACT

The management of low-level and TRU wastes at West Valley will be governed by the requirements in DOE Order 5820. This order requires the adoption of low-level waste disposal criteria and a TRU waste certification strategy; West Valley will meet the intent of the waste form requirements of 10 CFR 61 and base TRU waste certification on the Waste Isolation Pilot Plant Waste Acceptance Criteria. Solid waste will be packaged in 208 liter drums and rectangular boxes. Liquid and wet solid wastes will be treated and solifidied in cement in the Radwaste Treatment System. Equipment design and selection are currently being performed. Waste forms that will be generated by this system are currently being tested to ensure that the West Valley wastes can be safely disposed.

INTRODUCTION

Waste management at West Valley includes the collection, segregation, treatment, packaging, assay, and disposition of wastes generated by decontamination activities[1], high-level waste vitrification[2,3], and maintenance of the existing plant. These waste streams fall into two main categories, low-level waste (LLW) and TRU waste, both of which are regulated by DOE Order 5820-Management of Radioactive Waste[4].

DISPOSAL CRITERIA

As required by DOE Order 5820, the West Valley Demonstration Project (WVDP) is adopting waste disposal criteria for LLW and a certification strategy for TRU waste.

LLW will be disposed on-site in the NRC Disposal Area (NDA) using shallow land burial techniques. The WVDP plans for its waste forms to meet the intent of the requirements in Section 55 (Waste Classification) and Section 56 (Waste Characteristics) of 10 CFR 61[5]. These sections require the classification of waste according to activity and the meeting of waste form requirements. In summary, these requirements that are of concern to the WVDP are:

Cardboard and fiberboard boxes are not permitted;

Liquid waste must be solidified or packaged in absorbent material to absorb twice the liquid volume;

No more than one volume percent free liquid is allowed in solid waste. For Class B and Class C (higher activity) waste the free liquid is restricted to 0.5 percent or, if a high integrity container is used, 1 percent;

Waste must not be capable of exploding;

Waste must not contain or be capable of generating toxic gases;

Waste must not be pyrophoric; and

Class B and Class C waste must have structural stability (a program being conducted to demonstrate this is discussed later in this paper).

TRU waste will be disposed at a federal repository designed for the disposal of TRU waste. Prior to the availability of such a facility, the TRU waste will be stored on-site in a TRU Interim Storage Facility. The WVDP has been evaluating the Waste Isolation Pilot Plant (WIPP) Waste Acceptance Criteria[6] (WAC) and will monitor the development of other repository criteria. Because the WIPP-WAC are the most developed criteria, the WVDP is basing its TRU waste certification program on them. These criteria are:

Containers must be noncombustible, Type A, and have a design life of at least 15 years;

Combustible content of the waste must be documented;

Package size must not exceed 3.7 m x 2.4 m x 2.5 m;

Packages must be stackable and capable of being handled by standard lifting devices;

Powders, ashes, and particulates must be immobilized;

No free liquids are allowed;

Sludges must be packaged such that there is internal corrosion protection;

Pyrophoric materials must be processed to remove their hazardous nature;

Explosives and compressed gases are not permitted;

No toxic or corrosive materials are permitted unless they are co-contaminants;

Packages must weigh no more than 11,300 kg;

Fissile content must not exceed:

- 200 g per 208 liter drum
- 5 g in any 0.028 m^3 for other containers;

Contact handled waste dose rate must not exceed 200 mRem/hr;

Surface contamination must not exceed:

- 50 picocuries per 100 cm^2 alpha
- 450 picocuries per 100 cm^2 beta-gamma;

Packages with thermal power densities greater than 3.5 w/m^3 must be reported;

Gas generation rate is restricted;

Packages must be color coded to identify contents;

Packages must be labeled with a serial number and weight; and

Information must be reported in a data package.

In many respects, both the LLW and TRU waste criteria are similar. This is because some of the criteria were developed to protect the safety of the disposal facility workers. For example, the restrictions on free liquid and pyrophoric materials prevents the spread of contamination in the event of container failure. Also, the restriction on toxic substances (or those that may produce fumes) reduces the nonradiological hazard to workers.

SOLID WASTE HANDLING

Containers

Four types of containers are expected to be used to package the majority of West Valley low-level and TRU wastes. The B-25 (strong-tight) rectangular container has outside dimensions of 1.9 m x 1.2 m x 1.3 m (L x W x H) and is currently in use at the WVDP for packaging all solid LLW destined for on-site disposal.

Regarding rectangular TRU containers, our intent is to have an approved TRU container that meets the criteria of WIPP and interfaces efficiently with the TRUPACT (TRansUranic PACkage Transporter). A 1.7 m x 1.4 m x 1.0 m (L x W x H) rectangular steel container with mechanical closure (Fig. 1) has been designed, fabricated, and tested. The container passed all tests in accordance with the applicable requirements of 49 CFR 173.398 and has been certified as Type A.

Two types of 208 liter drums will be used at the WVDP. 17H drums are used currently for packaging LLW; they are painted black with appropriate labeling. 17C drums will be used for packaging TRU waste. They will be painted white to distinguish them from LLW drums; they will be labeled according to the TRU waste criteria and site handling requirements.

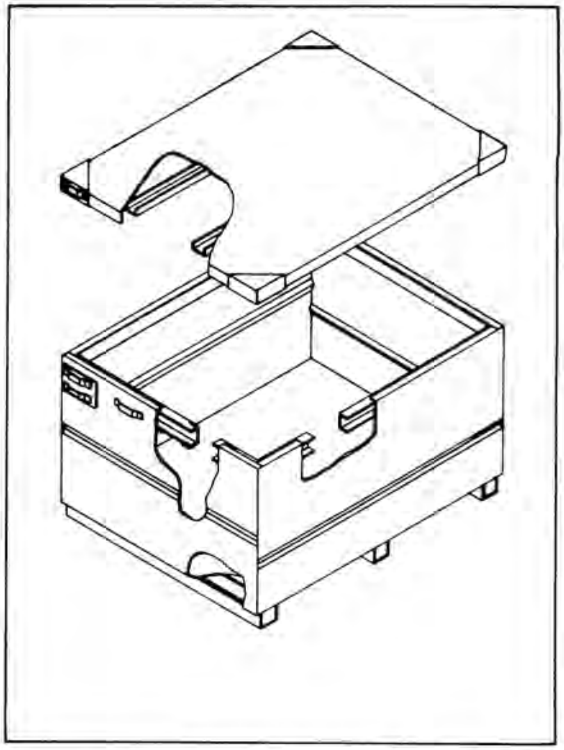

Fig. 1 Sketch of a Type A steel rectangular container built for use at West Valley.

Solid Waste Treatment

A large radioactive waste compactor, rectangular container type with HEPA filtration, is currently operational at the WVDP. The unit has a compaction force of 45,000 kg (100,000 lbs). It is designed to compact materials in the B-25 rectangular container. The compactor has been operating with a compaction ratio of 4-1/2 to 5:1. All low-level (non-TRU) compactible waste will be compacted. It is not planned to compact TRU waste, because of the contamination risk.

All small equipment (noncompactible) LLW items will be packaged in Spec. 17H 208 liter drums and/or B-25 rectangular steel boxes. TRU contaminated equipment will be packaged in Spec. 17C 208 liter drums and/or Type A rectangular steel boxes.

Large equipment TRU waste, e.g. tanks, will be decontaminated and fixed to acceptable levels on exterior only. This equipment will be wrapped in plastic sheeting and/or containerized and stored for future size reduction and additional decontamination.

Large equipment LLW will be decontaminated to levels acceptable for on-site handling, stored temporarily, and disposed on-site.

LIQUID WASTE TREATMENT

System Description

A Radwaste Treatment System (RTS) is required at West Valley to pretreat, volume reduce, and solidify in cement the liquid and wet solid LLW and TRU waste streams. Figure 2 is a flow diagram of the RTS, and Table I lists examples of waste streams it will process. The required system will have to collect wastes for sampling and characterization; pretreat and volume reduce liquid streams; solidify resins, concentrates, and sludges; polish effluents; and be capable of handling containers of solidified waste. Our current plans call for splitting this Radwaste Treatment System into two subsystems, a Cement Solidification Subsystem (CSS) and a Liquid Waste Treatment Subsystem (LWTS).

TABLE 1 A

Liquid Waste Streams to be Processed in the RTS

WASTE STREAM	VOLUME (LITRES)	CHEMICAL COMPOSITION	(μCi/cc) RADIOACTIVITY
Decontaminated Supernatant	2.1×10^6	See Table 1 B	1.4
Sludge Wash Solution	3.1×10^6	2 w/o salt solution ($NaNO_3$)	1.4
Internal Decon Solution	1.9×10^5	6.0 w/o $NaNO_3$, 1.0 w/o organic acid/salt, 0.8 w/o HNO_3, 0.1 w/o Mn, 0.1 w/o F	5.0
Eluate and Regenerate from IX Polishers	6.8×10^5	1.1 w/o HNO_3, 0.4 w/o $NaNO_3$	0.1
Melter Feed Concentrator Overheads	6.9×10^5	0.1 M HNO_3 with 25 ppm suspended solid	32
Spent Zeolite Slurry	5.3×10^5	14.2 w/o Linde IE-95 hydrated Zeolite	3.0

TABLE I B

Supernatant Chemical Composition

($\sim 2 \times 10^6$ litre, specific gravity at 20° C is 1.32)

Compound	Wt. Percent Wet Basis	Wt. Percent Dry Basis	Total Kg in Supernatant
$NaNO_3$	21.10	53.41	602,659
$NaNO_2$	10.90	27.59	311,326
Na_2SO_4	2.67	6.76	76,261
$NaHCO_3$	1.49	3.77	42,557
KNO_3	1.27	3.21	36,274
Na_2CO_3	0.884	2.24	25,249
NaOH	0.614	1.55	17,537
K_2CrO_4	0.179	0.45	5,113
NaCl	0.164	0.42	4,684
Na_3PO_4	0.133	0.34	3,799
Na_2MoO_4	0.0242	0.06	691
Na_3BO_3	0.0209	0.05	597
NaF	0.0176	0.04	503
$Sn(NO_3)_4$	0.00858	0.02	245
$Na_2U_2O_7$	0.00809	0.02	231
$Si(NO_3)_4$	0.00805	0.02	230
$RbNO_3$	0.00417	0.01	119
Na_2TeO_4	0.00287	0.007	82
AlF_3	0.00270	0.007	77
$Fe(NO_3)_3$	0.00151	0.004	43
Na_2SeO_4	0.00053	0.001	15
$Li(NO_3)$	0.00049	0.001	14
H_2CO_3	0.00032	0.0008	9
$Cu(NO_3)_3$	0.00021	0.0005	6
$CsNO_3$	0.00018	0.0004	<5
$Sr(NO_3)_2$	0.00014	0.0004	0.04
$Mg(NO_3)_2$	0.00007	0.0002	2
TOTAL	39.50	99.98	1,128,332
H_2O (by difference)	60.49		1,727,341

Cement Solidification Subsystem (CSS)

The Cement Solidification Subsystem will be a batch process system which will be automatically controlled to provide the optimum mixing time, and the optimum cement to waste ratio for the particular waste to be processed.

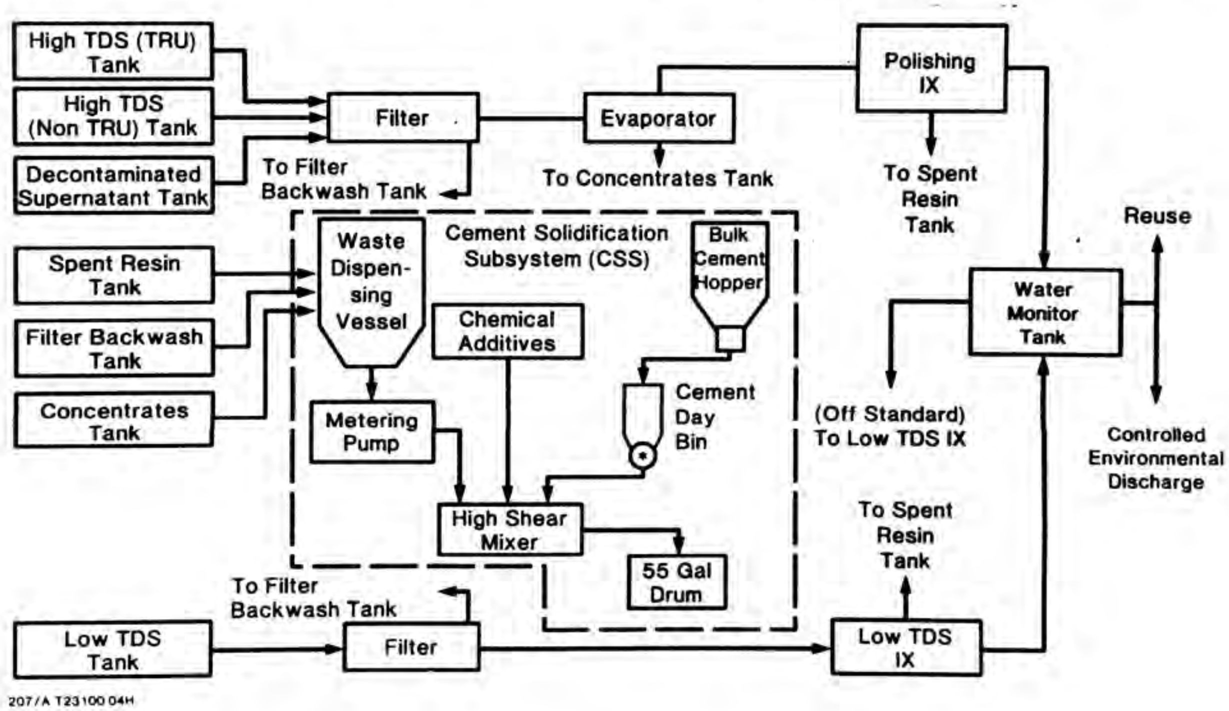

Fig. 2. Flow diagram for the Radwaste Treatment System.

The heart of this cement solidification subsystem will be a high-shear mixer developed for solidification of radwaste[7]. This mixer has the ability to encapsulate the wide variety of radioactive wastes generated at West Valley. The high-shear provides a strong mechanical action which has been demonstrated to overcome the adverse effects of various waste chemistries.

This high-shear mixer will consist of an impeller and a small high-shear mixing vessel where radwaste will be mixed with cement. This mixing vessel was intentionally designed to be small to minimize the volume of flushwater required, and to facilitate disposal at the end of its service life. An exact duplicate of the high-shear mixer was used for the waste form development and testing program discussed later.

The target date for initial hot operation at West Valley is July, 1985. To meet this schedule, the system will be adapted to and installed in an existing unused process building called the 01/14 Building. This building was designed and constructed during a plant expansion in 1972 to house an acid recovery system and an off-gas scrubbing system. The plant was not restarted following the expansion shutdown and this process equipment was never used, so the building does not need to be decontaminated. However, the processing equipment had been installed and is currently being removed to make way for the cement system. Construction, including building modifications and installation of the CSS, is scheduled to begin in July of this year (1984), and cold start-up is scheduled for April, 1985.

Liquid Waste Treatment Subsystem

The Liquid Waste Treatment Subsystem will consist of two parallel process trains; one for decontaminated supernatant and other liquid waste streams with a high total dissolved solids (TDS) content, and a second for low TDS waste.

The high TDS waste processing train will include chemical adjustment, filtration, evaporation, and ion-exchange polishing of condensates. Evaporator concentrates will be pumped to the cement solidification subsystem for disposal. Ion exchange polished condensate will be analyzed and combined with water from the low TDS train in a recycle hold tank. Current plans call for maximum recycle of this treated water within the Project. Treated water in excess of Project needs will be discharged to the environment in compliance with DOE Order 5480.1A[8]. Low TDS waste will be chemically adjusted, filtered, ion-exchanged, analyzed, and combined with the water from the high TDS train.

Target date for initial hot operation of this system is July, 1987. The Liquid Waste Treatment Subsystem (LWTS) will be installed in several cells inside the main process building which had previously been used for processing spent reactor fuel. These cells require decontamination as well as modifications to accommodate the LWTS. D/D of the cells required for the LWTS is a forty-one month effort expected to be complete in April of 1986. This will be followed by twelve months of building modification and installation work, with cold checkout scheduled for April, 1987.

Confirmatory Testing

To demonstrate that the liquid wastes can be solidified in cement in the mixer discussed above, a waste form development and testing program was begun. The goal of the first phase of this program was to develope recipes or formulations for solidifying in cement some of the well characterized waste streams in as high a waste to cement ratio as practicable and still meet the stability criteria. Ultimately the results of this program will form a part of the process control program for the CSS.

Recipes for the decontaminated high-level waste supernatant at 39 wt percent (see Table IB) and 53 wt percent (evaporated) salt, and the existing Low-Level Waste Treatment Facility (LLWTF) sludge (predominately clay) are shown in Table II. The water to cement ratio for the supernatant recipes was 0.7. The LLWTF sludge recipe water to cement ratio was 0.8. Specimens made from these recipes were subjected to the following tests[9]:

Compression tests in accordance with ASTM C39; compression test specimens with dimensions of 15 cm diameter x 30 cm long are shown in Fig. 3.

Expose specimens to a minimum of 10^8 rads in a gamma irradiator and then conduct the above compression tests;

Thermal degradation tests in accordance with the procedure in ASTM B553 followed by the above compression tests;

90 day immersion tests followed by the above compression tests;

Leach tests in accordance with the procedure in ANS 16.1;

Biodegradation resistance tests in accordance with ASTM G21 and ASTM G22.

TABLE II

Cement Recipes for Supernatant and LLWTF Sludge Wastes

(For a Volume of 75 Litres)

WASTE STREAM	AMOUNT OF WASTE (kg)	(liters)	AMOUNT OF CEMENT (kg)
39 Wt. Percent Supernatant	69.4	53.0	60.5
53 Wt. Percent Supernatant	76.5	54.3	54.7
LLWTF Sludge	61.3	56.2	62.8

The results of these tests are shown in Table III. Note that a successful test that includes compression testing results in a compressive strength greater than 0.34 MPa (50 psi); a leach index of at least 6, is required for the leach test. As Table III shows all of these waste streams can be stabilized. (Details and additional data on this program will be presented at a later date.)

WASTE PACKAGE ASSAY

Assay systems at West Valley that will be used to estimate the activity in waste packages are:

0 A segmented gamma scanner for assaying 208 liter drums of low density (~0.1 g/cm^3) waste. This system performs high resolution gamma

spectrometry through the use of a high purity reverse electrode germanium detector.

- A passive coincidence neutron counting system developed by Los Alamos National Laboratory for assaying TRU contamination on high density waste.
- Direct gamma spectroscopic and alpha survey equipment for estimating the radionuclide content of large volume low dose rate objects.
- Radiochemical methods. These will be used to analyze samples of liquids before solidification in cement and to estimate radionuclide content of high dose rate equipment using remote sampling. Examples of radiochemical methods are liquid scintillation counting, gamma spectroscopy, low energy photon spectroscopy, and separation followed by spectroscopy.

Most of the assay will consist of analyzing detectable gamma emitting radionuclides such as Cs-137, Co-60, and Am-241 and then using scaling factors to determine the quantities of other radionuclides. This approach will be used to classify LLW prior to disposal as well as segregate TRU waste from the LLW.

TABLE III

Test Results on Supernatant and LLWTF Sludge Waste Forms

WASTE FORM	COMPRESSION MPa (psi)	RADIATION STABILITY MPa (psi)	THERMAL DEGRADATION MPa (psi)	IMMERSION MPa (psi)	LEACH INDEX	BIODEGRADATION
39 WT Percent Supernatant	3.1 (450)	4.1 (640)	3.9 (570)	5.1 (740)	6.6	No Visible Growth
53 WT Percent Supernatant	2.6 (380)	2.6 (370)	2.9 (420)	2.8 (400)	6.8	No Visible Growth
LLWTF Sludge	10.1 (1,470)	10.0 (1,450)	12.7 (1,840)	9.7 (1,410)	6.9	No Visible Growth

CONCLUSIONS

Some of the guiding principles for the approaches discussed above are:

Provide as much flexibility as practicable in designed systems and components to accomodate future uncertainties (e.g., liquid and solid waste volumes, storage mode, etc.);

Minimize secondary waste generation and total waste volumes to the maximum extent practicable;

Segregate waste as much and as early as practicable to minimize the amount of TRU waste;

Minimize exposure; and

Minimize cost.

By applying these principles at the appropriate times in the waste management system, the WVDP will be able to collect, treat, and package waste to meet established criteria and to protect the environment and the safety and health of the workers and public.

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