DP-MS-88-112

TRU WASTE CERTIFICATION AT THE SAVANNAH RIVER PLANT

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A paper for presentation at the
American Institute of Chemical Engineers Summer Meeting
Denver, CO
August 21--24, 1988

and for publication in the Proceedings

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ABSTRACT

THE WASTE CERTIFICATION FACILITY (WCF) AT THE SAVANNAH RIVER PLANT (SRP) ASSESSES TRANSURANIC (TRU) WASTE IN 55-GAL DRUMS BY X-RAY AND NEUTRON INTERROGATION PRIOR TO SHIPMENT TO THE WASTE ISOLATION PILOT PLANT (WIPP) IN NEW MEXICO. THE FACILITY, EQUIPMENT, AND OPERATION ARE DESCRIBED. RESULTS OF A PROBABILISTIC RISK ASSESSMENT (PRA) SHOW THAT THE FACILITY CAN BE OPERATED WITHOUT UNDUE RISK TO PLANT PERSONNEL, THE PUBLIC, AND THE ENVIRONMENT.

INTRODUCTION

The Savannah River Plant (SRP) located near Aiken, South Carolina, is operated by the Atomic Energy Division of the Petrochemicals Department of E. I. du Pont de Nemours and Company. SRP has been producing plutonium and tritium for the United States Department of Energy (DOE) and predecessor organizations since the early 1950's. The materials, produced in nuclear reactors, are isolated in separations facilities and in other operations. Wastes from the separations facilities include solids and liquids of varying radioactive content. One special category of waste is transuranic (TRU) waste in which the major contaminant is plutonium. This paper describes TRU waste

handling at SRP, including interim storage and assay. The Waste Certification Facility (WCF) is basically a materials handling and remote inspection facility. The WCF assesses drummed TRU wastes to determine which meet the criteria for shipment to, and disposal at, the Waste Isolation Pilot Plant (WIPP) in New Mexico.

TRU WASTE AT SRP

A Computerized Burial Record Archives (COBRA) database has been maintained since 1974 for TRU waste placed on concrete pads in retrievable storage at SRP. This waste is divided into two categories, depending upon whether the curie content is above or below 0.5 Ci per container. In either case, contaminants exceed 100 nCi/g, the minimum level for TRU waste classification as specified by DOE. Drums of TRU waste containing less than 0.5 Ci are stored on concrete pads in the SRP burial ground without further shielding. Drums containing more than 0.5 Ci each are stored in concrete shielding containers (called "culverts" at SRP). Until mid-1985 the stored drums and culverts were covered with earth. Since mid-1985, the earth cover has not been used because of pending plans to repackage this material in a proposed transuranic waste facility. A picture of a TRU waste storage pad containing both drums and culverts is given in Figure 1.

TRU waste is packaged in 55-gal drums for long-term management, but some other package forms have also been used. TRU waste drums typically have a radiation level of <50 mrem/hr at contact. However, in extremely rare cases, drums may have levels up to 200 mrem/hr at contact. All TRU waste drums must be surveyed by the generator prior to shipment to the WCF to verify that the dose rate is <200 mrem/hr. All drums exceeding 50 mrem/hr at 3 in. from the

FIGURE 1. A TRU Waste Storage Pad in the Burial Ground

package must be tagged by the onsite generator to indicate a high dose rate. Such drums are then given special handling treatment.

The content of the drums varies widely in type of waste and in TRU content. A list of materials constituting typical TRU waste is given in Table 1. To limit heat generation, the maximum alpha activity permitted in any one drum in the WCF is 554 Ci, equivalent to 32 g of Pu-238. The maximum allowable fissile content in any one drum is 195 g of Pu-239, equivalent to 12.3 Ci. A maximum of 134 55-gal drums will be present in the WCF at any one time. Pu-238 content per SRP drum averages about 5 g/drum. Pu-239 content per SRP drum averages about 15 g/drum. Drums are neither opened nor permanently stored in the WCF.

The first phase of WCF operation will involve only newly generated TRU waste in 55-gal drums. In the future, TRU waste in drums currently stored retrievably on concrete pads will be recovered and assayed for shipment to the WIPP.

TRU WASTE CONTAINERS

The 55-gal drums used to store TRU waste are constructed of carbon steel having a galvanized coating of zinc adequate to meet DOT Specification 17C for drums. A rigid polyethylene liner and lid inside each drum isolates the contained TRU waste from direct contact with the drum, so waste is effectively doubly contained. In a recent development, a special (composite carbon) filtered vent is provided in each liner lid and also in each drum lid to vent radiolytic hydrogen and provide pressure relief.

Culverts, for the higher activity level drums containing Pu-238, are constructed of concrete and hold 14 drums. Each culvert is 6 in. thick, 7 ft in diameter, and 7 ft high. A concrete lid is grouted in place after the

TABLE 1

Typical TRU Solid Waste Materials

Combustible	Noncombustible
Paper	Filters (HEPA)
Wipes	Filters, canister
Cloth rags, uniforms	Glassware, ceramics
Cartons	Small tools
Gloves	Tin cans
Wood boxing	Machined metal hardware
Sweepings*	Miscellaneous metal hardware
Graphite*	Crucibles
Residues (undefined)*	Pipe lengths and fittings
Plastic film, sheeting, bottles, drum liners, windows, labware, and sponges	Concrete
Miscellaneous rubber	

Miscellaneous Chemicals	Equipment or Machinery
Evaporated sludge*	Cutoff saw
Caustic sludge*	Glove boxes
Soda lime*	Carver press
Contaminated mercury	Hood front
Filters*	Evaporator
Ash	Tanks
Spent resins (ion exchange)*	Hoods
	Vessels
	Instruments, laboratory
	Motors
	Scales
	Hot plates
	Shipping containers

* Could be considered respirable forms in event of an accident.

culvert is filled with 14 drums. Culverts, to be unloaded in a future facility, are not handled in the WCF.

DESCRIPTION OF FACILITIES

The WCF, located in the SRP burial ground for low-level wastes, provides two functions: assaying-certification and packaging-loading-shipping. Throughout this paper, the terms "assay bay" and "packaging bay" are used, respectively, in descriptions of the facility and its operations.

The WCF is of standard construction, designed to withstand the application of gravity loads, a 50-year wind (80-85 mph), and a standard seismic load (0.09 g). The assay bay was built and put into use first, followed by the packaging bay. Both structures are metal buildings having one common wall. The two-bay facility, one low (assay) and one high (packaging), has a combined floor area of 3,570 ft^2. An isometric view of the WCF is shown in Figure 2, and a floor plan is shown in Figure 3. The WCF cost about $2 million.

ASSAY BAY

The assay bay, 50 by 30 ft, has an external loading dock for receiving individual drums as they are off-loaded from a truck. An internal temporary storage area can accommodate up to 50 drums in a single tier array. Drum movement within the facility is accomplished manually with the use of a drum dolly. An outside concrete sump collects runoff from floor drains.

X-Ray Area

In the x-ray area, drums are individually examined using a real-time radiography system. Results of the x-ray examination are used to determine if the contents of the drums meet specified criteria such as: minimal free

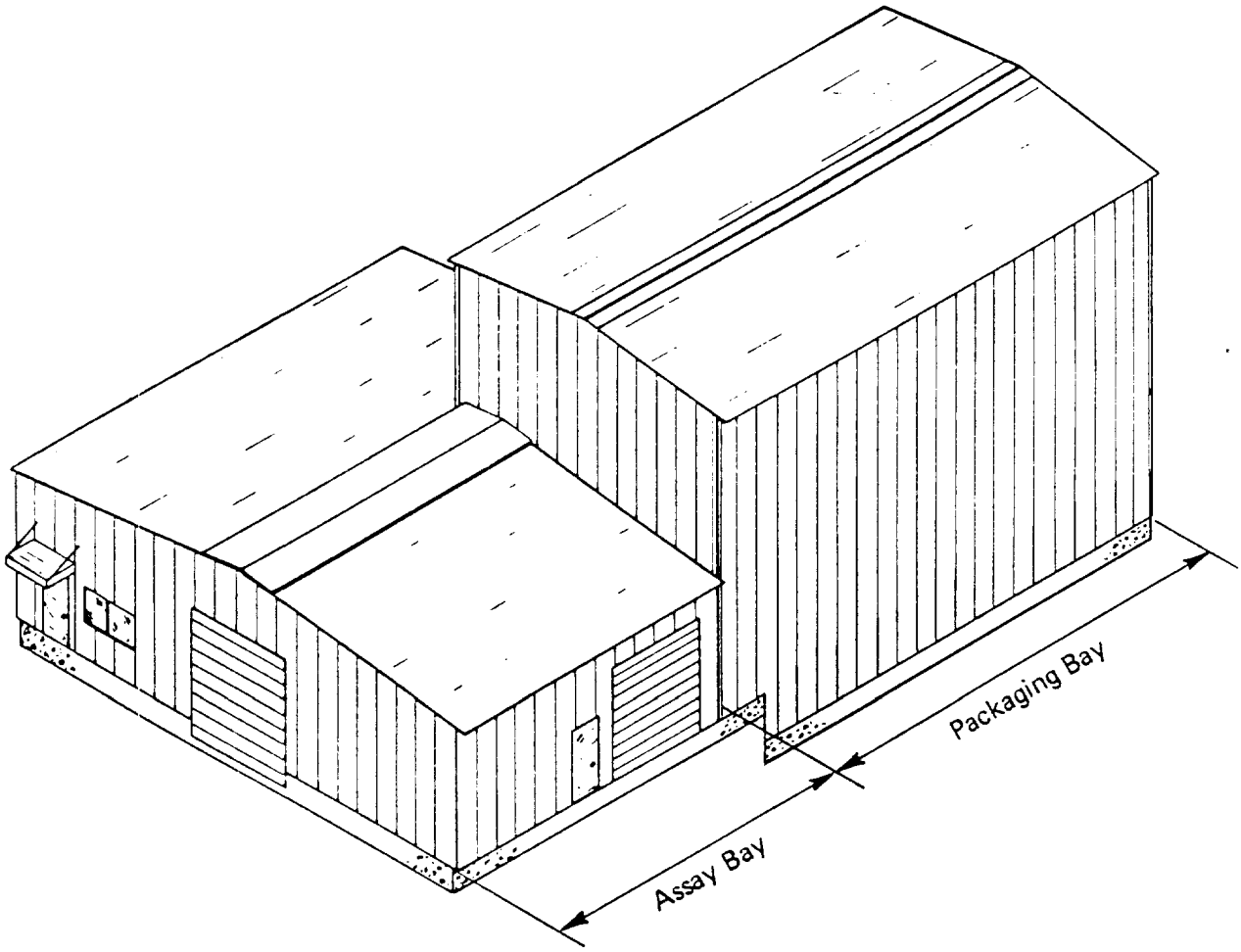

FIGURE 2. Isometric View of the Waste Certification Facility

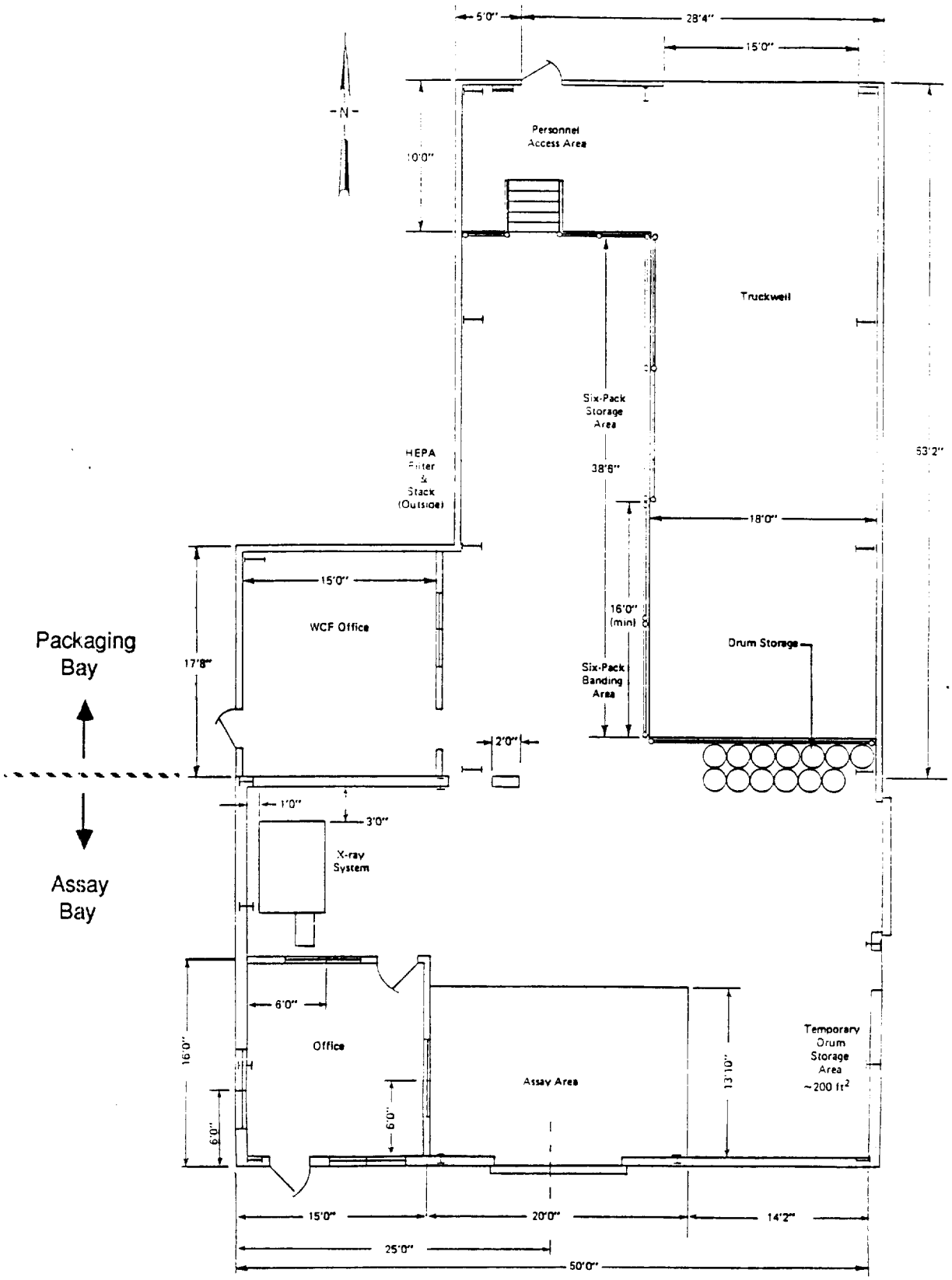

FIGURE 3. Floor Plan for Waste Certification Facility

liquids ($\leq$ 2 cups), no compressed gases (unpunctured aerosol cans), and no unsolidified sludges (sludge must not exhibit free liquid characteristics). The x-ray also confirms the presence of a carbon-composite filter vent in the lid of the polyethylene liner. Only one operator is needed to load and unload drums at the radiography system, which is remotely operated from the assay bay office. The x-ray area is equipped with a realtime radiography system that includes:

- A 160-kV constant potential x-ray generator.
- A realtime imaging system.
- An inspection manipulator.
- A radiation protective enclosure.

The radiation protective enclosure is constructed of steel and lead; the window in the door is constructed of lead glass. The shielding attenuates radiation exposure to a maximum of 0.5 mR/hr (0.5 mrem/hr) measured at the surface of the enclosure with the system operating at full power. Health Protection procedures require the x-ray safety devices to be checked quarterly and the x-ray system to be surveyed semiannually, and after repairs or significant changes are made.

Assay Area

In the assay area, drums are weighed and then noninvasively interrogated by the neutron activation system to determine fissile plutonium content. The results of the drum assay are used to determine if the content of the drums meet a specified criterion of fissile content no greater than 195 g of Pu-239 (or equivalent). One opeator loads and unloads drums at the assay system, which is remotely operated from the assay bay office. During an assay

operation, personnel are normally excluded from the assay area. The assay area is equipped with a weighing scale and a TRU Waste Assay System that includes:

- An assay chamber shielded with graphite (10.8 cm thick) and polyethylene (23 cm thick).
- A pulsed neutron generator loaded within the assay chamber.

The 14-MeV neutron activation source contains tritium as a metallic hydride in a hermetically-sealed glass, metal, and ceramic tube.

A 10-ft exclusion area around the assay chamber is enforced to limit radiation exposure.

Assay Bay Office

The assay bay office serves as a control room for operations in the assay bay. This office contains a data acquisition system and controls for the assay system; a video monitor, video recorder, and console for the x-ray system; and storage space for video records. Normal occupancy is two operators. The office is equipped with the following systems:

- Data Acquisition System - A computer is used to removely control the assay system. The computer collects and analyzes results from each 55-gal drum.
- Controls for the Radiography (X-Ray) System - Video equipment, including a closed-circuit TV and a video cassette recorder/player, is used to view and record the image as the drum is x-rayed.

PACKAGING BAY

The packaging bay, including an office and a high-bay craneway, is L-shaped, having dimensions of 50 by 53 ft. The craneway is located in the 30-ft-high part of the building that has plan dimensions of 33 by 53 ft. The

packaging bay includes those facilities needed to handle, label, package, and load or unload drums or "clusters" (multidrum arrays) of drums onto or from trucks, depending upon shipping requirements. A small area at the interior end of the truckwell provides temporary storage for 12 drums. An outside concrete sump collects runoff from floor drains.

Truckwell

The truckwell, 18 by 48.5 ft, provides access for loading drums, either singly or in clusters, onto the specially designed transport vehicles. The floor of the truckwell is 3 ft lower than the floor of the adjacent operating and temporary storage area. A large rollup door provides access through an exterior wall to the truckwell. A 20-ton bridge crane, having an auxiliary 2-ton hoist, handles either single drums or clusters of drums.

Equipment Operating Area and Temporary Storage

Equipment to package drums in clusters is located alongside the truckwell. The drum packaging configuration was selected to meet the requirements of the special vehicle used to transport TRU waste to the WIPP. The raised deck alongside the truckwell also provides an area for storing drums temporarily, which have been certified, coded, and packaged for shipping. The overhead crane spans this area as well as the truckwell.

Packaging Bay Office

The packaging bay office serves as a control center for operations in the packaging bay. This office contains a computer and bar coding and labeling equipment for marking drums and multidrum arrays.

PROCESS DESCRIPTION (OPERATIONS)

The WCF can accommodate a maximum of 134 drums at any one time, 50 in the assay bay and 84 in the packaging bay. Normally, the WCF is operated on day shift only, five days per week. The operation is manned by two to three people per shift, not counting occasional requirements for Health Protection and maintenance personnel.

A diagram of the operating sequence in the WCF is shown in Figure 4.

WASTE DRUM RECEIVING AND STORAGE

Drums are typically transferred to the WCF by van or truck and are delivered to the loading dock of the assay bay. A drum dolly is used to move individual drums to the temporary storage area. During unloading the drums are visually inspected. Drums in an unacceptable condition are returned to the shipper for repackaging. During temporary storage the records accompanying each drum are assessed for adequacy. Drums with incomplete paperwork are either returned to the shipper for review and further information, or the shipper is contacted to complete the records.

X-RAY INSPECTION AND ASSAY

Individual drums are examined in the x-ray inspection chamber. An operator in the office provides a verbal commentary on the videotape while the drum is rotated and moved vertically. After x-ray the drums are weighed and then nondestructively examined in the neutron counting assay system to determine the plutonium content. The system counts prompt neutrons after activation with a pulsed neutron source. The system also counts the passive neutrons generated by spontaneous fission and as singles. Gamma scanning techniques are under development to augment neutron counting.

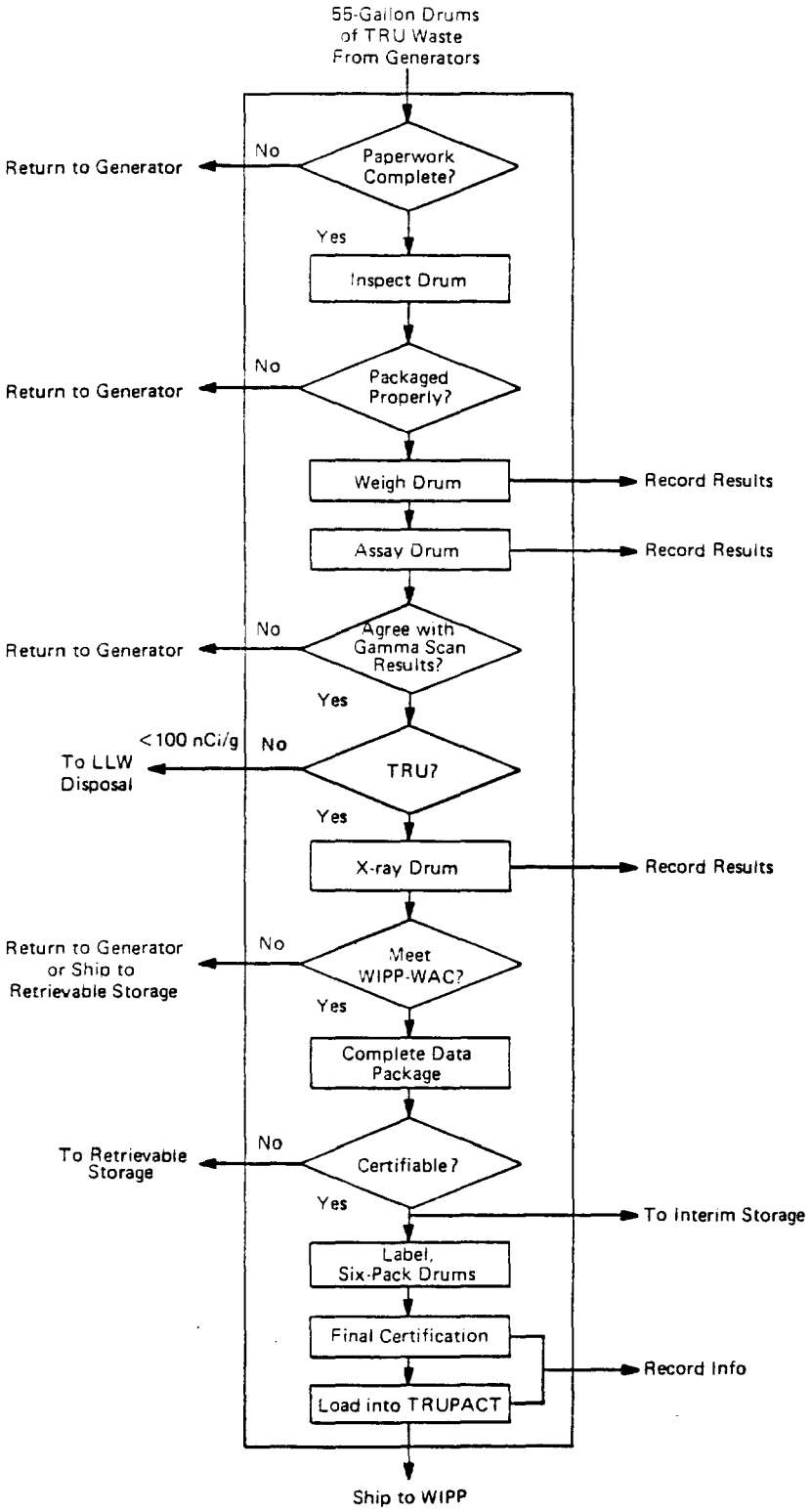

FIGURE 4. WCP Operating Sequence Diagram

LABELING, PACKAGING, AND STORAGE

Drums that meet certification requirements are labeled using bar coding equipment. Multidrum arrays are also labeled. Certified drums are packaged on pallets or in other modes involving multidrum arrays. Labeled multidrum arrays are kept temporarily in a designated storage area while awaiting loading on a transport vehicle.

LOADING AND SHIPPING

An overhead crane is used to move the multidrum arrays from the storage area to the transport vehicle. The truckwell provides access for the transport vehicle under the 20-ton crane.

PROCESS HAZARDS

Process hazards considered include:

- Nuclear criticality
- Drum contamination
- Radiation
- Fire
- Breaching of a drum
- Drum handling
- Operation of x-ray and pulsed neutron assay equipment
- Electrical hazards

A Process Hazards Review showed that chemical exposure risks are less than one fatality per 10,000 years of operation.

ENGINEERED SAFETY FEATURES

VENTILATION SYSTEM

The assay bay and the packaging bay are each served by a separate, once-through, fresh air supply that is conditioned. A common exhaust system includes HEPA filtration. Exhaust air is monitored in the stack by an isokinetic air sampling station.

MONITORING SYSTEMS

The following radiation monitoring equipment is provided:

	Number	
Instrument Type	Assay Bay	Packaging Bay
Area gamma monitor*	2	3
Count rate meter systems*	4	2
Alpha constant air monitor	2	1
Alpha contamination monitor	2	2
Beta contamination monitor	2	2
Beta-gamma dose rate meter	2	2
Low energy gamma dose rate meter	2	2
Neutron dose rate meter	1	1
Staplex air sampler/impactor	2	2
Isokinetic stack air sampler	1 unit in common	

* Built-in audible alarm.

EMERGENCY POWER SYSTEM

Emergency power from a diesel generation source maintains operation of exit lighting, fire protection, communications systems, exhaust blowers, and the isokinetic stack air sampler.

SUMPS FOR LIQUID

Separate, outside sumps serving the assay bay and the packaging bay collect any materials washed down the respective floor drains. The sumps will be pumped out as necessary after sampling.

FIRE DETECTION AND MITIGATION SYSTEM

Portable fire extinguishers are available for fighting small fires (trash, for example). A fire alarm system includes open-area, photoelectric smoke detectors, an exhaust duct photoelectric detector, alarm pull stations, vibrating horns, and a fire alarm control unit. These alarms are connected to a central alarm system. The fire alarm system is activated either manually, via a pull station, or automatically, via a signal from the smoke detectors.

RADIATION PROTECTION

- The x-ray system is provided with a radiation protection enclosure fabricated from lead and steel. This enclosure limits personnel radiation exposure to less than 0.5 mR/hr (0.5 mrem/hr) for continuous occupancy.
- Door interlock switches prevent x-ray tube operation while the x-ray chamber door is open.
- A steady warning sign, "X-Ray On," at the radiation enclosure and a red rotating beacon light operate when x-rays are being generated.

- An exclusion area (10-ft radius) is intended to restrict personnel access during operation of the neutron activation source.
- The assay system chamber is shielded with about 13 in. of graphite and polyethylene to limit personnel radiation exposure during intermittent occupancy to 5 mrem/hr at the exclusion area boundary.
- The interlock devices on the assay system include:
  - A microswitch in assay chamber door to prevent operation of neutron generator if door is open.
  - A microswitch in drum rotator mechanism to prevent system operation if rotator fails to operate.
  - A ribbon switch on door bottom interlock to stop door if resistance is encountered during enclosure.
- A blue, rotating beacon light on the assay chamber operates when a drum assay is in progress.

ADMINISTRATIVE CONTROL

Administrative controls in the onsite TRU waste-generating centers implement drum inventory limits such that no individual drums contain over 32 g of Pu-238 or 195 g of Pu-239. The Operational Safety Requirements specify that: (1) heat load limits restrict Pu-238 contents to 1.1 g per drum when an ion resin is present in the nitrate form, and 32 g per drum in the absence of nitrate; (2) containers of fissile material are handled and stored such that the neutron multiplication factor (K_{eff}) will not exceed 0.95; (3) separate calculations of K_{eff} will not be required where the following restrictions upon fissile material loading are adhered to for a single isotope: $\leq$195 g of Pu-239 per 55-gal drum and 2,000 g of Pu-238 per 55-gal drum. The heat load

limit for Pu-238 of 32 g per drum is much more restrictive than the 2,000-g criticality limitation.

TRAINING OF PERSONNEL

New Waste Management operators are given 2 weeks of intensive safety and basic classroom training (80 hr) followed by another 4 weeks of informal training on the job. Course content includes: Safety, Health Protection, and Occupational Health. Trainees, who must pass tests in various aspects of these topics, also receive detailed training in operating procedures. Continued on-the-job training is provided by supervisors and more experienced operators. Currently, a training program is being developed to strengthen the initial 80-hr course and implement classroom retraining for more experienced operators.

Before placing the equipment into operation at WCF, three supervisors and operators were trained at SRP on the x-ray equipment by vendor personnel from TFI Corporation. They were also trained at SRP on the assay equipment by vendor personnel from Los Alamos National Laboratory (LANL). LANL provided assistance as needed in developing a training program for the assay equipment for 6 months after system delivery. Others are trained as needed by a qualified Waste Management supervisor. All supervisors participate in a general, ongoing training program conducted by both onsite and offsite specialists.

RISK ANALYSIS

Risks from nonradiological accidents in the WCF are low, improbable in frequency, and marginal in consequences. No hazardous chemicals are used in the WCF. The main operation is drum handling, so there are no process hazards.

Radiological consequences of accidents involving both natural phenomena and man-made events were determined by the use of computer codes. Computer codes were used to calculate offsite and near-in doses: AXAIR and VENTSAR,

respectively. These codes take into account the cause of release, distances to the offsite and near-in individuals, and meteorological conditions. The near-in individual is one who works full time in the facility nearest to the WCF, the burial ground administration building.

A Probabilistic Risk Assessment (PRA) of the WCF produced the following consequences and risks of accidents, ranked in the order of decreasing consequences:

Event	Frequency, yr^{-1}	Consequences Respirable Airborne Release, Ci		Maximum Risk to Individual: Risk, rem/yr	
		Pu-238	Pu-239	Near-In	Offsite
Tornado, >200 mph	4.1E-6	1E+1	1E-1	1.1E-8	3.1E-7
Tornado, 100-200 mph	1.5E-4	3E+0	3E-2	1.2E-7	3.5E-6
Wind, >150 mph	3.3E-5	2E+0	3E-2	7.9E-8	2.0E-8
Wind, 100-150 mph	3.0E-3	1E+0	1E-2	4.8E-6	1.2E-6
Earthquake, 0.09-0.2 g	2.5E-3	1E-1	1E-3	1.6E-2	1.0E-4
Vehicle crash	6.3E-6	3E-2	3E-4	1.1E-5	7.2E-8
Fire	7.0E-4	3E-2	3E-4	1.3E-3	8.4E-6
Internal drum rupture	7.0E-4	1E-2	1E-4	4.5E-4	2.9E-6
External drum rupture	2.0E-2	4E-5	5E-7	5.2E-5	3.4E-7

The risks shown in rem/yr are the product of annual frequency times consequence (exposure dose in rem). For all accidents the risk (based on maximum, total body, 50-year dose commitment) is 0.018 rem/yr for an onsite (near-in) individual and 1.2E-4 rem/yr for the maximally-exposed offsite individual. For the normal operation onsite the Du Pont limit to operating personnel is 3 rem/yr; the DOE limit is 5 rem/yr. For an offsite individual the maximum total body, 50-year dose commitment due to the worst natural phenomena event, a >200-mph tornado, is estimated to be 0.075 rem. This consequence, when multiplied by the frequency of 4.1E-6 yr^{-1}, results in a very low risk of 3.1E-7 rem/yr.

Risks to the population were calculated to be 0.4 man-rem per year and 0.6 man-rem per year for the onsite and offsite populations, respectively, from all accidents. These dose commitments are low when compared to the population dose of 54,000 man-rem per year attributable to natural background radiation acting on the population within a 50-mile radius. Over 87% of the estimated risk potential is related to natural phenomena events as opposed to man-made events.

The PRA provides assurance that the WCF can be operated without undue risk (due to accidents) to the plant personnel, the public, and the environment.