WASTE RECEIVING AND PROCESSING (WRAP) FACILITY TECHNOLOGY

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ABSTRACT

Waste treatment capabilities for Waste Receiving and Processing (WRAP) Facility Module 1 (WRAP-I) will be limited to opening and repackaging of suspect transuranic (TRU) drums and the necessary nondestructive examination (NDE) and nondestructive assay (NDA) services for shipment of the certified waste packages to the designated disposal facilities [onsite disposal of low-level wastes (LLW), as well as TRU wastes to the Waste Isolation Pilot Plant (WIPP) site via the transuranic package transporter (TRUPACT-II)]. The principal technologies used within WRAP-I are the open/sort and repackaging techniques and the application of NDE/NDA package content verification.

The technologies used in WRAP Module 2 (WRAP-II) are principally those waste treatment methodologies necessary to ensure the final waste forms are in compliance with disposal and/or transportation criteria. The WRAP-II will treat the following:

- All TRU noncompliant waste items that do not meet the WIPP Waste Acceptance Criteria (WAC) segregated in WRAP-I
- All the Hanford Site radioactive/hazardous low-level mixed waste (LLMW)
- All large items requiring size reduction/sorting/treatment needed for disposal (mostly large suspect TRU waste items)
- Remote-handled (high surface dose) waste items.

The current scope of the WRAP-II Facility will employ the following waste treatment technologies: passivation of the waste by chemical additives, waste immobilization (within grout matrixes), size reduction via shears/mechanical saws/plasma arc torches/lasers, compaction, shred/grouting, plasma melting, and wet chemical decontamination techniques. All waste materials will be certified to meet the appropriate U.S. Department of Energy (DOE) orders for waste characterization and will adhere to the Resource Conservation and Recovery Act (RCRA) regulations in compliance with the promulgated treatment standards.

INTRODUCTION

The technological basis for the WRAP Facility is best represented by describing the process in which the WRAP Facility will achieve its goal, the process block flow diagrams. The WRAP Facility goal is to treat radioactive and radioactive/hazardous mixed waste to the necessary and required performance standards at a technology level that provides a means to certify the final waste form in accordance with the designated disposal facilities waste acceptance criteria. The term technology takes the meaning of encompassing all the tools, equipment, processes, actions, materials, and knowledge required to achieve the WRAP Facility goal.

The WRAP Facility scope is to examine and certify, segregate/sort, and treat for disposal suspect TRU wastes in drums and boxes placed in 20-yr retrievable storage since 1970, low-level radioactive mixed waste (RMW) generated and placed into storage at the Hanford Site since 1987, designated remote-handled wastes, and newly generated TRU and RMW wastes from high-level waste (HLW) recovery and processing operations.

BACKGROUND

The WRAP Facility will be an integral part of the Hanford Central Waste Complex (HCWC). The HCWC is to provide storage and treatment of solid waste at the Hanford Site. The HCWC will perform waste receipt, storage, repackaging, volume reduction, certification, treatment, and offsite shipment capability for a high percentage of solid TRU and RMW generated, stored, and received at the Hanford Site. All waste will be certified for disposal onsite or shipped to an offsite facility for disposal.

The major portion of the stored suspect TRU waste drums placed in 20-yr retrievable storage are to be handled within the WRAP-I. The stored suspect TRU waste drums are currently in earth-covered units and are subject to failure because of corrosion. For reasons such as this probable breached drum concern, it was determined that the risk of increased environmental contamination afforded the need to escalate the WRAP Project construction to demonstrate to the State of Washington, U.S. Environmental Protection Agency (EPA), and other regulators that the Hanford Site

has made a firm commitment to solid waste treatment and disposal.

The WRAP Project functions were partitioned into two phases as a means to expedite those parts of the WRAP duties that were well understood and use established technology, while allowing more time to better define the technological functions needed for the remainder of WRAP. The WRAP-I, phase one, is to provide the necessary NDE and NDA services, as well as all TRUPACT-II shipping for both WRAP Project phases, with heating, ventilation, and air conditioning (HVAC); change rooms; and administrative services. Phase two of the project, WRAP-II, will provide all necessary waste treatment facilities for disposal of solid wastes (comply with the appropriate waste treatment disposal criteria).

DISCUSSION

All wastes, newly generated or retrieved, require treatment to the prescribed disposal standards. The WRAP Facility was initiated as part of the planned Hanford Site series of facilities to centralize radioactive solid waste receiving, storage, treatment, and disposal operations. The function of the WRAP-I is to provide the necessary processes and certification means for contact-handled (CH) drums of suspect TRU and TRU waste in accordance with the WIPP WAC. The function of the WRAP-II is to provide the technological means to treat waste forms for disposal that are incompatible with the WRAP-I Facility, and provide the necessary treatment processes to enable waste disposal in accordance with all applicable regulations. The technology associated with the WRAP Facility is to provide treatment and certification for waste when a waste generator may not be capable of meeting the treatment standards to allow disposal, and wastes that have been placed in long-term storage (i.e., retrieved suspect TRU wastes). An overall block flow diagram for the HCWC facilities is shown in Fig. 1 in which WRAP is the key in the required treatment technologies.

The WRAP Facility will employ treatment technologies that meet the Best Demonstrated Available Technology (BDAT) treatment standards established for land disposal restricted wastes. These waste treatment standards are based on the performance of the BDAT and are established as a specific treatment technology for certain waste (e.g., high temperature incineration) or a concentration level based on a BDAT waste form stabilization.

WRAP MODULE I

The principal technologies used within the WRAP-I are the open/sort and repackaging techniques and the application of NDE/NDA package content verification. Waste treatment capabilities for the WRAP-I will be limited to receiving, examination, sorting, characterization, treatment, repackaging, certifying, and preparation for transport of CH retrieved and newly generated radioactive solid waste shipment to disposal. Newly generated waste drums and boxes will be overchecked by NDE/NDA to verify the waste packages are compliant with disposal criteria (onsite disposal of LLW as well as TRU wastes to the WIPP site via the TRUPACT-II). The TRU waste packages will be certified to the WIPP site and the TRUPACT-II transportation criteria. Waste that requires further treatment (remote-handled and mixed waste) will be segregated and packaged for storage pending later treatment in the WRAP-II. Fig. 2 displays the WRAP-I block flow diagram.

The WRAP-I will provide the CH drum handling area and NDE/NDA for newly generated CH TRU in standard waste boxes (SWB). All incoming waste containers will be inspected by NDE and NDA, compliant containers routed directly to shipping, and noncompliant drums routed to open/sort for correction of the noncompliant condition or removal of the noncompliant item. Noncompliant SWBs will be routed to storage or to the WRAP-II Size Reduction Facility, as appropriate. Noncompliant waste items removed from drums will be transferred to a special processing enclosure within the WRAP-I for individual processing. Sorted, compliant TRU and LLW waste from drums will be compacted into new containers and routed to shipping. The drum handling area will accept new generated drums, drums from retrieval, and drums from the Size Reduction Facility, and will provide shipping to WIPP via TRUPACT-II and onsite disposal. The technology used within the WRAP-I is briefly outlined as follows.

Both incoming TRU and LLW waste will be examined against the same criteria, but those containers later determined to be LLW may be reclassified as certifiable if the only noncompliant conditions do not apply to LLW [e.g., particulates and high-efficiency particulate air (HEPA) filters]. The NDE area will provide for assaying CH drums (including drums overpacked in 83-gal drums) and for CH TRU in SWBs. The NDE will use real-time radiography (RTR) consisting of x-ray fluoroscopy to examine the contents of each drum. The NDE systems will be used to identify dense waste items (e.g., concrete) that might impact NDA; and to identify noncompliant waste items, such as free or containerized liquids, HEPA filters, large quantities of particulates, aerosol cans, and suspect hazardous materials (hazardous constituents in the Hanford Site waste are generally containerized within the waste and are thus easy to spot); and to "flag" noncompliant drums on the facility computer database for opening/sorting.

The NDA will determine the radionuclide content of each container to the extent required to meet certification and shipping requirements. The NDA equipment will include passive-active neutron (PAN), segmented gamma scan (SGS), and a fission and activation product (FP) drum

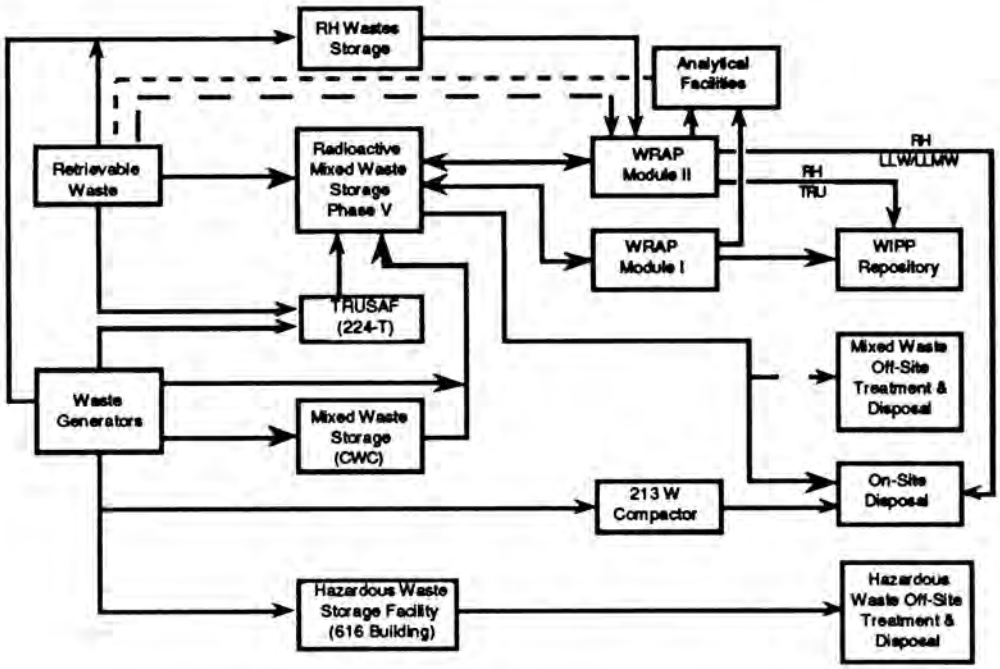

Fig. 1. Solid waste facilities integrated block flow diagram.

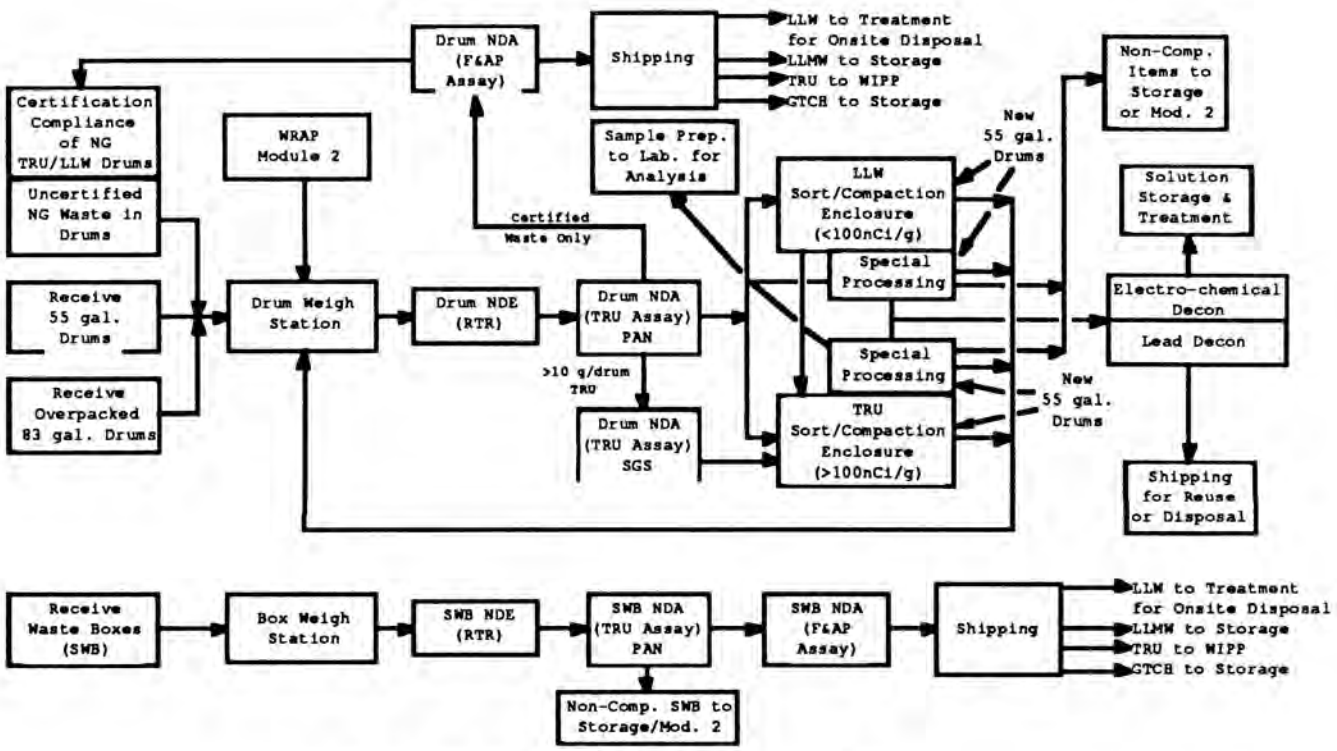

Fig. 2. WRAP module 1 overall block flow diagram.

assay systems; a box PAN; and a box FP assay system. Each NDA system will use weight, density, and radionuclide distribution data from the facility computer database and established algorithms to calculate necessary radionuclide information. All drums will be assayed using the PAN system, and those determined to contain over 10 g of TRU material will be reassayed using the SGS system. All processed containers will be assayed using the FP system before certification and shipping. Containers with known waste matrices and radionuclide content will be used as standards for periodic recalibration of all NDA equipment.

The open/sort/compaction operation will occur within glovebox enclosures and will be used to open all retrieved drums and those newly generated drums that have been identified as noncompliant. Examples of noncompliant drums include those that exceed fissile material limits; drums in poor physical condition; drums whose compliance could not be verified by NDE or NDA; and drums with noncompliant waste items such as free or containerized liquids, HEPA filters, lead bricks, quantities of particulates, aerosol cans, or suspect RMW. Within the open/sort/compaction area, information on waste materials placed within the final waste drums will be entered into the facility computer database, and bar code labels will be applied to all drums exiting the open/sort/compaction enclosure. Currently, plans are to open each TRU and LLW drum in separate enclosures, but the opening and sorting processes will be similar. All sorting will be performed manually through gloveports with extension tools.

For drums that do not meet the fissile material criteria, the contents will be redistributed into one or more new drums. For drums that have been identified as containing potentially noncompliant items, those items will be removed, placed on a transfer cart, and transferred to special processing (noncompactable waste items may also be segregated). Examples of noncompliant items include free or containerized liquids, HEPA filters, large quantities of particulates (HEPA filters and particulates are noncompliant for TRU only), aerosol cans, and suspect RMW. All repackaged drums from the open/sort/ compaction enclosures will be routed back to NDA.

The special processing enclosure will receive noncompliant waste items via transfer cart from the TRU and LLW open/sort enclosures. Any materials suspected to contain hazardous constituents will be sampled, and the samples will be transferred to the sample management area for transfer to existing Hanford Site laboratories for characterization as hazardous or nonhazardous. Treatment and disposal methods will be determined on a case-by-case basis for materials identified as RMW.

Special Processing will include operations for the following:

- RMW sampling
- Immobilization of particulates
- Absorption of liquids
- HEPA filter immobilization
- Pyrophoric material
- Aerosol cans
- Lead waste segregation.

The facility will be capable of processing approximately 37,400 drums (total) of retrieved waste over its 20-yr operational life and 15,000 ft^3/yr of newly generated waste. The facility will also be capable of decontaminating small waste objects for waste volume reduction and changing the waste classification [i.e., TRU to LLW and LLW to below regulatory concern (BRC)]. The WRAP-I is to provide the flexibility allowing for a greatly reduced volume of stored waste, 50% is expected to be assayed as LLW and disposed of through onsite burial.

WRAP MODULE II

The technologies used in WRAP-II are principally those waste treatment methodologies necessary to ensure that the final waste forms are in compliance with disposal and/or transportation criteria. The WRAP-II will treat the following:

- All TRU noncompliant waste items that do not meet the WIPP WAC segregated in WRAP-I
- All Hanford Site radioactive/hazardous mixed waste (LLMW)
- All large items requiring size reduction/sorting/treatment needed for disposal (mostly large suspect TRU waste items)
- Remote-handled (high surface dose) waste items.

The current scope of the WRAP-II facility will employ the following waste treatment technologies: passivation of the waste by chemical additives, waste immobilization (within grout matrixes), size reduction via shears/mechanical saws/plasma arc torches/lasers, compaction, shred/grouting, plasma melting, and wet chemical decontamination techniques. All waste materials will be certified to meet the appropriate DOE orders for waste characterization and will adhere to the RCRA regulations in compliance with the promulgated treatment standards. Figure 3 shows the WRAP-II block flow diagram.

The WRAP-II Facility will provide the size reduction facility, remote handling facility, and mixed waste treatment facility. The RMW treatment facility will provide all necessary capabilities to treat, characterize, and certify low-level CH RMW for disposal at the Hanford Site. The size reduction facility will repackage all TRU from boxes and "other"

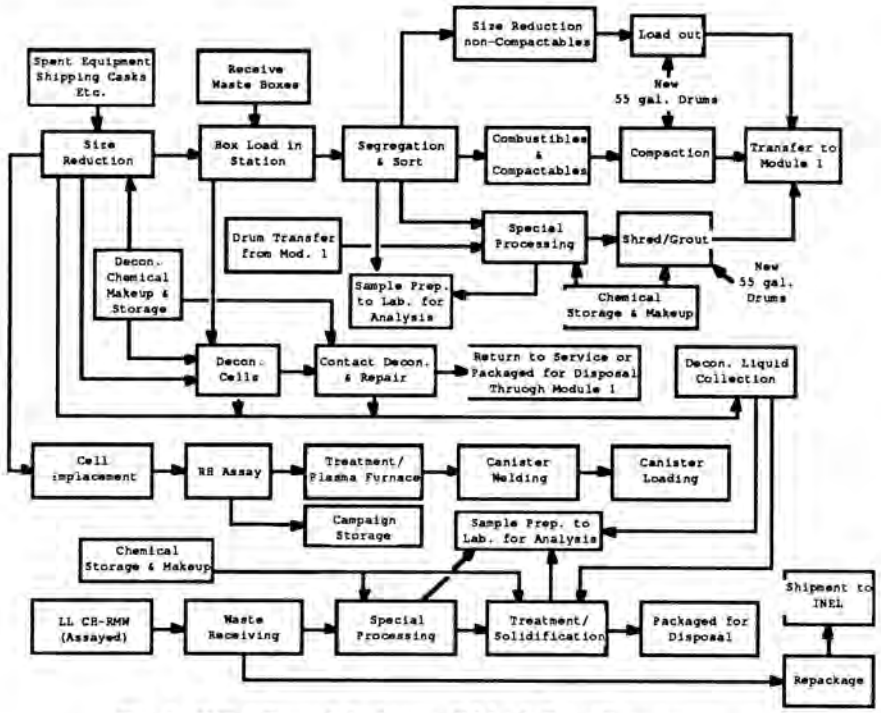

Fig. 3. WRAP module 2 overall block flow diagram.

containers, including certain drummed waste into 55-gal drums. All CH drums will be transferred to the WRAP-I for assay, LLW/TRU segregation, inspection, certification, and shipping. All remote-handled (RH) drums from the size reduction facility will be transferred to remote handling for assay, LLW/TRU segregation, inspection, packaging into RH canisters (RH TRU only), certification, and shipping via the RH TRU cask. The four primary inner facilities of the WRAP-II are briefly described as follows.

Currently the scope of the size reduction facility will include waste receipt, container opening, real-time dose rate measurement, smear sampling, various sectioning operations, compaction, repackaging, and load out. Waste determined to have a dose rate greater than 200 mR/h will be transferred to the remote handling facility.

The size reduction facility will accept boxes, drums, and "other" containers on a daily basis. Boxes, drums, and other containers may be received in a reusable overpack [overpack configuration is to be determined (TBD)] by truck and/or rail, or drums may be overpacked in reusable 83-gal drums. Each container will be visually and radiologically inspected and its accompanying documentation inspected for completeness and correctness. All containers will be visually examined for damage and proper closure and labeling, radiologically surveyed, weighed, documentation reviewed, and all information entered into the facility computer database. Because the accuracy limits of box assay systems may not permit TRU/LLW determination, all retrieved waste boxes and "other" containers will be loaded into the size reduction facility and processed to TRU WAC requirements. Waste will be segregated between cut up containers and packaging materials; combustible materials (plastic, paper, cloth, wood); noncombustible materials (primarily metal); and materials requiring further processing such as shredding, grouting, solidification, and immobilization.

Suspect RMW will be sampled and the samples transferred to an existing Hanford Site laboratory for chemical characterization. The processing area will also have capabilities for taking and loading out routine swipe samples for radionuclide characterization.

All sectioning and cutting tools within the main sectioning area will be handled by manipulators [wall-mounted master-slave manipulators (MSM) and wall- and bridge-mounted electromechanical manipulators (EMM)]. The types of sectioning and cutting techniques to be used include mechanical nibblers; portable mechanical saws (including reciprocating hacksaws, circular saws, and bandsaws); portable abrasive saws; arc saws; plasma arc torches; lasers; and scissor shears.

All operations in the receiving and shipping areas will be performed by CH methods; all operations in the process enclosure will be performed remotely from the operating gallery using MSMs, programmable and remote (PAR) manipulators, positioning tables, and cranes with the assis-

tance of closed-circuit television (CCTV) and direct viewing windows.

A decontamination facility will provide both remote and hands-on decontamination services for shipping casks and internally and externally generated equipment. The decontamination facility will have a 65-ft-long truck and railcar airlock, decontamination areas, and chemical storage areas. Some limited repair services may also be provided, but these will include primarily hands-on replacement of components. The decontamination area will also provide cutting services for those equipment items too long for the size reduction facility airlock. The decontamination facility will provide for equipment to be remotely sprayed with wet chemical decontamination agents and then transferred into the contact decontamination and repair cell.

The remote-handled facility will include waste receipt, assay, smear sampling, plasma melting, measurement of unshielded total and neutron dose rates, repackaging, canister welding, and cask handling. Separate processing campaigns will be performed for LLW and TRU waste, and all RH LLW will be packaged into 55-gal drums while all RH TRU waste will be repackaged into RH canisters. All RH TRU canisters will be directly certified for WIPP emplacement and transported to the WIPP in the RH cask system. Newly generated RH TRU would also be treated, packaged into RH TRU canisters, and certified for WIPP disposal.

Specific technologies within the RH handling area include the following:

- Receiving and cask handling
- RH assay
- Plasma furnace
- Canister welding
- Cask loading.

Each container will have a bar code label with a unique identification number preinstalled at the retrieval or generator site. The RH facility will also provide services for loading and unloading RH casks.

Incoming drums will be assayed via a modified PAN/SGS system for unshielded drums and smaller containers, and an FP assay system for unshielded drums and canisters. Assay of incoming waste will be used primarily for criticality control, while outgoing waste will be assayed for certification.

The RH waste will be processed in batches through a plasma furnace. The plasma furnace will operate at temperatures greater than 3,000°C and are capable of melting all materials of interest. The plasma torches within the furnace will keep most of the feed metal molten so that it can be poured from the hearth to the withdrawal crucible. The furnace is to be operated in a controlled atmosphere to prevent oxidation of certain metals, primarily zirconium with an inert gas (usually nitrogen or argon). This system would melt one can and its contents into stainless steel molds and allow it to cool; routine samples will be taken for radiochemical analyses. Once cooled the molds are sealed, decontaminated, and transferred back to the assay area. Each container would have a bar code label preinstalled with a unique identification number.

The mixed waste treatment facility will provide all necessary treatment for low-level CH RMW to enable disposal of the treated residues in accordance with all applicable DOE, EPA, and Washington State Department of Ecology (WDOE) regulations, including the land disposal restrictions. The mixed waste treatment facility includes liquid waste treatment (for liquids generated in the WRAP by decontamination and condensation only), solidification of sludges and ion exchange resins, pretreatment and solidification of metallic wastes, and shipment of organic RMW to the Idaho National Engineering Laboratory (INEL) for incineration. This facility may be broken down into functional areas as follows:

- Waste receiving
- Pretreatment
- Solidification
- Metals treatment
- Liquid treatment
- Treated waste shipment
- General support areas.

The waste receiving area is the area where wastes are accepted, inspected, and stored before treatment. Waste will include sludges, ion exchange resins, metallic wastes, organic wastes, and dry active waste. Most of the waste will be contained in drums although boxes or bulk shipments may also be accepted. As waste is received each container will be visually and radiologically inspected, and its accompanying documentation will be reviewed for completeness and correctness. Any discrepancies will either be resolved with the shipper noted on a computer database for resolution upon opening, returned to the generator, or transferred to another facility.

Wastes requiring pretreatment, a means for providing introduction to the solidification process (slurried and/or filtered), have been broadly categorized as follows:

- Dry solids--These are primarily the sludges
- Sludge--This category includes wastes that are pumpable and that are generally in the 15 to 30 wt% solids range
- Slurry--This category includes wastes generally of less than 15 wt% solids Ion exchange resins.

Solidification is to occur within mix tanks where the sludges, slurries, and ion exchange resins will be combined with cement. The mix tanks will be fed by the closed conveyor carrying dry solids and filter press cake, or they can accept pumped waste from any of the pretreatment tanks. Bulk chemicals will be transferred pneumatically from storage silos to the mix tank. After mixing is complete, the solidification mix tank contents will be placed in 55-gal drums, and the drums will be conveyed and moved by forktruck to a drum curing and inspection area. After curing, the drums will be closed, labeled, and prepared for final shipment for disposal.

Except for final drum filling, the entire solidification process will be remotely operated. It is anticipated that dose rates will be typically less than 50 mR/h. The general solidification area should be surrounded with a shield wall. The drum loading operators in the basement area should also be in shielded areas with a clear view of the conveyor area.

Organic waste and animal waste will be repackaged for shipment to the INEL. Organic liquids will be pumped or poured from their containers and loaded into U.S. Department of Transportation (DOT)-approved shipping containers. Absorbed organic waste and animal waste will be manually loaded into shipping containers. Thermal oxidation, mercury mineralization, lead refining, and solidification will be used to treat zirconium and zirconium/beryllium shavings and fines, beryllium power, mercury metal, lead, and other miscellaneous solid metals. The liquid and solids will be dumped into a decant tank. The solid fraction of the waste will be allowed to settle to the bottom of the tank while the liquid fraction will be drawn off and transferred to liquid treatment.

The solid fraction will be removed from the decant tank and placed in the fuel oil-fired thermal oxidizer. Air emissions will be controlled with a secondary combustion chamber and baghouse filter. The fine residual ash will be placed in drums and transported to the solidification process.

Currently it is planned for mercury metal to be mineralized to reduce its toxicity by conversion to mercuric sulfide (this compound has a very low solubility and is nontoxic). The technology used in this process is to react mercury with a sulfide compound such as hydrogen sulfide or sulfur dioxide in a stirred reaction tank. Liquids containing residual traces of mercury will be sent to the liquid treatment system. The separated sludge will be solidified. Lead will be treated using a refining process using a small induction furnace. Miscellaneous solid metals will be encapsulated in cement.

The liquid treatment consists of a collection system in which all liquids generated in the decontamination area and in the LLMW area by dewatering processes, resin sluicing, compaction, floor drains, and other sources will be collected for transfer to the solidification operation.

A number of facility support areas have been identified and include the following:

- Drum reclaim area
- Instrument calibration area
- Sample testing area
- Electrical/utility
- Control room.