CCP-AK-ORNL-500

Central Characterization Project Acceptable Knowledge Summary Report For

Oak Ridge National Laboratory Radiochemical Engineering Development Center Remote-Handled Transuranic Waste

Waste Stream:
OR-REDC-RH-HET

REVISION 0

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LIST OF ACRONYMS AND ABBREVIATIONS

AK	Acceptable Knowledge
CBFO	Carlsbad Field Office
CCP	Central Characterization Project
CFR	Code of Federal Regulations
CH	contact-handled
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DQO	Data Quality Objective
DTC	Dose-to-curie
EPA	U.S. Environmental Protection Agency
GNEP	Global Nuclear Energy Partnership
HEPA	High Efficiency Particulate Air
HFIR	High Flux Isotope Reactor
HLW	High-level waste
HSGS	Headspace Gas Sampling
HWNs	Hazardous Waste Numbers
kg	Kilogram
LAA	Limited Access Area
LANL	Los Alamos National Laboratory
LET	Lid Extraction Tool
LWA	Land Withdrawal Act
LWR	Light Water Reactor
m^3	cubic meters
MCNP	Monte Carlo Neutron-Particle
MEK	methyl ethyl ketone
mrem/hr	millirems per hour
MSDS	Material Safety Data Sheet
NTS	Nevada Test Site
NWPA	Nuclear Waste Policy Act of 1982
ORNL	Oak Ridge National Laboratory
PCB	Polychlorinated biphenyl
PPE	Personal Protective Equipment
QA	Quality Assurance
QAO	Quality Assurance Objective
RCRA	Resource Conservation and Recovery Act
R/hr	Rems per hour
RH	remote-handled
RH TRUCON	RH TRU Waste Content Code
REDC	Radiochemical Engineering Development Center
SETF	Solvent Extraction Test Facility
SNF	Spent Nuclear Fuel
SRS	Savannah River Site
TA	Transfer Area
TBD	To Be Determined

TRU	transuranic
TWBIR	Transuranic Waste Baseline Inventory Report
TWPC	Transuranic Waste Processing Center
VE	Visual Examination
WCPIP	Remote-Handled TRU Waste Characterization Program Implementation Plan (Reference 1)
WIPP	Waste Isolation Pilot Plant
WIPP-WAP	Waste Isolation Pilot Plant Hazardous Waste Facility Permit Waste Analysis Plan (Reference 2)
WIR	Waste Incidental to Reprocessing
WSPS	Waste Stream Profile Sheet

1.0 EXECUTIVE SUMMARY

This Acceptable Knowledge (AK) Summary Report has been prepared for the Central Characterization Project (CCP) for remote-handled (RH) transuranic (TRU) waste generated at the Oak Ridge National Laboratory (ORNL) in Oak Ridge, Tennessee. The waste described in this report was generated in Building 7920 of the Radiochemical Engineering Development Center (REDC) and subsequently repackaged in Building 7880 of the Transuranic Waste Processing Center (TWPC). This report was prepared in accordance with DOE/WIPP-02-3214, *Remote-Handled TRU Waste Characterization Program Implementation Plan* (WCPIP), Attachment A, Acceptable Knowledge Procedure for Remote-Handled Waste; NM 4890139088-TSDF, *Waste Isolation Pilot Plant Hazardous Waste Facility, Permit Waste Analysis Plan,* (WIPP-WAP), and CCP-TP-005, *CCP Acceptable Knowledge Documentation* (References 1, 2, and 3).

The CCP is tasked with certification of TRU waste for transportation to and disposal at the Waste Isolation Pilot Plant (WIPP). The CCP is responsible for reviewing, approving, and maintaining this report and supporting AK source documentation as CCP Quality Assurance (QA) records. The CCP maintains responsibility for all referenced documentation stored at the CCP Records Center in Carlsbad, New Mexico.

Waste Stream OR-REDC-RH-HET includes RH TRU debris waste originating from the REDC hot cell facility target fabrication and processing, analytical chemistry, and process development activities. This debris is currently stored in concrete casks, boxes, and drums at ORNL. These storage containers are transferred to the TWPC hot cell in the Building 7880 for repackaging and certification.

This AK Summary Report includes information relating to the mission and process operations of the REDC, waste identification and characterization, waste management, and TWPC repackaging. This report also includes information regarding the physical form, radiological characteristics, and chemical contaminants of the waste, as well as, prohibited items management.

This report, along with the referenced supporting documentation, provides a conservative, defensible, and auditable record of the AK for an RH debris waste stream resulting from operations conducted in the REDC and repackaged in the TWPC. The references and AK sources used to prepare this report are listed in Sections 8.0 and 9.0. The AK sources are referenced within this report by an alphanumeric designator (e.g., C001, DR001, I001, M001, P001, and U001), corresponding to a unique CCP Source Document Tracking Number for this waste stream. This report includes information relating to the facility's history, mission, process operations, and waste management practices. Information contained in this report was obtained from numerous sources, including facility safety basis documentation, historical document archives, generator and storage facility waste records and documents, interviews with cognizant personnel, and program/process documents (plans, procedures, etc.).

This report and supporting source documentation provide the mandatory waste program and waste stream-specific information required by Section B4 of the WIPP-WAP (Reference 2). This report also compiles data relevant to the applicable U.S. Environmental Protection Agency (EPA) requirements and presents the documentation necessary to satisfy each WCPIP data quality objective (DQO) and quality assurance objective (QAO) for RH TRU waste streams (Reference 1).

2.0 WASTE STREAM IDENTIFICATION SUMMARY

Site Where TRU Waste Was Generated and Stored

Generation and Storage Location:
Oak Ridge National Laboratory
1 Bethel Valley Road
Oak Ridge, TN 37831
EPA ID TN1890090003

Facility Where TRU Waste Was Generated

This waste was generated in Building 7920 which is part of the REDC located at the ORNL in Oak Ridge, Tennessee. The waste is transferred to the TWPC hot cell in Building 7880 for repackaging and certification.

Facility Mission

Since 1966, the primary mission of Building 7920 has been the fabrication of target rods containing plutonium, americium, and curium, and to separate and purify heavy actinide elements including Bk-249, Cf-252, Es-253, and Fm-257 isotopes from the irradiated targets. Between 1979 and 1986, some uranium fuel cycle development work was performed in specially designed equipment in one of the Building 7920 hot cells. Since 1991, Building 7920 has also processed Mark-42 target assemblies. Fundamental research, chemical process development, and analytical chemistry are also performed in Building 7920 (refer to Section 4.1.3).

The TWPC serves as the primary ORNL processor of contact-handled (CH) and RH wastes originating from containerized RH and CH waste inventories in storage at ORNL; ongoing and future ORNL demolition, decontamination, and remediation operations; future laboratory operations; and existing inventories or wastes received from other regional Department of Energy (DOE) sites. TRU waste inventories are transferred to the TWPC hot cell in the Building 7880 where RH waste streams are repackaged and certified for WIPP disposal (refer to Section 4.1.3).

Waste Stream:	OR-REDC-RH-HET
Summary Category Group:	S5000
Waste Matrix Code Group:	Heterogeneous Debris
Waste Matrix Code:	S5400, Heterogeneous Debris
RH TRU Waste Content Code (RH TRUCON):	To Be Determined (TBD)

TWBIR Number(s):

The DOE/TRU-2006-3344, *Transuranic Waste Baseline Inventory Report – 2004* (TWBIR), identifies five waste streams for ORNL RH TRU waste (Reference 4):

- OR-W211, RH TRU Heterogeneous Debris – Treated
- OR-W212, RH TRU Heterogeneous Debris – Mixed
- OR-W213, RH TRU Environmental Restoration Soil
- OR-W214, RH TRU PCB-Contaminated Debris
- OR-W215, RH TRU Solidified Sludge

The TWBIR waste streams that apply to Waste Stream OR-REDC-RH-HET are OR-W211, OR-W212, and OR-W214.

Waste Stream Description:

As described in Section 5.4, Waste Stream OR-REDC-RH-HET is comprised primarily of repackaged organic and inorganic debris waste items. The waste includes cellulosics (paper), plastic, rubber, metal, and glass items. Specific waste items present in the storage container inventory include the following:

- Cellulosic waste consists of paper, cotton, cloth, and wood items, including wipes, swabs, bags, towels, rags, protective clothing, gloves, rope, string, cardboard, brushes, blotter paper, and filter media.

- Plastic waste consists of polyethylene, polypropylene, polyvinyl chloride, Tygon, nylon, Bakelite, and Plexiglass items, including sheeting, melted plastic, beads, blocks, tape, tubing, bags, fittings, buckets, bottles, caps, pans, discs, brushes, laboratory equipment (pipettes, syringes, etc.), gloves, manipulator boots, and filter media.

- Rubber waste consists of items, including gaskets, rings, hose/tubing, squeegees, bulbs, stoppers, gloves, boots, leaded glovebox gloves, wire/cord/cable insulation, and filter media.

- Glass waste consists of glass and ceramic items, including bottles, laboratory glassware, pipettes, columns, plates, thermometers, light bulbs (mercury and incandescent bulbs), mirrors, lenses, insulation, and unidentified broken glass items.

- Metal items including ferrous materials made from carbon steel, stainless steel, and iron. Non-ferrous materials include items made from aluminum, brass, copper, and lead. Specific metal waste items include cans (including aerosol cans), needles, tubes, valves, cable, wire, planchets, valves, piping, tools (tongs, dies, punches, wrenches, knives, clamps, tweezers), foil, weights, blocks, plates, frames, columns, racks, shielding, sheeting, light fixtures, equipment (pumps, motors, balance, ultrasonic cleaner, hot plates, furnace, centrifuge), hardware (nuts, bolts, brackets, washers, etc.), manipulator parts, and filter components.

The AK record identifies numerous packaging configurations utilizing plastic bags and liners, 1-gallon paint cans (some lead-lined), sealed and unsealed polyethylene buckets (2- to 5-gallon), 5-gallon lard cans, and 10-gallon rigid cardboard fiber drums. Secondary waste generated during repackaging operations in the TWPC hot cell may include solidified liquids, amalgamated mercury, personal protective equipment (PPE), and other miscellaneous process materials and equipment generated during routine operations of the hot cell. Although the waste stream, as a whole, is comprised of more than 50 percent heterogeneous debris, the casks are expected to contain a wide range of the waste material parameters. No individual repackaged drum of RH waste will contain greater than 50 percent homogeneous solids in this waste stream (e.g., solidified/absorbed liquids, grouted resins, filter bed media, etc.).

This waste stream was determined to contain Resource Conservation and Recovery Act (RCRA)-regulated constituents and is conservatively assigned the following EPA Hazardous Waste Numbers (HWNs): D005, D006, D007, D008, D009, D010, D011, D019, F002, and F005 (Refer to Section 5.4.2).

According to TRU waste packaging procedures dating back to 1988, liquids are removed from the waste or absorbed onto a solid such as vermiculite, and semi-liquid waste forms such as sludges and resins are immobilized (e.g., grouted). Waste generated prior to 1988 may contain un-punctured aerosol cans or small amounts of liquids, and waste generated prior to the mid-1990s may contain sealed containers greater than four liters. The following steps are taken to assure that prohibited items are not included in the RH drums repackaged at the TWPC:

- Residual liquids are removed or immobilized.
- Un-punctured aerosol cans are punctured or removed from the waste stream.
- All internal containers (buckets, cans, and bags) are opened and all layers of confinement breached.

Certified Visual Examination (VE) is performed to ensure the waste does not contain prohibited items in accordance with the WCPIP and WIPP-WAP.

REDC waste will be repackaged in the TWPC hot cell into unlined, vented 55-gallon drums (no layers of confinement in drums).

Waste Stream OR-REDC-RH-HET meets the WIPP-WAP and the WCPIP waste stream definitions of waste material generated from a single process or from an activity that is similar in material, physical form, hazardous constituents, and radiological constituents.

3.0 ACCEPTABLE KNOWLEDGE DATA AND INFORMATION

TRU waste destined for disposal at the WIPP must be characterized prior to shipment. Development of knowledge of the waste materials and processes that generate and control the waste is required to provide a clear and convincing argument about the characteristics of each waste stream. The AK characterization documented herein complies with the requirements of the WIPP-WAP (Reference 2) and the WCPIP (Reference 1) and was developed in accordance with CCP-PO-001, *CCP Transuranic Waste Characterization Quality Assurance Project Plan* (Reference 5). The WCPIP identifies waste characterization requirements and methods to satisfy requirements in:

- 40 Code of Federal Regulations (CFR) Part 191, *Radiation Protection Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes* (Reference 6)

- 40 CFR Part 194, *Criteria for the Certification and Re-Certification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR 191 Disposal Regulations* (Reference 7)

- *Criteria for the Certification and Re-Certification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations: Certification Decision* (Reference 8)

- Public Law 102-579, *WIPP Land Withdrawal Act* (LWA) (Reference 9).

A majority of the AK sources used for development of this report were originally collected by Weston Solutions, Inc. for CH debris waste from the REDC. These ORNL sources include, laboratory logbooks, standard operating procedures, safety analysis reports, program plans, radiological data, waste packaging logs, container forms, inventory reports, and personnel interviews. Additional information for the REDC CH and RH inventories was collected and interviews were conducted with cognizant REDC personnel to augment and clarify the data collected. The corresponding REDC CH debris Waste Stream (OR-REDC-CH-HET) is described in CCP-AK-ORNL-002, *Central Characterization Project Acceptable Knowledge Summary Report for Oak Ridge National Laboratory Radiochemical Engineering Development Center Contact-Handled Transuranic Waste, Waste Stream OR-REDC-CH-HET* (Reference 12).

The references and AK sources used to prepare this report are listed in Sections 8.0 and 9.0, respectively. The AK sources referenced within this report by alphanumeric designations (e.g., C001, DR001, I001, M001, P001, and U001) correspond to the unique CCP Source Document Tracking Number using the following convention:

- C – Correspondence
- DR – Discrepancy resolutions
- I – Internal Procedures and Notes
- M – Miscellaneous data
- P – Published documents
- U – Unpublished documents

4.0 PROGRAM INFORMATION

This section provides a description of the facility and operations associated with the generation of REDC RH TRU waste. Included is a description of the location of the REDC facility. In addition, a description of the facility, summary of the mission, defense determination, and descriptions of the TWPC waste repacking operations associated with the generation of Waste Stream OR-REDC-RH-HET are provided.

4.1 Facility Location, Description, Mission, and Defense Determination

4.1.1 Facility Locations

ORNL is located on the DOE Oak Ridge Reservation within the Bethel and Melton Valleys of Roane County, Tennessee, approximately six miles southwest of the city of Oak Ridge and about 23 miles west of downtown Knoxville. Building 7920 is located in the Melton Valley area of ORNL within the 7900 building area which includes the REDC (Buildings 7920 and 7930) and the High Flux Isotope Reactor (HFIR). Maps showing the locations of ORNL, the REDC, and Building 7920 are presented in Figure 1, Map of Oak Ridge National Laboratory; Figure 2, Map of Radiochemical Engineering Development Center, Transuranic Waste Processing Center, and Solid Waste Storage Areas; and Figure 3, Location of Building 7920 at the end of this report (References P014, P161, P272).

Prior to 1972, RH TRU waste generated at ORNL facilities was disposed in shallow land burial trenches. From 1972 on, the wastes were retrievably stored, initially in a series of 22 earthen trenches and later in engineered bunker-type facilities. RH TRU waste generated in Building 7920 is currently stored in large concrete casks, boxes, and 55-gallon drums in Buildings 7572, 7823, 7823B, 7823C, 7823D, 7823E, 7834, 7855, 7879, and 7883 which are also located in the Melton Valley area of ORNL. A map denoting the locations of the TRU waste storage buildings is shown in Figure 2. All of the concrete casks will be overpacked into carbon steel RH casks prior to processing in the TWPC (References M024, M100, P272, P953, U038, U046).

The TWPC is located within an approximate five-acre area in the Melton Valley area of ORNL. RH storage containers are transferred to the hot cell in Building 7880 at the TWPC where the waste items are extracted, sorted, segregated and reduced in volume for repackaging and certification to produce waste suitable for disposal at WIPP. The location of TWPC is shown in Figure 2 (References P256, P272, U046).

4.1.2 Facility Description

Building 7920, constructed in the mid-1960s, is a two-level structure with a high bay area housing a heavily shielded, reinforced concrete hot cell bank, hot cell support area, laboratories, and an office wing (Reference P161).

The bank of nine hot cells contains equipment for radiochemical processing and target fabrication activities. Each hot cell contains a cubicle which is a confinement enclosure with a viewing window and master-slave manipulators. Tank pits housing process and storage tanks and piping are located behind and below the cubicles. The area above and behind the hot cell bank is a high-bay area known as the Limited Access Area (LAA). Systems and equipment are located in the LAA for interfacing with the hot cells and for movement of materials and equipment in and out of the hot cells and cubicles and in and out of the building. The Transfer Area (TA), which is adjacent to Cubicle 9, contains the transfer cubicle, gloveboxes, and other equipment used for the addition and removal of small equipment and materials in the hot cell bank. The decontamination glovebox room is on the second floor adjacent to the LAA. This room contains the decontamination glovebox, equipment repair glovebox, and liquid waste transfer boxes (Reference P161).

The laboratory area of Building 7920 contains three alpha laboratories (Rooms 109, 209, and 211) with gloveboxes for chemical development work and special projects. Another alpha laboratory (Room 111) contains two small hot cells, called shielded caves that provide small chemical processing areas with sufficient shielding for final purification of various transuranium elements and for special projects. The laboratory area of the building also contains two analytical chemistry laboratories (Rooms 108 and 208) (Reference P161).

The TWPC, constructed in 2003, consists of a three-story reinforced concrete structure with internal concrete and steel shielding. RH waste repackaging is performed in the TWPC hot cell on the second floor of the facility. The facility is designed to receive the over-packed concrete RH casks then remotely repackage the RH waste into 55-gallon drums for shipment to WIPP (Reference U046).

4.1.3 Facility Mission

Since 1966, the REDC has been the production, storage, and distribution center for the heavy-element research program of DOE, producing Bk-249, Cf-252, Es-253, and Fm-257. Target rods containing americium and curium are remotely fabricated in the Building 7920 hot cells, irradiated in the adjacent HFIR facility, and then processed in the Building 7920 hot cells for the separation and purification of the heavy actinide elements. The purified Bk-249, Es-253, and Fm-257 are packaged for shipment. The Cf-252 has been subsequently fabricated into neutron sources (Reference P161).

Between 1979 and 1986, some uranium fuel cycle development work was performed in specially-designed equipment in one of the Building 7920 hot cells known as the Solvent Extraction Test Facility (SETF). Solvent extraction flow sheets for processing irradiated fuels from commercial light water reactors and fast breeder reactors were developed and tested, and plutonium recovery schemes were demonstrated. This equipment is no longer used for its original purpose but remains in place and has been adapted and used for other processing and development activities related to the facility mission (References I044, P161, U011).

Since 1991, the REDC has processed Mark-42 target assemblies irradiated at the Savannah River Site (SRS). High-purity Am-243, Cm-244, and Pu-242 are separated and recovered in the Building 7920 hot cells for shipment to the Los Alamos National Laboratory (LANL). The Mark-42 Processing Program activities utilize many of the same processes used for the transuranium element targets, allowing for dual use of the same hot cell equipment (Reference P161).

Beginning May 2007, small-scale development work associated with the Global Nuclear Energy Partnership (GNEP) was initiated. Previously known as the Advance Fuel Cycle Initiative, the mission of the GNEP program includes the development of advanced, proliferation-resistant fuel cycle technologies for application to current operating commercial reactors and next-generation reactors. ORNL tasks for this program involve the demonstration of isotopic separations technologies using fuel from the H.B. Robinson and Dresden light water reactors (LWRs) (References C306, P951, P952, U568).

The four alpha laboratories are used for transuranium element product finishing operations and for fundamental research and chemical process development. Small-scale process development and special project operations similar in type to those done in the processing areas may be performed in the gloveboxes and shielded caves. The analytical chemistry laboratories provide support for the REDC production, research, and development programs as well as environmental and waste management at ORNL. Two hot cell cubicles have been used to perform analyses that must be done without dilution on highly-irradiated samples, and to make dilutions for subsequent analyses in the glovebox laboratories (References P161, U011).

The TWPC was designed with the capability and flexibility to serve as the primary ORNL processor of CH and RH wastes originating from (Reference U046):

- Containerized RH and CH waste inventories in storage at ORNL
- Ongoing and future ORNL demolition, decontamination, and remediation operations
- Future laboratory operations
- Existing inventories or wastes received from other regional DOE sites

4.1.4 Defense Waste Assessment

The WIPP requires generator sites to use AK to document that TRU waste streams to be disposed of at WIPP meet the definition of TRU defense waste. TRU waste is eligible for disposal at the WIPP if it has been generated in whole or part by one of the atomic energy defense activities listed in Section 10101(3) of the *Nuclear Waste Policy Act of 1982* (NWPA) (Reference 10). In April 2006, the formal defense determination submitted by ORNL in April 2005 was approved by DOE Carlsbad Field Office (CBFO) for TRU waste originating from the operations in the REDC complex (including Building 7930). This determination concluded that the wastes generated by operations in the REDC are irretrievably commingled with materials generated, in part, by the following atomic energy defense activities (Reference M023):

- Naval reactors development
- Defense nuclear materials production
- Defense nuclear waste and by-products management
- Defense research and development activities

Specifically, the HFIR target campaigns that ultimately produce Cf-252 that is fabricated into neutron sources have been ongoing since inception of the REDC operations in 1966 and continue to generate waste today (References P161, U038, U039). The Cf-252 neutron sources have many applications, several of which are related to defense activities. These include neutron radiography of weapons components and military aircraft, neutron counting of fissile material and transuranic waste, land mine detection, and in-field inspection and verification of chemical weapons and high explosives (References M023, P258, P281, U038).

The SETF operations, consisting of nine campaigns conducted from 1979 to 1986, were research and development activities supporting the DOE Breeder Reactor Program. The Mark-42 Processing Program, which began in 1991, supported the recovery of Pu-242, Am-243, and Cm-244 for use in other DOE and U.S. Department of Defense (DOD) programs. The HFIR target campaigns ran concurrently with the SETF and Mark-42 campaigns. Due to the similarity of contamination in the REDC hot cells from prior HFIR target campaigns, the waste generated from SETF and Mark-42 campaigns have not been segregated from waste generated by the HFIR target campaigns (Reference I044).

4.2 RH TRU Waste Management

The elements of RH TRU waste management discussed in this section include waste identification, segregation, and characterization, as well as, organizational and administrative controls in place to ensure proper management of TRU waste from the REDC operations.

The REDC waste generators completed a UCN-2109 form in which a waste description is recorded for each container (i.e, casks, boxes, and drums). The brief waste descriptions indicate that wastes are not segregated by material type (e.g., plastic, metal, glass). For the 55-gallon drums, the UCN-2109 includes a waste container log sheet which indicates that individual packages within a drum contain a mixture of material types. The predecessor to the UCN-2109 form is the UCN-2822. The UCN-2822 for the casks only provides a brief waste description (e.g., burnable or non-burnable waste). The UCN-2822 for the drums includes waste type codes and provides a brief waste description as well as the volume of combustible waste in the 55-gallon drums. The waste type codes include (References M100):

- BW – Biological Waste
- CE – Contaminated Equipment
- DD – Decontamination Debris
- DS – Dry Solids
- SS – Solidified Sludge
- NC – Not Classified

DS is the only waste type code assigned to the drums in this waste stream. The brief waste description on the UCN-2822 also shows that wastes were not segregated by material type. Included with the UCN-2822 is a data log sheet which provides a brief waste description and the volume percent combustible for each inner package (drums only). The volume of combustible waste recorded on the UCN-2822, and the volume percent combustible recorded on the log sheets indicate a wide range of combustible wastes (Reference M005). Burnable and non-burnable wastes, or combustible and non-combustible wastes, were to be segregated at one time, but review of the above forms and log sheets does not support this segregation (References M005, M100, U011).

In approximately 1987, Building 7920 implemented a program for the identification and segregation of hazardous waste regulated by the RCRA, Title 40 CFR Part 261, *Identification and Listing of Hazardous Waste* (References 11, P240, P263). Data log sheets for packaging TRU waste identified the presence or absence of hazardous materials. The UCN-2109 form also identified whether or not waste is RCRA-regulated (References M005, M100).

Even with implementation of a RCRA program in 1987, the earliest generation date of waste assigned EPA HWNs is 1994. The EPA HWNs assigned by generators are D005 (barium), D006 (cadmium), D008 (lead), D009 (mercury), and D011 (silver) based on the presence of lead, incandescent light bulbs, mercury-vapor light bulbs, and equipment containing solder with lead or silver. There are several drums generated before 1987 and some after 1987 where the generator indicated no hazardous materials were present but have now been identified as suspect RCRA waste. Much of the waste was suspected of containing incidental hazardous waste items and presumed to be RCRA hazardous (References M005, M012, M024, M100, U038). In addition to the EPA hazardous waste numbers listed above, several other RCRA hazardous materials have been identified in this waste stream (see Section 5.4.2).

Prior to 1999, each waste package was monitored for beta-gamma radiation and neutron radiation, and then the surface dose rate measurements were converted to activity values based on a defined conversion factor. This activity was assigned to the dominant nuclide in the package, typically Cm-244 and/or Cf-252 (References M100, P240).

Beginning in 1999, an isotopic distribution was developed that included 30 different nuclides. This distribution was created using a combination of knowledge of the materials processed in the hot cells, smear sampling and analysis data, and Monte

Carlo Neutron-Particle (MCNP) code modeling data. Activity values are then assigned to each nuclide in the container based on the dose rate of the cask (References M024, M100, U045, U049).

4.2.1 Types and Quantity of TRU Waste Generated

Waste Stream OR-REDC-RH-HET consists primarily of repackaged RH waste originally generated between April 1972 and February 2007, packaged in 263 concrete casks (4.5-, 6-, and 12-inch thick walls), eight 55-gallon drums, and one B-88 box. It is projected that the TWPC hot cell will generate a total of 550 cubic meters (m^3) during the processing of the approximately 341 concrete storage casks currently in inventory from all ORNL RH waste generators. Since the waste from Building 7920 is estimated to account for 77 percent of waste in this inventory, it is estimated that Waste Stream OR-REDC-RH-HET will contain approximately 423 m^3 of RH waste packaged in 55-gallon drums from cask repackaging operations. Table 4-1, Projected Volume of Waste from Repackaging of Stored Building 7920 RH Waste Containers, provides an estimate of the number of drums to be generated during the processing of the current inventory in the TWPC. Many of the RH casks are expected to contain significant amounts of debris that may not have elevated radioactive dose rates requiring that the debris be loaded into CH drums. Although the relative proportion of RH cask waste that will be loaded into CH drums is not known, it has been estimated to be 50 percent (References C302, M024, P256, U046, U047, U048).

Table 4-1. Projected Volume of Waste from Repackaging of Stored Building 7920 RH Waste Containers

Current Waste Inventory	Projected RH Volume (m^3)	Projected Number of 55-Gallon Drums
263 Concrete Casks	423	2,034
8 55-gallon drums	1.7	8
1 B-88 box	2.7 (maximum)	13
TOTAL	**427.4**	**2,055**

In addition to the current RH inventory, it is projected that the Building 7920 REDC operations will generate approximately an additional 3.4 m^3 (two casks) of waste to be processed in the TWPC per year with no projected end date. This estimate is based on the volume of waste generated by the facility over the past five years and input from ORNL personnel (References C302, M024).

Waste Stream OR-REDC-RH-HET meets the WIPP-WAP and the WCPIP waste stream definitions of waste material generated from a single process or from an activity that is similar in material, physical form, hazardous constituents, and radiological constituents (References 1 and 2). As described in Section 4.2.2, the production of the heavy actinide elements and those operations that support these processes (process development, analytical chemistry, and facility maintenance) in Building 7920 have been ongoing during the entire time frame of waste generation.

4.2.2 Description of Waste Generating Processes

Waste Stream OR-REDC-RH-HET consists of RH debris repackaged in the TWPC originating from REDC operations generated since the early 1970s. This section provides an overview of the Building 7920 operations including chemical processing, target fabrication, analytical laboratory, and process development..

Chemical Processing

Transuranium element processing includes the dissolution of irradiated targets, the separation of the transuranium elements from miscellaneous impurities and fission products, and the separation of the transuranium elements from each other. This is accomplished using a variety of solvent extraction, precipitation, and ion-exchange process steps. The processing steps are arranged to separate the transplutonium elements as a group from fission products and gross impurities before partitioning and purifying the individual elements. Recovered americium and curium are purified and converted to oxide for fabrication of new targets. The general sequence of steps used to process transuranium element targets in the hot cells is shown in Figure 4, Transuranium Element Target Processing (References P161, P279, U011).

After the berkelium, einsteinium, and fermium have been separated from most of the curium and californium in the hot cell cubicles, they are transferred to shielded caves or gloveboxes and purified further from radioactive and nonradioactive contaminants by additional cycles of ion-exchange. The purified products are then packaged for shipment. The californium is sorbed on cation-exchange resin and calcined to convert the californium to the oxysulfate for future use (References P279, U011).

The SETF was in operation from 1979 to 1986 and involved the recovery of uranium and plutonium from irradiated commercial power reactor fuels. This was achieved by dissolution of irradiated fuel assembly sections, solvent extraction, ion-exchange, precipitation, and calcination process steps. The sequence of operating steps in the SETF campaigns is illustrated in Figure 5, Solvent Extraction Test Facility Operations (Reference U011).

The Mark-42 program began operation in 1991 and includes the dissolution of irradiated segments; the separation of the transuranium elements from miscellaneous impurities, activation products, and fission products; and the separation of the transuranium elements from each other. This is accomplished using a variety of solvent extraction, precipitation, and ion-exchange process steps. The general sequence of steps used to process Mark-42 segments in the hot cells is shown in Figure 6, Mark-42 Processing (Reference P161).

The GNEP program initiated in May 2007 involves the demonstration of isotopic separations technologies using fuel from the H.B. Robinson and Dresden LWR reactors. The REDC supports small-scale experiments involving the separation of several volatile fission products from uranium fuel oxides (e.g., tritium, C-14, iodine, krypton, and xenon) followed by the separation of the non-volatile fission products utilizing chemical extraction technologies (References C306, P951, P952, U568).

The operations described above represent the primary chemical processing activities in the REDC; however, special separation projects were periodically performed in cells reserved for this purpose. These special separations (e.g., separating Cf-249 from decaying Bk-249 or purifying a sample for shipment to another site) were performed in laboratory-type equipment especially installed in the cell for each job. These procedures generally involved a small fraction of the amount of material handled in the main line (Reference P279).

Target Fabrication

Actinide oxide (americium and curium) is incorporated into aluminum target rods for irradiation in the HFIR. The operations and inspections include pellet forming, weighing, measurement, calorimetry, thermal cleaning, target loading, welding, x-ray examination, helium leak tests, dimensional inspections, hydrostatic compression of the aluminum tube around the pellets, coolant shroud attachment, decontamination, and carrier loading for transfer to the HFIR. Generally, pellet forming operations with loose powders are performed in Cubicle 3, target tubes are assembled in Cubicle 2, and final assembly and inspection operations with sealed target rods are performed in Cubicle 1. Pellet and target tube fabrication and target assembly operations are illustrated in Figure 7, Pellet Fabrication; Figure 8, Target Tube Fabrication; and Figure 9, Target Assembly (Reference P279).

Analytical Laboratory

Cubicle 8 is used exclusively to collect and store samples from the hot cells, to perform analyses that must be made without dilutions on highly-radioactive samples, and to make dilutions for analyses in the glovebox analytical chemistry laboratories. Cubicle 9 has also been used for analytical chemistry purposes. Sample preparation and analyses include pipetting, titration, dissolution, filtration, solvent extraction, and centrifugation (References P161, U011).

Process Development

The process development alpha laboratories (Rooms 109, 209, 111, and 211) have been used for fundamental studies and process development of alpha-active materials. Much of the early work was concerned with the development of sol-gel processes and with process development for the isolation and purification of various alpha-active materials. Other fundamental research and process development work has included reprocessing of reactor fuels, conversion of recovered uranium and plutonium to forms suitable for use in fabrication of recycle reactor fuel elements, and development of waste separation processes. The chemical processes (e.g., solvent extraction, ion-exchange, and precipitation) performed in the gloveboxes are much the same as the hot cells but with smaller equipment and smaller amounts of material (References P161, P279, U011).

Maintenance Operations

The processing equipment in the hot cell bank was designed and built so that it can be maintained or replaced within the hot cell cubicles using remote techniques. Occasionally, large equipment items and equipment racks require maintenance that cannot be performed in the cubicles. These items are moved to the decontamination glovebox for cleaning and repair. The decontamination glovebox is wheeled onto the top of the hot cell bank where the equipment is introduced into the glovebox from the equipment transfer case (References P279, U011). For maintenance operations in a tank pit, work may be performed directly in the pit in supplied air or may be done remotely from the top of the pit using long-handled tools. Maintenance of the off-gas systems for the cells and the process tanks generate filter change out waste including HEPA filters and charcoal and Hopcalite organic vapor trap filters. Glovebox operations are performed using neoprene or leaded glovebox gloves which are periodically replaced. Glovebox equipment items and components require periodic decontamination, inspection, maintenance, and repair. Glovebox equipment may also require replacement, and glovebox interiors require regular decontamination (Reference C302, U011, P161, P279).

Process Waste Handling

Waste items generated in the Building 7920 hot cell cubicles during the process operations and maintenance activities are removed from the cubicles through connecting gloveboxes in the TA, LAA, and decontamination glovebox room. Glovebox waste transfers are accomplished using a plastic bag transfer technique through 6-inch and 12-inch diameter access ports. Some gloveboxes are also equipped with sphincter-valve devices in which materials are placed in cardboard ice cream cartons. Large pieces of equipment are transferred in and out of the hot cell through the roof door using the equipment transfer case. Liquid wastes are transferred out of the gloveboxes through liquid waste lines (References P161, U011).

Prior to 1976, all Building 7920 solid wastes were managed as RH TRU waste, even though a significant portion of the inventory produced was CH-TRU waste. In March 1976, operations to formally segregate RH- from CH-TRU wastes were initiated. Intensive segregation did not occur until the 1978 time frame. Most of the waste generated prior to 1978 would have been placed into concrete casks called "floor casks." The majority of the floor casks have 4.5 inch thick side walls because the lower activity materials typically required much less shielding. This waste will contain significant amounts of lower dose rate waste (paper, glassware, PPE, wipes, glovebox equipment, and HEPA filters) generated from the laboratory and support areas. The amount of these lower dose rate materials would have decreased significantly in RH casks loaded after 1978, which will contain greater volumes of waste from hot cell activities (References P125, U038).

In addition to the concrete casks with 4.5-inch thick walls, waste from REDC operations has been loaded in casks providing additional shielding with 6- and 12-inch thick concrete walls. The external dimension for all three of these cylindrical casks is approximately 7.5 feet tall by 4.5 feet in diameter. The waste materials loaded into the casks are packaged in a variety of configurations utilizing the following packaging materials (References P125, P161, U011):

- 1-gallon metal paint cans (some lead-lined)
- Polyethylene bags, liners, bottles, and draw-string bags
- Cardboard ice cream cartons
- 3.4-gallon polyethylene plastic buckets (sealed and unsealed)
- 2-gallon Bain-Marie polyethylene plastic containers
- 5-gallon metal lard cans
- 10-gallon rigid-cardboard fiber drum

In the hot cell cubicles, waste items are typically placed into small containers (e.g., plastic buckets or metal cans) and monitored for radiation. Depending on the type of waste and radiation level, the item is acid leached, water rinsed, and air dried before placement into the bucket. Larger waste items are cut up to fit into the buckets. To reduce the volume of waste, a low-temperature furnace in Cubicle 9 is used to melt small plastic items such as polyethylene bottles to consolidate them in a metal bucket. Spent cation-exchange resins are calcined, leached with nitric acid, collected in a polyethylene bottle and melted in the furnace, then placed into a metal bucket. Spent anion-exchange resins are de-nitrated, rinsed, and fixed in a concrete grout mixture in a metal bucket. Unusable empty metal buckets are compacted in a crusher (Reference P161). Waste buckets are transferred from the hot cell cubicles through the inter-cell conveyor system to Cubicle 9 where the waste is characterized to assure that the waste forms in each bucket meet the waste acceptance criteria. The buckets are transferred by conveyor to the TA cubicle and monitored for beta-gamma and neutron radiation. Buckets with low radiation levels are disposed in a drum for CH waste (Reference M005, M100, P161).

Larger equipment, such as processing racks (2x3x6 feet), charcoal filter beds (24x24x24 inches), and Hopcalite organic filters traps (6x24x24 inches) are directly loaded into the casks. Processing racks used in the hot cells are replaced due to malfunctions, wear, change in process requirements, or upgrades. Typically, the racks have been packaged in several layers of polyethylene bags then placed directly into the concrete cask. Lead bricks have been used to balance the processing racks and will be found in the disposal casks (References C302, P125).

Concrete casks of TRU waste are loaded in a solid waste loading station located in the LAA. Waste to be loaded into the cask from the transfer area is generally transferred to the loading station in sealed plastic buckets and unsealed plastic bags. Larger equipment is transferred to the loading station via the equipment transfer case for disposal. The incoming empty cask is prepared by placing a polyvinyl chloride plastic bag liner (0.01 inch) into the cask. Plywood expanders are placed inside the bag (a circular disk at the bottom and a circular ring at the top), and the bag is then secured to one of the waste station roof plugs. Two roof plugs are available for loading the waste packages. One is used when the waste is to be transferred using the equipment transfer case, the other is used when plastic buckets are loaded. After the cask is loaded, the plastic bag is collapsed and an electrically-driven turntable inside the waste station rotates the cask, twisting the top of the bag. The bag is then cut and sealed with a hot-knife sealer. The cask lid is then installed, sealed with roofing pitch, and secured using two steel tapes, attached around the outside of the cask. The cask lid may also be attached to the cask body by three anchor bolts aligned with holes drilled in the cask lid (References C302, U011).

5.0 WASTE STREAM INFORMATION

This section presents the waste stream information required by the WIPP-WAP and the WCPIP for Waste Stream OR-REDC-RH-HET (References 1 and 2). The area of generation, waste stream volume, period of generation, waste packaging, and the physical, chemical, and radiological composition of the waste stream are described.

5.1 Area and Building of Generation

Waste Stream OR-REDC-RH-HET originated in Building 7920. Areas within the building generating waste included in this waste stream are the TA (Room 118), the LAA (Room 120), and the decontamination glovebox room (Room 216) which are associated with the hot cell cubicle operations and waste transfers. Waste from the Building 7920 analytical chemistry laboratories (Rooms 108 and 208) and process development laboratories (Rooms 111, 211, 109, and 209) are also included (References M024, M100, P161).

REDC waste management practices have resulted in the mixing of waste materials within the storage containers, with limited segregation of these wastes based on the radiological and chemical properties. Solid wastes have not been segregated according to programmatic source during the waste accumulation and packaging operations conducted to date at the REDC. Most solid wastes from the REDC were, and continue to be, accumulated over a significant period of time, resulting in mixing of campaign wastes conducted during the period of accumulation (Reference U038). As containers of REDC debris waste are generated during repackaging in the TWPC, the container-specific documentation will be reviewed to assure that each container included in Waste Stream OR-REDC-RH-HET meets the WIPP-WAP and the WCPIP waste stream definitions of waste material generated from a single process or from an activity that is similar in material, physical form, hazardous constituents, and radiological constituents (References 1, 2, M100, U038).

5.2 Waste Stream Volume and Period of Generation

As described in Section 4.2.1, the current inventory of REDC waste to be repackaged into Waste Stream OR-REDC-RH-HET is contained in 263 concrete casks, 8 55-gallon drums, and 1 B-88 box generated between April 1972 and February 2007. It is estimated that this inventory will generate approximately 2,055 55-gallon drums (427.4 m^3) of RH and CH waste. In addition to the current RH inventory, it is projected that the Building 7920 REDC operations will generate approximately an additional 3.4 m^3 (two casks) of waste to be processed in the TWPC per year with no projected end date. This estimate is based on the volume of waste generated by the facility over the past five years and input from ORNL personnel (References C302, M024, P256, U046, U047, U048).

5.3 Waste Generating Activities

Waste Stream OR-REDC-RH-HET is generated during the repackaging of RH waste originating from REDC Building 7920 operations. Section 4.2.2 provides a summary of the waste generating process operations conducted in the REDC and the TWPC RH TRU processing operations.

5.4 Type of Wastes Generated

This section describes the waste materials based on process inputs and outputs, waste matrix code assignment, waste material parameter weight estimates, radionuclide contaminants, and hazardous waste determinations for Waste Stream OR-REDC-RH-HET.

5.4.1 Materials Related to Physical Form

Waste Stream OR-REDC-RH-HET is comprised primarily of organic and inorganic debris waste items. Waste descriptions are provided on UCN-2109 and UCN-2822 forms and waste container log sheets. The primary source for descriptions of TRU waste materials from the REDC were obtained from the waste container log sheets for the CH Waste Stream (OR-REDC-CH-HET) described in CCP AK Summary Report, CCP-AK-ORNL-002 (Reference 12). The waste includes cellulosics (paper), plastic, rubber, metal, and glass. Specific waste items present in the storage container inventory include the following: (References M005, M024, M100, P125, P161, U011):

- Cellulosic waste consists of paper, cotton, cloth, and wood items, including wipes, swabs, bags, towels, rags, protective clothing, gloves, rope, string, cardboard, brushes, blotter paper, and filter media.

- Plastic waste consists of polyethylene, polypropylene, polyvinyl chloride, Tygon, nylon, Bakelite, and Plexiglass items, including sheeting, melted plastic, beads, blocks, tape, tubing, bags, fittings, buckets, bottles, caps, pans, discs, brushes, laboratory equipment (pipettes, syringes, etc.), gloves, manipulator boots, and filter media.

- Rubber waste consists of items, including gaskets, rings, hose/tubing, squeegees, bulbs, stoppers, gloves, boots, leaded glovebox gloves, wire/cord/cable insulation, and filter media.

- Glass waste consists of glass and ceramic items, including bottles, laboratory glassware, pipettes, columns, plates, thermometers, light bulbs (mercury and incandescent bulbs), mirrors, lenses, insulation, and unidentified broken glass items.

- Metal items including ferrous materials made from carbon steel, stainless steel, and iron. Non-ferrous materials include items made from aluminum, brass, copper, and lead. Specific metal waste items include cans (including aerosol cans), needles, tubes, valves, cable, wire, planchets, valves, piping, tools (tongs, dies, punches, wrenches, knives, clamps, tweezers), foil, weights, blocks, plates, frames, columns, racks, shielding, sheeting, light fixtures, equipment (pumps, motors, balance, ultrasonic cleaner, hot plates, furnace, centrifuge), hardware (nuts, bolts, brackets, washers, etc.), manipulator parts, and filter components.

The AK record identifies numerous packaging configurations utilizing plastic bags and liners, 1-gallon paint cans (some lead lined), sealed and unsealed polyethylene buckets (2- to 5-gallon), 5-gallon lard cans, and 10-gallon rigid cardboard fiber drums. Secondary waste generated during repackaging operations in the TWPC hot cell may include solidified liquids, amalgamated mercury, PPE, and other miscellaneous process materials and equipment generated during routine operations of the hot cell (Reference P125, U038, U046).

5.4.1.1 Waste Matrix Code

As discussed in the previous section, Waste Stream OR-REDC-RH-HET is comprised primarily of organic and inorganic debris waste items and generally consists of cellulosics (e.g., paper, cloth), plastic, rubber, glass, and metal. The waste matrix code was assigned to this waste stream based on the evaluation of AK information relating to the physical form of the waste recorded on UCN-2109 and UCN-2822 forms and container log sheets. This container documentation for the concrete casks contains limited information relating to the physical composition of the waste contained; typically only whether the waste is burnable or non-burnable (Reference M100).

For the CH inventory, the UCN-2109 records an estimate of the volume percent combustible which ranges from 0 to 100 percent with an average of 62. The UCN-2822 provides an estimate for total volume and combustible volume in cubic feet. The calculated volume percent range for combustibles on the UCN-2822 forms is 0 to 100 percent, averaging 54 percent. The container log sheets provide an estimate of the volume percent combustible for each package in CH drums. The calculated volume percent combustible range for combustibles in drums with container log sheets is 33 to 98 percent averaging 65 percent (Reference M005).

Due to the high degree of variability in the amount of combustible waste in the CH waste, Waste Matrix Code S5400, Heterogeneous Debris, is applied to the CH REDC waste stream. For this reason, S5400 is also applied to Waste Stream OR-REDC-RH-HET, assuming that the composition of the RH waste is comparable to the CH waste generated by the same operations. The definition of this Waste Matrix Code is provided in the DOE/LLW-217, *DOE Waste Treatability Group Guidance* (Reference 13). This category includes waste that is at least 50 percent, by volume, debris materials that do not meet the criteria for assignment as either an Inorganic Debris (S5100) or Organic Debris (S5300).

Although the waste stream, as a whole, is comprised of more than 50 percent heterogeneous debris, the casks will contain a wide range of the waste material parameters listed in Section 5.4.1.2, except that no individual drum will contain greater than 50 percent homogeneous solids (e.g., solidified/absorbed liquids, grouted resins, filter bed media, etc.).

5.4.1.2 Waste Material Parameters

To estimate the relative waste material parameter weights for Waste Stream OR-REDC-RH-HET, data were obtained from ORNL personnel in the form of electronic databases and miscellaneous site-specific waste disposal, transportation, and storage forms. The ORNL RH-TRU Database Inventory was queried for containers originating from the REDC designated as RH waste generated after November 1991. These casks were selected because they are the first casks that will be repackaged in the TWPC. Additionally, the container documentation generated after 1990, typically includes waste items descriptions that are sufficient to estimate the waste material parameters within the casks. A majority of the earlier container documentation contains limited information and typically only identifies the waste as “burnable” or “unburnable” material (References M004, M024).

The population assessed consists of 45 casks, generated between December 1991 and February 2007. It is assumed that this inventory will be representative of the entire REDC RH debris waste stream, due to the production type of operations performed over the entire time frame for this facility. Based on review of waste generator documentation (e.g., 2109 forms), each cask may contain numerous inner containers, ranging from a single plastic bag, to 63 metal cans nested inside 63 poly buckets. Site documentation did not quantify the contents of this waste in regards to waste material parameters, so estimates were based on the descriptions of the contents and the recorded volume percent of combustibles. In cases where the volume percent of combustibles was not recorded on the 2109 form, an estimate was made by averaging the percent combustibles in inner containers. An assumed specific gravity was applied for each waste material parameter to convert it to a weight percent. An average weight percent was then calculated by using the net weight of each cask as recorded in the ORNL RH-TRU Database. Average, minimum, and maximum waste material parameter weight percentages, based on this evaluation are presented in Table 5-1, Waste Material Parameter Estimates for Waste Stream OR-REDC-RH-HET. This assessment is documented in a memorandum (included with Attachment 6) as required by CCP-TP-005 (References 3, M004, M024).

Table 5-1. Waste Material Parameter Estimates for Waste Stream OR-REDC-RH-HET

Waste Material Parameter	Average Weight Percent	Weight Percentage Range		
Iron Base Metal Alloys	59.13%	30.23%	to	95.51%
Aluminum Base Metal/Alloys	0.01%	0.00%	to	0.64%
Other Metal/Alloys	5.91%	0.00%	to	52.38%
Other Inorganic Materials	16.78%	0.00%	to	47.51%
Cellulosics	6.68%	0.00%	to	18.03%
Rubber	1.66%	0.00%	to	11.90%
Plastics	8.62%	1.44%	to	30.97%
Organic Matrix	0.00%	0.00%	to	0.00%
Inorganic Matrix	1.21%	0.00%	to	7.93%
Soil/Gravel	0.00%	0.00%	to	0.00%
Total Inorganic	**83.03%**			
Total Organic	**16.97%**			

5.4.2 Chemical Content Identification – Hazardous Constituents

This section describes the characterization rationale for assignment of EPA HWNs to Waste Stream OR-REDC-RH-HET. The EPA HWNs assigned to this waste stream are summarized in Table 5-2, Waste Stream OR-REDC-RH-HET Hazardous Waste Characterization Summary.

Table 5-2. Waste Stream OR-REDC-RH-HET Hazardous Waste Characterization Summary

EPA Hazardous Waste Number	Constituent
Toxicity Characteristic Metals	
D005	Barium
D006	Cadmium
D007	Chromium
D008	Lead
D009	Mercury
D010	Selenium
D011	Silver
Toxicity Characteristic Organics	
D019	Carbon tetrachloride
F-Listed Organic Solvents	
F002	1,1,2-Trichloroethane
F002	Trichloroethylene
F005	Benzene
F005	Methyl ethyl ketone (MEK)
F005	Toluene

To assign EPA HWNs, AK sources including, procedures, personnel interviews, previous AK reports, container packaging and shipping documentation, and material safety data sheet (MSDS) information for commercial products noted in the AK record were reviewed to determine potential waste material inputs and possible chemical contaminants associated with the Building 7920 REDC operations. A comprehensive list of materials and chemicals identified during this assessment are provided in Table 5-3, Waste Stream OR-REDC-RH-HET Material and Chemical Inputs. HWNs were conservatively assigned for compounds used in and around the hot cells, due to the lack of analytical evidence quantifying the concentration of RCRA toxic contaminants in the waste matrix (Reference DR005).

Table 5-3. Waste Stream OR-REDC-RH-HET Material and Chemical Inputs

Chemical/Material	Use/Description/Location	AK Source	EPA HWNs
1,1,2-trichloroethane	REDC organic chemical inventory.	C078	F002
1,10-phenanthroline	Iron spectrophotometric analysis reagent.	P282	NA
2,5-di-tert-butylhydroquinone (DBHQ)	Plutonium solvent extraction reagent.	C078, P145, U011	NA
2-ethylhexyl phenylphosphonic acid (Pharex)	Pharex solvent extraction reagent.	P136, P279	NA
2-ethylhexanol	Plutonium solvent extraction diluent.	C078, P136, P145, U011	NA
2-thenoyltrifluoroacetone (TTA)	Total plutonium, berkelium, and neptunium analytical chemistry extraction reagent.	P282	NA
Acetic acid	REDC organic chemical inventory.	C078, U011	NA[2]
Acetone	Equipment cleanout solvent (degreaser).	C078, P161, P279, P282, U011	NA[1]
Adogen 364	High purity tertiary amine dissolved in diethylbenzene for solvent extraction.	C078, P136, M022, P282, U011	NA
Ajax All Purpose Cleaner	Decontamination detergent used on dampened wipes.	M022, P263	NA
Alcohol (Formula 3A)	Cleanout of equipment (95% ethanol, 5% methanol).	M022, P282	NA[1]
Aluminum chloride	REDC inorganic chemical inventory.	C078, U011	NA
Aluminum powder (alumina)	Americium/curium fuel pellet component. Purifying diethylbenzene and kerosene.	C078, P161, P279, U011	NA[3]
Aluminum nitrate	Neptunium solvent extraction reagent. Uranium alpha spectroscopy reagent. High pressure liquid chromatography separation reagent.	C078, P282	NA[1]
Ammonia	Reagent used to precipitate nickel and copper in ion-exchange product solutions.	P229, P279	NA
Ammonium alpha-hydroxyisobutyrate (AHIB)	Chromatographic cation-exchange eluent. High pressure liquid chromatography separation reagent.	P136, P161, P279, P282, U011	NA[2]
Ammonium hydroxide	Oxide precipitation reagent. Used to convert nitrated anion-exchange resins to the hydroxide form before drying. Neptunium solvent extraction reagent. Iron spectrophotometric analysis reagent. High pressure liquid chromatography separation reagent.	P279, U011, P282, C078, P136, P145	NA[2]
Ammonium nitrate	Cation-exchange reagent (wash).	C078, U011	NA[1]

Table 5-3. Waste Stream OR-REDC-RH-HET Material and Chemical Inputs (continued)

Chemical/Material	Use/Description/Location	AK Source	EPA HWNs
Ammonium persulfate	REDC inorganic chemical inventory.	C078, U011	NA
Ammonium thiocyanate	Uranium spectrophotometric analysis reagent.	C078, P282	NA
Ascorbic acid	Plutonium extraction reagent.	P136, U011	NA
Barium	Fission product contaminant of HFIR targets. Californium product solution impurity.	M024, M100, P151, U011	D005
Benzene	REDC organic chemical inventory.	C078	F005
Beryllium	Electroplating microgram quantities of transplutonium elements on beryllium foil targets and source plate. Sources.	P223	NA
Cadmium	Californium product solution impurity. D006 assigned by generator to REDC containers (flashlight batteries and electronic equipment).	M005, M012, M024, M100, P151	D006
Carbon/activated charcoal	Organic chemical vapor filter media.	C078, M001, P161, U011	NA
Carbon tetrachloride	REDC organic chemical inventory.	C078, U011	D019
Citric acid	REDC organic chemical inventory.	U011	NA[2]
Chromium	Contaminant of aluminum target cladding and fuel matrix. Californium product solution impurity.	P151, P161, P279, U011	D007
Cyclohexane	REDC organic chemical inventory.	C078	NA[1]
Diatomaceous earth	Process stream and liquid waste filtering media.	P161, P173, P229	NA
Diethylbenzene (DEB)	Solvent extraction organic extractant.	C078, P136, P161, P279, U011	NA[1]
Diethylene triaminepentaacetic acid (DTPA)	REDC organic chemical inventory.	C078, P145, U011,	NA
Di (2-ethylhexyl) phosphoric acid (HDEHP)	Solvent extraction organic extractant in decane diluent.	C078, P136, P145, P161, P279, U011	NA
Diisopropylbenzene (DIPB)	REDC organic chemical inventory.	C078, U011	NA[1]
Dioctylphthalate	High efficiency particulate air (HEPA) filter testing.	P263, P279, U011	NA
Dodecane	Solvent extraction organic extractant.	P161, U011	NA[1]
Dowex 1	Anion-exchange resin.	C078, P279, P282, U011	NA
Dowex 50	Cation-exchange resin.	C078, P279, P282, U011	NA
EDTA	REDC organic chemical inventory.	C078, U011	NA
Ethanol	Analytical Laboratory equipment cleaning reagent. Component of Formula 3A alcohol (95%) used to cleanout equipment. Decontamination and equipment repair solvent.	C078, M022, P161, P279, P282, U011	NA[1]
Ether (non-specific)	REDC organic chemical inventory.	U011	NA[1]
Ethylene glycol	REDC organic chemical inventory.	C078	NA

Table 5-3. Waste Stream OR-REDC-RH-HET Material and Chemical Inputs (continued)

Chemical/Material	Use/Description/Location	AK Source	EPA HWNs
Ferric chloride	REDC inorganic chemical inventory.	C078, U011	NA
Ferric nitrate	Total plutonium analytical chemistry extraction reagent.	C078, P282	NA[1]
Ferrous ammonium sulfate	Iron spectrophotometric analysis reagent.	P282	NA
Ferrous chloride	Neptunium and plutonium solvent extraction reagent.	P136, P282	NA
Ferrous sulfamate	REDC inorganic chemical inventory (SETF reductant reagent).	P229, U011	NA
Ferrous sulfate	Determination of total reducing normality reagent.	C078, P282	NA
Hydrazine	SETF solvent extraction reduction agent.	C078, P016, P173, P229,U011	NA[1,2,3]
Hydrochloric acid	Solvent extraction aqueous solution. LiCl chromatographic anion-exchange solution. Curium and plutonium target dissolution. Process solution titration reagent.	C078, P136, P161, P223, P279, P282, U011	NA[2]
Hydrofluoric acid	Target dissolution.	P136, P223, P279, P282, U011	NA[2]
Hydrogen peroxide	SETF, Berkex, and Cleanex extraction reductant.	C078, P173, P223, P279, U011	NA[1,2,3]
Hydroquinone	REDC organic chemical inventory.	C078, U011	NA
Hydroxylamine hydrochloride	REDC inorganic chemical inventory (SETF reagent). Total plutonium analytical chemistry extraction reagent. Neptunium solvent extraction reagent. Iron spectrophotometric analysis reagent.	C078, P136, P229, P282, U011	NA
Hydroxylamine nitrate	REDC inorganic chemical inventory (SETF reagent).	U011	NA
Hopcalite	Organic chemical vapor filter media oxidation catalyst (CuO_2-MnO_2).	M001, P263, U011	NA
Ionac A-580	Anion-exchange resin used for plutonium solvent extraction.	U011	NA
Isopropanol	Electroplating solution for californium on platinum foils and disks.	C078, P021, P223	NA[1]
Kerosene (Amsco)	Deodorized mineral spirits. Pharex solvent extraction diluent.	C078, P279, U011	NA[1]
Lead	Glovebox gloves and window. Fission product contaminant of HFIR targets. Californium product solution impurity. Lead shielding, lead pigs, bricks, shavings, electronic equipment (circuit boards), and solder.	C078, C148, C302, M005, M012, M024, M100, P151, P272, P279, U011, U038	D008
Lead-acid batteries	Contained in mule carrier lead-acid batteries.	C078, P161	D008
Lithium chloride	Transcurium and Mark-42 LiCl chromatographic anion-exchange oxidant. Process solutions free acid and adogen titration reagent.	C078, P136, P145, P161, P223, P279, P282, U011	NA

Table 5-3. Waste Stream OR-REDC-RH-HET Material and Chemical Inputs (continued)

Chemical/Material	Use/Description/Location	AK Source	EPA HWNs
Lithium hydroxide	Process solutions free acid and adogen titration reagent.	C078, P282, U011	NA[2,3]
Lithium hypochlorite	Cleanex extraction oxidant.	C078, U011	NA[3]
Lithium nitrate	REDC inorganic chemical inventory.	U011	NA
Mercuric chloride	REDC inorganic chemical inventory.	C078	NA[1]
Mercuric nitrate	Radioiodine trap reagent.	C078, U011	D009[1]
Mercury	Contained between the liners and shells of evaporator tanks. Mercury vapor lamps, electronic equipment, thermostats, and solder.	C078, C148, M005, M012, M024, M100, P161, P272, U038,	D009
Mercury amalgamation agents	Used to treat residual mercury during cask repackaging.	M022, U046	NA
Methanol	Tramex extraction reagent. Ingredient in Formula 3A alcohol (5%) used to cleanout equipment.	C078, M022, P030, P136, P145, P161, P279, U011	NA[1]
Methyl ethyl ketone	REDC organic chemical inventory.	C078	F005
Methyl isobutyl ketone	Neptunium solvent extraction reagent (organic phase). Uranium alpha spectroscopy reagent.	P282	NA[1]
Mr. Clean	Liquid cleaner used in ultrasonic cleaning of HFIR targets.	C148, M022, P263	NA
Napthalene	REDC organic chemical inventory.	C078	NA[1]
N-paraffin hydrocarbon (NPH)	SEFT solvent extraction diluent.	C078, P161, P173, P229, U011	NA
Nitric acid	Plutonium fuel and transcurium target dissolution. Solvent extraction aqueous solution. Plutonium and americium anion/cation-exchange feed solution and eluent. Dilute aqueous samples and cleaning counting plates for radiological analyses.	C078, P136, P145, P161, P229, P279, P282, U011	NA[2]
Nochar	Solidifying agent for absorbing residual liquids during cask repackaging.	M022, U046	NA
Oxalic acid	REDC organic chemical inventory.	C078, U011	NA[2]
Pentasodium diethylene-triamine pentaacetate	Decontamination solution detergent.	P279	NA
Phenolphthalein	Process solution titration end point indicator.	P282	NA
Potassium bromate	Berkelium extraction process oxidant.	P279, U011	NA[1]
Potassium carbonate	In-tank americium and curium precipitation. Scrubbing system basic solution.	C078, P136, P145, P161, U011	NA
Potassium dichromate	Determination of total reducing normality reagent.	P282	D007
Potassium hydroxide	Scrubbing system basic solution.	C078, P161, U011	NA[2]
Potassium iodide	Plutonium/Uranium anion-exchange reagent.	P282	NA
Potassium nitrate	REDC inorganic chemical inventory.	C078, U011	NA[1]
Potassium oxalate	Process solution titration reagent.	P282	NA
Potassium permanganate	Neptunium solvent extraction reagent.	P282	NA[1]
Scouring powder	Used to decontaminate packages before shipment.	P263	NA

Table 5-3. Waste Stream OR-REDC-RH-HET Material and Chemical Inputs (continued)

Chemical/Material	Use/Description/Location	AK Source	EPA HWNs
Selenium metal	REDC inorganic chemical inventory.	C078	D010
Silica gel	Purifying diethylbenzene and kerosene.	C078, P279, U011	NA
Silver	Photographic development solutions. Electronic equipment (circuit boards).	C078, C148, M005, M012	D011
Silver nitrate	REDC inorganic chemical inventory.	C078	D011[1]
Sodium carbonate	Acid vapor scrubber solution.	C078, P161, U011	NA
Sodium bromate	Berkelium cation-exchange oxidant.	C078, P136, U011	NA[1]
Sodium dichromate	Berkelium separation extraction reagent.	P282	D007
Sodium hydroxide	Aluminum cladding target dissolution. Acid vapor scrubber and I-131 sorbent solutions. Decontamination and waste line flush solution. Neutralization of process solutions. Process solution titration reagent.	C078, P145, P161, P279, P282, U011	NA[2]
Sodium nitrate	Aluminum cladding target dissolution.	C078, P145, P161, P279, U011	NA[1]
Sodium nitrite	Total plutonium analytical chemistry extraction reagent.	P282	NA[1]
Sodium oxalate	Process solution titration reagent.	C078, P282	NA
Sodium thiosulfate	Reagent for stabilization of iodine during aluminum jacket dissolution.	U011	NA
Stannous chloride	Tramex holding reductant reagent. Uranium spectrophotometric analysis reagent.	P136, P279, P282	NA
Stearic acid	Fuel pellet forming die lubricant.	P161, U011	NA
Sulfuric acid	Contained in mule carrier lead-acid batteries. Berkelium extraction reagent. Determination of total reducing normality reagent. Iron spectrophotometric analysis reagent.	C078, P145, P161, P282	NA[2]
Tartaric acid	Iron spectrophotometric analysis reagent.	P282	NA
Trialkyl amine	Dissolved in diethylbenzed as an liquid ion-exchanger solution for solvent extraction operations.	P279	NA
Tributylphosphate	Solvent extraction organic phase solvent for LWR (SETF) fuels.	C078, P173, P229, U011	NA
Trichloroethylene	REDC organic chemical inventory.	C078, U011	F002
Toluene	Scintillation reagent solvent.	C078, P223	F005
Ultima Gold	Liquid scintillation cocktail.	M022, P282	NA
Vermiculite	Used to absorb free liquids.	P263	NA
Xylene	Dilute organic samples for radiological analyses. Total plutonium, berkelium, and neptunium analytical chemistry extraction reagent.	P161, P282, U011	NA[1]
Zinc bromide	REDC inorganic chemical inventory.	C078, U011	NA
Zircaloy/zirconium	Contaminant from process tanks. Leached fuel cladding hulls from LWR (SETF) dissolution.	C078, P136, P161, P173, P229, P223, P279, U011	NA

Notes 1, 2, and 3: These chemicals may exhibit the characteristic of ignitability (1), corrosivity (2), and/or reactivity (3) in their pure form. The absence of potentially ignitable, corrosive, or reactive materials in Waste Stream OR-REDC-RH-HET is verified during repackaging operations in the TWPC.

5.4.2.1 F-Listed Constituents

Based on review of AK relative to REDC chemicals usage and chemical inventory information, Waste Stream OR-REDC-RH-HET contains or is mixed with F-listed hazardous wastes from non-specific sources listed in 40 CFR Part 261, Subpart D (40 CFR 261.31). As shown in Tables 5-2 and 5-3, F002 and F005-listed solvents have been used during REDC operations. F003 constituents, including acetone, methanol, methyl isobutyl ketone, and xylene are listed solely because these solvents are ignitable in the liquid form. The waste stream will not exhibit the characteristic of ignitability because it is not liquid; therefore, F003 is not assigned. Although F001-listed solvents were identified in the AK record (carbon tetrachloride and trichloroethylene), EPA has provided a regulatory clarification that the F001 listing is only appropriate when the listed solvents are used in a "large-scale" degreasing operation such as cold cleaning or vapor degreasing on an industrial scale (Reference 14). Large-scale degreasing operations have not been conducted in the REDC, and therefore, EPA HWN F001 is not assigned to this waste stream. Waste Stream OR-REDC-RH-HET is assigned F-listed EPA HWN F002 for 1,1,2-trichloroethane and trichloroethylene and EPA HWN F005 for benzene, MEK, and toluene (Reference DR005).

5.4.2.2 Toxicity Characteristic Constituents

Based on review of AK relative to chemicals used or present in the REDC and supporting analytical operations, Waste Stream OR-REDC-RH-HET is contaminated with toxicity characteristic compounds as defined in 40 CFR Part 261, Subpart C (40 CFR 261.24). Where a constituent has been identified and there is no quantitative data available to demonstrate that the concentration of a constituent is below regulatory threshold levels, the applicable EPA HWN is conservatively applied to the waste stream in accordance with the CCP AK procedure CCP-TP-005 (Reference 3).

Debris waste from the REDC operations contain or is contaminated with toxicity characteristic metal compounds listed in 40 CFR 261. Based on the references identified in Table 5-3, EPA HWNs D005, D006, D007, D008, D009, D010, and D011 are assigned to Waste Stream OR-REDC-RH-HET (Reference DR005).

The AK sources identified the use of organic toxicity characteristic compounds including benzene (HWN D018), carbon tetrachloride (HWN D019), and trichloroethylene (HWN D040). EPA HWNs F005 and F002 are assigned to the waste stream for F-listed solvents benzene (HWN F005) and trichloroethylene (HWN F002). Because the more specific F-listed EPA HWNs have been assigned for these compounds, assignment of the corresponding toxicity characteristic HWNs D018 and D040 is not necessary. Therefore only HWN D019 for carbon tetrachloride is conservatively assigned to Waste Stream OR-REDC-RH-HET (Reference DR005).

5.4.2.3 Ignitables, Corrosives, and Reactives

Potentially ignitable, corrosive, and reactive waste materials are prohibited during the repackaging of the RH TRU waste in the TWPC. For this reason, the materials in this waste stream do not meet the definition of ignitability as defined in 40 CFR 261.21. Additionally, REDC process solutions prepared with the reagents identified in Table 5-3 were prepared outside of the cubicles and introduced into the closed loop process tanks. The resulting waste process solutions were piped out of the facility and are not expected to be included in the stored inventory of REDC waste to be repackaged. The materials are not liquid and VE is performed during repackaging to ensure prohibited amounts of residual liquids are not added to the containers. This material will not cause fire through friction, absorption of moisture, or spontaneous chemical changes. This material is not a compressed gas and is not an oxidizer. Prior to WIPP disposal, prohibited quantities of liquids identified during repackaging are removed and/or immobilized. Waste Stream OR-REDC-RH-HET is therefore not ignitable (HWN D001) (References P161, P241, P242, P263, P282, and U011).

The debris materials in this waste stream do not meet the definition of corrosivity as defined in 40 CFR 261.22. The materials are not liquid and VE is performed to ensure liquids are not added to containers during repackaging. Prohibited quantities of liquids identified during VE are removed and/or immobilized. Waste Stream OR-REDC-RH-HET is therefore not corrosive (HWN D002).

The materials in this waste stream do not meet the definition of reactivity as defined in 40 CFR 261.23. The debris waste materials are stable and will not undergo violent chemical change. The materials will not react violently with water, form potentially explosive mixtures with water, or generate toxic gases, vapors, or fumes when mixed with water. The waste does not contain reactive cyanide or sulfide compounds. There is no indication that the waste contains explosive materials, and it is not capable of detonation or explosive reaction. As described above, processing solutions containing potentially hazardous chemical reagents in the pure form were prepared outside of the processing area and the resulting process solutions were piped from the process area. Additionally, preventative measures have been taken to prevent potential accidents associated with nitrated ion-exchange resins typically involving the removal of the resins from the column and conversion to the hydroxide form before disposal. Anion-exchange resins used with nitric acid are flushed from the column, rinsed with ammonium hydroxide to convert the resin to the hydroxide form, air dried, and grouted in metal cans. Spent cation-exchange resins are calcined to an oxysulfate ash, and the ashes are leached with nitric acid and dried prior to assimilation (and fixing) into melted polyethylene waste in a metal bucket. Prohibited quantities of liquids identified during VE are removed and/or immobilized during repacakaging. Waste Stream OR-REDC-RH-HET is therefore not reactive (HWN D003) (References P161 and U011).

5.4.2.4 P- and U-Listed Wastes

Review of the AK record did not identify any specific source or incident where the REDC waste was mixed with or contaminated with discarded commercial chemical product, an off-specification commercial chemical product, or a container residue or spill residue thereof. No listed chemicals were identified in the container-specific documentation for Waste Stream OR-REDC-RH-HET. The only specific source identified for beryllium is small foil targets and source plates electroplated with microgram quantities of transplutonium elements. Review of the available container documentation did not identify beryllium as a component of the waste in these containers. Therefore, if present, beryllium will be a minor contaminant, well below 1 weight percent in any given waste container and far less than 18.14 kilograms (kg) in any payload container. Additionally, since no beryllium powder is present in the debris waste, P015 is not assigned to the waste stream. Hydrofluoric acid is used as a dissolution reagent; however, there is no indication that unused acids or other reagents, or spills of these reagents were disposed of in this waste stream. Therefore, U-and P-listed EPA HWNs, including U134, are not assigned to Waste Stream OR-REDC-RH-HET (References M005, M100, and P223).

5.4.3 Radiological Characterization

This section summarizes the approach developed by ORNL to characterize RH TRU waste generated at the REDC to be included in Waste Stream OR-REDC-RH-HET. It should be noted that the ORNL characterization approach described in this section does not represent the approach implemented by CCP. The approach implemented by CCP to fully characterize this waste stream is documented in CCP-AK-ORNL-501, *CCP Remote-Handled Transuranic Radiological Characterization Technical Report For Remote-Handled Transuranic Waste From Oak Ridge National Laboratory Radiochemical Engineering Development Center* (Reference 17).

As described in Section 4.0, the primary mission of the REDC facility is the recovery and purification of transplutonium elements from targets irradiated in the HFIR and Mark-42 targets from SRS. Transuranium element processing in Building 7920 includes dissolutions of irradiated targets, separation of the transuranium elements from miscellaneous impurities and fission products, and separation of the transuranium elements from each other (Reference P093, P161). Between 1979 and 1986, some uranium fuel cycle development work was performed in specially designed equipment in one of the Building 7920 hot cells (References I044, P161, U011). Based on the mainstream operation process, the REDC isotopic waste profile is expected to contain similar actinides, fission, and activation products present in materials processed at the REDC (Reference P093). Waste generated from the REDC is composed largely of non-TRU waste isotopes, and classification as TRU waste by alpha-activity concentration alone is complicated by these non-TRU isotopes.

5.4.3.1 Radiological Characterization Prior to 1999

Prior to 1999, waste was monitored for beta-gamma radiation and neutron radiation. These dose rate measurements were converted to activity values based on a predetermined conversion factor. This activity was assigned to the dominant nuclide in the package, typically Cm-244 and/or Cf-252 (References M024, M100, and P240). During 2006, the radionuclide inventory for overpacked casks from the trenches was revised to include an average decay correction of generator reported radionuclides (References M024 and M100). This decay correction adjusted the generator reported radionuclides, typically only Cm-244 and/or Cf-252. TRU radionuclides of plutonium and americium are known to be present in the waste, but records prepared by waste generators for waste generated prior to 1999 do not included information to demonstrate whether the TRU concentration was less than or greater than 100 nanocuries per gram (Reference P058).

5.4.3.2 Radiological Characterization of CH Waste Generated After 1999

On April 1, 1999, ORNL finalized and began implementation of the Waste Stream Profile Sheet (WSPS) 7920-HCAL-002 for the radiological characterization of CH waste generated at Building 7920 Hot Cell and Analytical Laboratories. Although this WSPS is specific to CH waste, the isotopic distribution developed and documented in the WSPS was also utilized to assign isotopic values to RH waste generated after 1999 (refer to Section 5.4.3.3). The following information is a summary of the data flow used in development of the isotopic distribution for WSPS 7920-HCAL-002 (Reference U045).

1. Twenty-eight in-cell smears samples were collected and analyzed. The analysis reported 19 radionuclides; however, no beta nuclides were analyzed as part of the original analysis. The average data for the 19 nuclides was used for the development of the WSPS.

2. Two additional smears were taken and analyzed for the beta constituents, as well as selected alpha and gamma emitting nuclides. The Cm-244 values were used to scale the activities for the beta emitters to be included with the data from the 28 smears samples.

3. The Pu-241 content was estimated based on the concentration of Pu-241 in the MK-42 targets which had the highest Pu-241 content. The plutonium isotopic distribution was analyzed on the MK-42 targets by mass spectrometry.

4. Data for the curium and californium isotopic distribution was taken from the Master of Science Thesis, *"Characterization of ORNL Transuranic Waste from the Measurement of Fission and Activation Products"* prepared by L. K. Nguyen, May, 1997 (Reference P093). The curium and californium contributions were calculated using the Cm-244 and the Cf-252 reported in item number one above.

5.4.3.3 Radiological Characterization of RH Waste Generated After 1999

On August 8, 1999, ORNL finalized WSPS 7920-HCAL-005 for the radiological characterization of RH waste in concrete casks generated at Building 7920 Hot Cell and Analytical Laboratories.

Initially, a study was performed to determine the neutron shielding characteristics of the goethite high density concrete cask using both field surveys and Monte Carlo Neutron-Particle (MCNP) code modeling data. A 102 microgram Cf-252 source was used for the study. The field surveys were taken using a REM 500™ neutron survey instrument manufactured by Far West Technologies Measurements. The measurements were compared to the modeling results from the MCNP code. The study is documented in a Master of Science Report, *"Neutron Shielding Effectiveness of Goethite High Density Concrete"* prepared by Keith Waggoner, July 1999 (Reference U049).

A factor to convert the neutron dose rates at one meter from the wall of the RH TRU waste cask to microgram quantities of Cf-252 was calculated. Two neutron dose rates are taken on opposite sides of the waste cask. The first dose rate at one meter is taken at the highest millirem/hour rate of the cask, and then the second dose rate is taken at a distance of one meter on the opposite side of the waste cask. The two dose rates are averaged to normalize the Cf-252 to the theoretical center of the waste cask. The average neutron dose rate is used to calculate the amount of Cf-252 inside the waste cask. The remaining radionuclides are calculated using the quantity of Cf-252 in the waste cask and the isotopic distribution documented in WSPS 7920-HCAL-002 (References M024, M100, U045 and U049).

5.4.3.4 Generator Reported Radionuclides for Waste Stream OR-REDC-RH-HET

To determine isotopic ratios for Waste Stream OR-REDC-RH-HET as a whole, the total gram value for each individual generator reported radionuclide was divided by the total mass of all radioactive constituents in the waste stream and converted to a percentage. This result is listed in Table 5-4, Waste Stream OR-REDC-RH-HET Radiological Characterization, as “Total Nuclide Weight%.” To determine the radionuclide weight percent range for individual containers, the radiological mass in each container was summed. The mass of each individual radionuclide in a container was divided by the total radiological mass for that container and converted to a percentage. The minimum and maximum results are listed as “Nuclide Weight% Range for Individual Containers.” Since the majority of the radionuclides were reported in only a few containers, the “Nuclide Weight% Range for Individual Containers” includes only those containers where the radionuclide was reported. The same process was applied to determine “Total Nuclide Curie%” and “Nuclide Curie% Range for Individual Containers.” As shown in Table 5-4, Pu-239 and Cm-246 are the two most prevalent radionuclides by mass, and Cm-244 and Sr-90 are the two most prevalent radionuclides by activity.

Table 5-4. Waste Stream OR-REDC-RH-HET Radiological Characterization

Nuclide	#[1]	Total Nuclide Weight%[2]	Total Nuclide Curie%[3]	Nuclide Weight% Range for Individual Containers[4]	Nuclide Curie% Range for Individual Containers[5]	Expected Present (Yes/No)
WIPP Required Radionuclides						
Am-241	19	2.38%	0.41%	0.13% - 91.8%	0.01% - 20.0%	Yes
Pu-238	17	0.33%	0.28%	0.31% - 2.17%	0.17% - 0.47%	Yes
Pu-239	18	**21.29%**	0.07%	1.94% - 99.9%	0.01% - 86.1%	Yes
Pu-240	13	16.54%	0.19%	25.1% - 54.4%	0.36% - 0.37%	Yes
Pu-242	15	10.55%	0.00%	1.56% - 21.1%	Trace - 0.01%	Yes
U-233	Not Reported					No
U-234	Not Reported					Yes[6]
U-238	Not Reported					Yes
Cs-137	34	0.39%	1.71%	0.30% - 69.9%	0.79% - 49.2%	Yes
Sr-90	29	1.54%	10.53%	1.42% - 36.6%	13.33% - 47.7%	Yes
Additional Radionuclides						
Co-60	14	Trace	0.01%	Trace - Trace	0.02% - 0.02%	Yes
Nb-95	3	Trace	0.04%	Trace - Trace	0.21% - 5.22%	Yes
Zr-95	15	Trace	0.16%	Trace - 0.01%	0.22% - 5.38%	Yes
Ru-103	15	Trace	0.29%	Trace - 0.01%	0.42% - 12.9%	Yes
Ru-106	16	0.01%	1.31%	0.01% - 0.24%	1.88% - 23.6%	Yes
Ag-110m	15	Trace	0.02%	Trace - Trace	0.03% - 0.42%	Yes
Sb-125	14	Trace	0.07%	Trace - Trace	0.11% - 0.11%	Yes
Cs-134	15	Trace	0.11%	Trace - 0.03%	0.16% - 1.25%	Yes
Ce-141	15	Trace	0.60%	Trace - 0.01%	0.89% - 7.95%	Yes
Ce-144	15	Trace	0.21%	Trace - 0.20%	0.29% - 18.6%	Yes
Eu-152	14	Trace	0.04%	Trace - 0.01%	0.06% - 0.06%	Yes
Eu-154	14	0.02%	0.20%	0.01% - 0.02%	0.30% - 0.30%	Yes
Eu-155	15	0.01%	0.16%	0.01% - 0.33%	0.22% - 1.87%	Yes
U-235	Not Reported					Yes[6]
U-236	Not Reported					Yes[6]
Np-239	14	Trace	0.05%	0.00% - Trace	0.08% - 0.08%	Yes
Pu-241	15	0.65%	3.38%	0.14% - 0.90%	0.44% - 5.07%	Yes
Am-243	15	2.68%	0.03%	2.52% - 6.83%	0.04% - 0.04%	Yes
Cm-242	15	Trace	0.21%	Trace - Trace	0.07% - 0.31%	Yes
Cm-244	263	18.40%	74.81%	0.01% - 100%	0.08% - 100%	Yes
Cm-246	15	**20.96%**	0.32%	15.2% - 28.7%	0.14% - 0.49%	Yes
Cm-248	15	4.06%	Trace	2.94% - 5.58%	Trace - Trace	Yes
Cf-249	15	Trace	Trace	Trace - 0.01%	Trace - Trace	Yes
Cf-250	15	Trace	0.02%	Trace - 0.01%	0.03% - 0.03%	Yes
Cf-251	15	Trace	Trace	Trace - Trace	Trace - Trace	Yes
Cf-252	193	0.18%	4.77%	Trace - 100%	Trace - 100%	Yes

1. # is the number of RH containers where the radionuclide was reported. All 272 containers in this waste stream have at least one radionuclide reported.
2. This listing indicates the total weight percent of each radionuclide over the entire Waste Stream.
3. This listing indicates the total activity (curie) percent of each radionuclide over the entire Waste Stream.
4. This listing is the weight percent range of each radionuclide on a container-by-container basis. Only containers where the radionuclide was reported are included in the range.
5. This listing is the curie percent range of each radionuclide on a container-by-container basis. Only containers where the radionuclide was reported are included in the range.
6. U-234, U-U235, U-236, and U-238 were not reported in any waste container, but are expected present due to the SETF fuel processing work performed in waste generating areas.

"Trace" indicates less than 0.01 weight percent or activity percent for that radionuclide.

5.4.4 Polychlorinated Biphenyls

Based on a review of the AK record, incandescent bulbs, mercury-vapor bulbs, vacuum pumps, and lighting fixtures (bases) were identified in the CH container documentation, however items potentially containing polychlorinated biphenyl (PCB) compounds were not specifically identified (capacitors, ballasts, etc.). No other potential sources for PCBs were identified in the AK record for this stream; however the ORNL waste management practices described in the AK record did not historically identify PCB materials as prohibited items or special management of these materials in the REDC. Additionally, interviews with ORNL waste management personnel have identified that vacuum pumps and capacitors containing PCB liquids could potentially be present in ORNL waste containers. If the waste is found to contain fluorescent light ballasts or other potential PCB-containing items during repackaging, these items will be managed in accordance with CCP Waste Certification Program (References 5, 12, 15, C307, C308, M024, M100, P240, and P263).

5.4.5 Prohibited Items

According to TRU waste packaging procedures for Building 7920, liquids are removed from the waste or absorbed onto a solid such as vermiculite, and semi-liquid waste forms such as sludges and resins are immobilized (e.g., grouted). Procedures also required the emptying and puncturing of spray cans, and indicate pyrophorics and explosives were not used in established glovebox or hot cell operations. These materials have been prohibited by procedure since at least 1988 (References P240, P263).

Since this waste stream dates back earlier than 1988, it is suspected that un-punctured spray cans may be present in some of the storage containers. It is unlikely that TRU waste from Building 7920 generated prior to 1988 contains process liquids because waste liquids were disposed into the process drain or intermediate level waste drains for treatment or storage. However, small amounts of residual liquids are expected in internal containers (e.g., sample bottles and aerosol cans) (References P161, P279, U011, P125).

A review of UCN-2109 forms for waste generated since the mid-1990s indicate that prohibited items, including liquids, pyrophorics, explosives, and sealed container greater than 4 liters are not present (References M005 and M100). However, as described in

Section 5.5 below, sealed containers greater than four liters will be present in waste generated before this time frame. The following steps are taken to assure that prohibited items are not included in the RH drums during TWPC repackaging operations (Reference U046):

- Residual liquids are removed or immobilized.
- Un-punctured aerosol cans are punctured or removed from the waste stream.
- All internal containers (buckets, cans, and bags) are opened and all layers of confinement breached.

Certified VE is performed to ensure the waste does not contain prohibited items in accordance with the WCPIP and WIPP-WAP (References 1 and 2).

The WIPP LWA bans the disposal of spent nuclear fuel (SNF) and high-level waste (HLW), as defined by the NWPA (Reference 10). According to the NWPA, "spent nuclear fuel" is defined as "fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated by reprocessing." "High-level waste" is defined by the NWPA as "the highly radioactive material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations, and other highly radioactive material that the Commission, consistent with existing law, determines by rule requires permanent isolation."

DOE states that SNF includes spent driver elements and/or irradiated target elements that contain transuranium elements. Under this guidance, the irradiated HFIR targets, SETF fuel segments, and Mark-42 assemblies that have been processed in the Building 7920 hot cells would be considered SNF. However, these materials are processed (i.e., dissolved) and are not included in this RH TRU waste stream (References P161, P279, U011, U044). Therefore, this waste stream does not contain SNF (References 9 and 10).

DOE allows further evaluation of waste generated from nuclear fuel reprocessing activities, as described in the *Implementation Guide for Use with DOE M 435.1-1* (Reference I043). This guidance document states "Waste resulting from reprocessing SNF that is determined to be incidental to reprocessing is not HLW, and shall be managed under DOE regulatory authority in accordance with the requirements for transuranic waste or low-level waste, as appropriate." DOE allows two ways to determine if waste from reprocessing SNF is "waste incidental to reprocessing" (WIR); the Citation Process and the Evaluation Process. The following wastes are included in the Citation Process (References I043, U044):

- Contaminated job wastes, a general category of wastes that are generated during HLW transfer, pretreatment, treatment, storage and disposal activities. Included is protective clothing, personal protective equipment, work tools, ventilation filter media, and other job-related materials necessary to complete HLW management activities

- Sample media (e.g., sampling vials, crucibles, other hardware)

- Decontamination media and decontamination solutions (e.g., swabs or other decontamination work-related materials)

- Laboratory clothing, tools, and equipment

The Foster Wheeler TRU Waste Project has evaluated the TRU waste from the Building 7920 hot cell cubicles (described in Section 5.4.1) and determined that they correspond to the waste description used for the Citation Process. Therefore, the waste generated from nuclear fuel reprocessing in Building 7920 is not considered HLW, but rather TRU waste (References I022, I023, I043, U044).

5.5 Waste Packaging

This section describes the packaging configuration for the current inventory of RH waste originating from the REDC. This waste will be repackaged in the TWCP and loaded into unlined, vented 55-gallon drums (no layers of confinement in drums). As containers of REDC debris waste are generated during repackaging in the TWPC, the container-specific documentation will be reviewed to assure that each container included in Waste Stream OR-REDC-RH-HET meets the WIPP-WAP and the WCPIP waste stream definitions of waste material generated from a single process or from an activity that is similar in material, physical form, hazardous constituents, and radiological constituents (References 1, 2, M100, U038).

Concrete Casks

As described in Section 4.2.2, most of the waste generated prior to 1978 would have been placed into concrete casks called “floor casks.” The majority of the floor casks have 4.5 inch thick side walls because the lower activity materials typically required much less shielding. In addition to the concrete casks with 4.5-inch thick walls, waste from REDC operations have been loaded in casks providing additional shielding with 6- and 12-inch thick concrete walls. The external dimension for all three of these cylindrical casks is approximately 7.5 feet tall by 4.5 feet in diameter. The waste materials loaded into the casks are packaged in a variety of configurations utilizing the following packaging materials (References P125, P161, U011, U038):

- 1-gallon metal paint cans (some lead-lined)
- Polyethylene bags, liners, bottles, and draw-string bags
- Cardboard ice cream cartons
- 3.4-gallon polyethylene plastic buckets (sealed and unsealed)
- 2-gallon Bain-Marie polyethylene plastic containers
- 5-gallon metal lard cans
- 10-gallon rigid-cardboard fiber drum

In the hot cell cubicles, waste items are typically placed into small containers (e.g., plastic buckets or metal cans). Larger waste items are cut up to fit into the buckets. Larger equipment, such as processing racks, charcoal filter beds, and Hopcalite organic filters traps are directly loaded into the casks. Typically, the racks have been packaged in several layers of polyethylene bags then placed directly into the concrete cask (References M005, M100, C302, P125, P161).

Concrete casks of TRU waste are loaded in a solid waste loading station located in the LAA. Waste to be loaded into the cask from the transfer area is generally transferred to the loading station in sealed plastic buckets and unsealed plastic bags. Larger equipment is transferred to the loading station via the equipment transfer case for disposal. The incoming empty cask is prepared by placing a polyvinyl chloride plastic bag liner (0.01 inch) into the cask. Plywood expanders are placed inside the bag (a circular disk at the bottom and a circular ring at the top), and the bag is then secured to one of the waste station roof plugs. Two roof plugs are available for loading the waste packages. One is used when the waste is to be transferred using the equipment transfer case, the other is used when plastic buckets are loaded. After the cask is loaded, the plastic bag is collapsed and an electrically-driven turntable inside the waste station rotates the cask, twisting the top of the bag. The bag is then cut and sealed with a hot-knife sealer. The cask lid is then installed, sealed with roofing pitch, and secured using two steel tapes, attached around the outside of the cask. The cask lid may also be attached to the cask body by three anchor bolts aligned with holes drilled in the cask lid. All the concrete casks are overpacked into carbon steel RH cask prior to processing in the TWPC. (References C302, U011, U046).

55-Gallon Drums

Several inner packaging configurations may be present in the stored waste inventory in 55-gallon drums, including plastic bags, small cardboard ice-cream cartons, gallon paint cans, metal lard cans, and plastic buckets (References C098, C103, C148, P093, P263, U046). The one gallon metal cans are slip-lid cans. Tape is wrapped around the sealing surface of the lid, but the lid has a hole in it (References C148, C302, P240). The plastic bucket lids were heat sealed until the late-1990s; however, a hole was punctured in the lid starting in the mid-1990s. Beginning in the late-1990s, the bucket lids have been snapped in place, not heat-sealed (References C098, P161, P240). The buckets that are not heat-sealed are placed in plastic bags and sealed with tape (References C148, P093). Waste placed into plastic bags may be heat-sealed or sealed with tape, but heat-sealing was the preferred method for waste removed from a glovebox (References P240, P263). The drums are lined with a single poly drum liner bag; rigid liners have not been used. Drum liners may or may not be sealed with tape (References C148, P263).

B-88 Box

Wooden boxes were typically used to discard unusually shaped waste materials (e.g., gloveboxes, feed tanks, etc.) that could not be packaged directly into waste drums or concrete casks (Reference P125).

6.0 QUALIFICATION OF AK INFORMATION

As stated in CCP-PO-002, *CCP Transuranic Waste Certification Plan,* (Reference 15), this AK Summary Report provides a description of the characterization of this RH waste stream. CCP-AK-ORNL-502, *CCP RH TRU Waste Certification Plan for 40 CFR 194 Compliance and Confirmation Test Plans for ORNL REDC RH Waste* (Reference 16), describes how each DQO and QAO is met along with the rationale for selection of the AK qualification methods used. As required by the appropriate section of the WCPIP (Reference 1), the description of Waste Stream OR-REDC-RH-HET is provided in Sections 4.0 and 5.0. The description of the confirmatory testing process, the percentage of containers that are subjected to the process, a discussion of why the process is considered representative of the waste stream, and quantitative acceptance criteria is presented in CCP-AK-ORNL-502 (Reference 16).

The CCP intends to use a combination of methods to qualify the AK information associated with the ORNL REDC waste stream because this will make the best use of the information available (such as existing sampling and analytical data). Table 6-1, Waste Stream OR-REDC-RH-HET DQO Determination Summary lists the DQOs to be addressed using AK associated with Waste Stream OR-REDC-RH-HET relating to the defense waste, radiological, and physical waste stream determinations. The location (page number, section, etc.) of the relevant information is identified in the AK Source Document Summary forms for each AK source identified in Table 6-1.

Table 6-1. Waste Stream OR-REDC-RH-HET DQO Determination Summary

DQO Determinations	Summary of AK	AK Sources
Defense Waste	As described in the defense waste justification in Section 4.1.4, a formal defense determination has been approved by CBFO for TRU waste originating from the operations in the REDC complex (including Building 7930). This determination concluded that the wastes generated by operations in the REDC are irretrievably commingled with materials from atomic energy defense activities associated with naval reactors development; nuclear materials production; nuclear waste and by-products management; and research and development activities. **Qualification Method**: Not Applicable	I044, M023, P258, P281, U038, U039
TRU Waste	As described in the radiological characterization in Section 5.4.3, non-TRU radionuclides Cm-244 and Cf-252 were the only radionuclides reported by the waste generator for the majority waste containers, and no process has been implemented to quantify additional TRU radionuclides known to be present in those waste containers. Additionally, all, or nearly all of the existing inventory of waste currently categorized by the site as RH TRU waste will be extracted from storage containers, visually inspected, and segregated based on the dose rate of incoming waste material at the time of repackaging. The final radiological characterization of resulting repackaged RH waste will be assessed as described in CCP-AK-ORNL-501 (Reference 17). **Qualification Method**: Dose to Curie Method described in CCP-AK-ORNL-502, *CCP RH TRU Waste Certification Plan for 40 CFR 194 Compliance and Confirmation Test Plans for ORNL REDC RH Waste* (Reference 16).	M024, M100, P058, P240, U038, U045, U049 CCP-AK-ORNL-501 (Reference 17)
RH Waste	As described in the radiological characterization in Section 5.4.3, waste storage casks were monitored for beta-gamma radiation and neutron radiation, however, these measurement represent the dose rate external to the Goethite high density concrete storage casks and are not relevant to this DQO. Additionally, all, or nearly all of the existing inventory of waste currently categorized by the site as RH TRU waste will be extracted from storage containers, visually inspected, and segregated based on the dose rate of incoming waste materials at the time of repackaging. The final radiological characterization of resulting repackaged RH waste will be assessed as described in CCP-AK-ORNL-501 (Reference 17). **Qualification Method**: Dose rate measurement of each container as described in CCP-AK-ORNL-502 (Reference 16).	M024, M100, P058, P240, U038, U045, U049 CCP-AK-ORNL-501 (Reference 17)
Activity	This DQO is specific to payload containers and will not be assessed until the final payload configuration has been established.	Not Assessed
WIPP 10 Required Radionuclides	As described in the radiological characterization in Section 5.4.3, Cm-244 and Cf-252 were the only radionuclides reported by the waste generator for the majority waste containers, and no process has been implemented to quantify additional radionuclides known to be present in those waste containers. Additionally, all, or nearly all of the existing inventory of waste currently categorized by the site as RH TRU waste will be extracted from storage containers, visually inspected, and segregated based on the dose rate of incoming waste material at the time of repackaging. The final radiological characterization of resulting repackaged RH waste will be assessed as described in CCP-AK-ORNL-501 (Reference 17). **Qualification Method**: Dose-to-Curie Method described in CCP-AK-ORNL-502 (Reference 16).	M024, M100, P058, P240, U038, U045, U049 CCP-AK-ORNL-501 (Reference 17)

DQO Determinations	Summary of AK	AK Sources
Physical Form	As described in Section 5.4.1, Waste Stream OR-REDC-RH-HET consists primarily of organic and inorganic debris meeting the WCPIP (Reference 1) definition for Summary Category Group S5000. **Qualification Method**: 100% VE will be performed during repackaging to verify the physical form of the waste as discussed in CCP-AK-ORNL-502 (Reference 16).	M005, M024, M100, P125, P161, U011 CCP-AK-ORNL-502 (Reference 16)
Residual Liquids	Prohibited quantities of residual liquids will be immobilized or removed during the packaging of Waste Stream OR-REDC-RH-HET **Qualification Method**: 100% VE will be performed during repackaging to verify the absence of prohibited liquids as discussed in CCP-AK-ORNL-502 (Reference 16).	U046 CCP-AK-ORNL-502 (Reference 16)

7.0 CONTAINER SPECIFIC INFORMATION

In accordance with procedure CCP-TP-005 (Reference 3), a CCP Waste Containers List (Attachment 8 of the procedure) is completed and maintained as a quality record for waste tracking purposes. Information tracked includes container identification number, waste stream number, and the closure date for each container.

8.0 REFERENCE INFORMATION

1. DOE/WIPP-02-3214, *Remote-Handled TRU Waste Characterization Program Implementation Plan*, Carlsbad, New Mexico, U.S. DOE Carlsbad Field Office.

2. *Waste Isolation Pilot Plant Hazardous Waste Facility Permit, Waste Analysis Plan,* NM4890139088-TSDF, Santa Fe, New Mexico, New Mexico Environment Department.

3. CCP-TP-005, *CCP Acceptable Knowledge Documentation*, Carlsbad, New Mexico, Washington TRU Solutions, LLC.

4. DOE/TRU-2006-3344, *Transuranic Waste Baseline Inventory Report – 2004,* Carlsbad, New Mexico, U.S. DOE Carlsbad Field Office.

5. CCP-PO-001, *CCP Transuranic Waste Characterization Quality Assurance Project Plan*, Carlsbad, New Mexico, Washington TRU Solutions, LLC.

6. Title 40 CFR Part 191, *Radiation Protection Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes*, Washington, D.C., U.S. EPA, December 20, 1993.

7. Title 40 CFR Part 194, *Criteria for the Certification and Re-Certification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations*, Washington, D.C., U.S. EPA, February 9, 1996.

8. *Criteria for the Certification and Re-Certification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations: Certification Decision*, Washington, D.C., U.S. EPA, May 18, 1998.

9. Public Law 102-579, *WIPP Land Withdrawal Act*, October 30, 1992 as amended by Public Law 104-201, September 23, 1996.

10. 42 U.S.C. 10141, *Nuclear Waste Policy Act of 1982*, U.S. Congress.

11. Title 40 CFR Part 261, *Identification and Listing of Hazardous Waste*, Washington, D.C., U.S. EPA, July 1, 2007.

12. CCP-AK-ORNL-002, *Central Characterization Project Acceptable Knowledge Summary Report for Oak Ridge National Laboratory Radiochemical Engineering Development Center Contact-Handled Transuranic Waste, Waste Stream OR-REDC-CH-HET,* Carlsbad, New Mexico, Washington TRU Solutions, LLC.

13. DOE/LLW-217, *DOE Waste Treatability Group Guidance*, Idaho Falls, Idaho, INEL-Lockheed Idaho Technologies.

14. McCoy and Associates, Inc. 2002. *McCoy's RCRA Unraveled*. Second Edition.

15. CCP-PO-002, *CCP Transuranic Waste Certification Plan*, Carlsbad, New Mexico, Washington TRU Solutions, LLC.

16. CCP-AK-ORNL-502, *Central Characterization Program RH TRU Waste Certification Plan for 40 CFR 194 Compliance and Confirmation Test Plans for ORNL REDC RH Waste, Waste Streams: OR-REDC-RH-HET.001, OR-REDC-RH-HET.002, and OR-REDC-RH-HET.002,* Carlsbad, New Mexico, Washington TRU Solutions, LLC.

17. CCP-AK-ORNL-501, *Central Characterization Project Remote-Handled Transuranic Radiological Characterization Technical Report for Remote-Handled Transuranic Waste From the Mark-42 Time Period from Oak Ridge National Laboratory Radiochemical Engineering Development Center*, Carlsbad, New Mexico, Washington TRU Solutions, LLC.

9.0 AK SOURCE DOCUMENTS

Document Number	Title	Document Number	Date
C026	Memo to J. T. Hargrove re: Description of the Item 10PUPROD2	NA	10/09/1986
C027	Memo to J. T. Hargrove re: Description of the Item 10PUPROD3	NA	10/09/1986
C028	Memo to J. T. Hargrove re: Description of the Item 10PUPROD4	NA	10/09/1986
C029	Memo to Davis jA. Reed, 4500-N, MS-6244 re: Composition of Curium-II Curium	NA	6/27/1996
C033	Email to Trabalka re: Source of Pu-238(?) from Lab 208 Cleanout in 7920 (mid – 1983)	NA	4/14/1999
C038	Memo to W. S. Aaron re: REDC Shipment No. 1418: ~ 1.55 g of 244Cm (MC-12304)	NA	3/23/1989
C044	Memo to J. T. Hargrove re: Description of Item 10PUPROD1	NA	4/25/1986
C053	Email to JW Moore re: Process Knowledge – [1960s] Target Leak	NA	1/06/2005
C078	Memo to Bryan Roy transmitting Historical Survey – RCRA Information	NA	4/04/2005
C098	Interview with Wayne Evans: Waste management practices at REDC (Buildings 7920 and 7930)	NA	5/09/2005
C101	Memo re: Use of ORNL/TM-7688 as Reference for Process Knowledge	NA	8/29/1996
C102	Memo to distribution re: Results of Testing of HEPA Filters in Waste Packets	NA	10/29/1993
C103	Memo to distribution re: Seal out buckets used at REDC	NA	7/17/1995
C148	Interview of REDC Personnel	NA	6/20/2007 & 6/21/2007
C302	ORNL Comments on CCP-AK-ORNL-500, Rev. 0, Draft C	CCP-AK-ORNL-500, Rev. 0, Draft C	3/5/2008
C306	Email from Don Coffey to Steve Schafer – GNEP Information	NA	3/14/2008
C307	Interview of Walt Bond. Subject: Processes and Waste in Building 3508 at ORNL.	NA	2/21/2008
C308	Interview of Jason Taylor. Subject: PCB Management at ORNL.	NA	4/8/2008
DR005	EPA Hazardous Waste Number Discrepancies	NA	TBD
I002	REDC Programs Through the Years	NA	2/25/1998
I022	DOE Order 435.1, Radioactive Waste Management (4.50)	DOE O 435.1	7/9/1999
I023	U.S. Department of Energy Radioactive Waste Management Manual	DOE M 435.1-1 Chg. 1	6/19/2001
I043	Implementation Guide for Use With DOE M 435.1-1	DOE G 435.1-1	7/9/1999
I044	Re-Evaluation of the Radiological Data for Legacy CH TRU Waste from REDC Building 7920	CAN-02MVSWSF-0014, Rev. 0	4/14/2005
M001	Review by Charles Roberts of REDC Maintenance and Operational Log Books	NA	1970-1980
M002	Radioactive Operations Committee Review of the Transuranium Processing Plant (TRU), Building 7920	ORNL/CF-85/49	2/22/1985
M005	UCN-2109 Forms and Related Container Paperwork.	NA	Various
M012	EM Waste Database Query	NA	Not Dated
M015	Process Knowledge (PK) Documentation for Building 7920/X-10	RES-7920-000-002	6/08/1995
M022	MSDS for REDC	NA	Various

Document Number	Title	Document Number	Date
M023	REDC Defense Determination	NA	4/25/05
M024	RH EM Waste Database Query	NA	Received 10/4/07
M100	RH UCN-2109 Forms and Related Container Paperwork.	NA	Various
P013	Solvent Extraction Studies with Intermediate-Burnup Fast Flux Test Facility Fuel in the Solvent Extraction Test Facility	ORNL/TM-9514	4/1986
P014	Inventory of ORNL Remedial Action Sites: 11. Research Laboratories	RAP 86-52	6/30/1986
P016	Solvent Extraction Studies with High-Burnup Fast Flux Test Facility Fuel in the Solvent Extraction Test Facility	ORNL/TM-9993	10/1986
P020	Chemical Technology Division Annual Progress Report Period Ending March 31, 1979	ORNL-5542	11/1979
P021	Chemical Technology Division Progress Report for the Period April 1, 1981 to March 31, 1983	ORNL-5933	9/1983
P030	Chemical Technology Division Transuranium Processing Plant Semiannual Report of Production, Status, and Plans for Period Ending June 30, 1968	ORNL-4376	4/1969
P031	Transuranium Processing Plant Semiannual Report of Production, Status, and Plans for period ending June 30, 1969	ORNL-4447	3/1970
P032	Chemical Technology Division Transuranium Processing Plant Semiannual Report of Production, Status, and Plans for Period Ending December 31, 1971	ORNL-4767	5/1972
P033	Separation of Am, Cm, and Pu from Irradiated Targets	Unavailable	NA
P037	Chemical Technology Division Annual Progress Report for Period Ending May 31, 1968	ORNL-4272	9/1968
P047	The Management of Radioactive Waste at the Oak Ridge National Laboratory: A Technical Review	DOE/DP/48010-T1 (DE85016347)	1985
P058	Statistical Analysis of Radiochemical Measurements of TRU Radionuclides in REDC Waste	ORNL/TM-13298	10/1996
P059	Transuranium Processing Plant Semiannual Report of Production, Status, and Plans for Period Ending June 30, 1973	ORNL-4921, UC-4-Chemistry	3/1974
P071	A Brief History of the Research Reactors Division of Oak Ridge National Laboratory	ORNUM-2342	10/15/1993
P077	Transuranium Processing Plant Report of Production, Status, and Plans for Period October 1, 1978 to September 30, 1980	ORNL-5596	8/1981
P078	Transuranium Processing Plant Semiannual Report of Production, Status, and Plans for Period Ending June 30, 1977	ORNL-5358	12/1977
P079	Transuranium Processing Plant Semiannual Report of Production, Status, and Plans for Period Ending December 31, 1972	ORNL-4884	8/1973
P081	Architectural/Historical Assessment of the Oak Ridge National Laboratory, Oak Ridge Reservation, Anderson and Roane Counties, Tennessee	ORNL/M-3244	1/1994
P088	Transuranium Processing Plant Semiannual Report of Production, Status, and Plans for Period Ending June 30, 1971	ORNL-4718	12/1971
P093	Characterization of ORNL Transuranic Waste from the Measurement of Fission and Activation Products	NA	5/1997
P096	Chemical Technology Division Annual Progress Report, Period Ending March 31, 1974	ORNL-4966	8/1974
P097	Chemical Technology Division Annual Progress Report, Period Ending March 31, 1978	ORNL-5383	3/31/1978
P098	Chemical Technology Division Annual Progress Report, for the Period April 1, 1979 to March 31, 1971	ORNL-5757	11/1981
P105	Metals and Ceramics Division Annual Progress Report for Period Ending June 30, 1973. (4.13.113)	ORNL-4870	10/1973

Document Number	Title	Document Number	Date
P110	Chemical Technology Division Annual Progress Report for Period Ending March 31, 1972	ORNL-4794	8/1972
P113	Progress in Nuclear Energy, Series III, Process Chemistry, Volume 4; Section: 7.2 Processing Methods For The Recovery Of Transplutonium Elements	NA	1970
P114	Chemical Technology Division Annual Progress Report for Period Ending March 31, 1971	ORNL-4682	7/1971
P115	Chemical Technology Division Annual Progress Report for Period Ending May 31, 1966	ORNL-3945	9/1966
P118	Metals and Ceramics Division Annual Progress Report For Period Ending June 30, 1971 (4.13.111)	ORNL-4770	9/1971
P121	Solvent Extraction Studies of 10% TBP Flowsheets in the Solvent Extraction Test Facility Using Irradiated Fuel from the Fast Flux Test Facility	ORNL/TM-10266	3/1988
P123	Solvent Extraction Studies of Coprocessing Flowsheets – Results from Campaign 6 of the Solvent Extraction Test Facility (SETF)	ORNL/TM-9961, Rev. 0	11/1986
P125	Remote-Handled Transuranic Solid Waste Characterization Study: Oak Ridge National Laboratory	ORNL/TM-11050	6/1989
P130	Solvent Extraction Studies of Coprocessing Flowsheets – Results from Campaign 5 of the Solvent Extraction Test Facility (SETF)	ORNL/TM-8598	11/1983
P131	Transuranium Processing Plant Semiannual Report of Production, Status, and Plans for Period Ending June 30, 1970	ORNL 4588	1/1971
P136	Chemical Technology Division Annual Progress Report for Period Ending May 31, 1967	ORNL-4145	10/1967
P145	Chemical Technology Division Annual Progress Report for Period Ending May 31, 1970	ORNL-4572	10/1970
P151	Chemical Technology Division Annual Progress Report for Period Ending May 31, 1973	ORNL-4883, UC-10	8/1973
P153	Chemical Technology Division Annual Progress Report; Period Ending March 31, 1975	ORNL-5050, UC-10	10/1975
P155	Application of the TRUEX Process to highly Irradiated Targets	ORNL/TM-12784	3/1995
P156	Transuranium Processing Plant Semiannual Report Of Production, Status, and Plans For Period Ending June 30, 1976	ORNL-5216	2/1977
P157	Chemical Technology Division, Transuranium Processing Plant Report of Production, Status, and Plans for the Period January 1, 1978 – September 30, 1978	ORNL-5531	6/1979
P160	Chemical Technology Division Annual Progress Report; Period Ending March 31, 1977	ORNL-5295 UC-10, Rev. 1	10/1977
P161	Safety Analysis Report Radiochemical Engineering Development Center Building 7920	SAR/7920-CTD/01	3/14/2001
P164	Chemical Technology Division Annual Progress Report; Period Ending March 31, 1976	ORNL-5172 UC-10	9/1976
P173	Solvent Extraction Studies of Coprocessing Flowsheets – Results from Campaigns 3 and 4 of the Solvent Extraction Test Facility (SETF)	ORNL/TM-7991, Dist. Category UC-86	5/1982
P176	Transuranium Processing Plant Semiannual Report of Production, Status, and Plans for Period October 1, 1980 to March 31, 1983	ORNL 5992, Dist. Category UC-4	10/1984
P180	Metals and Ceramics Division Annual Progress Report for Period Ending June 30, 1970 (4.13.110)	ORNL-4570	10/1970
P181	Metals and Ceramics Division Annual Progress Report Period Ending June 30, 1972 (4.13.112)	ORNL-4820	9/1972
P185	Measurements of Fission and Activation Products for Oak Ridge National Laboratory Transuranic Waste Characterization	ORNL/TM-13292	6/1997
P197	Transuranium Processing Plant Semiannual Report of Production, Status, and Plans for Period Ending December 31, 1968	ORNL 4428	11/1969

Document Number	Title	Document Number	Date
P198	Transuranium Processing Plant Semiannual Report of Production, Status, and Plans for Period Ending December 31, 1969	ORNL 4540	6/1970
P199	Transuranium Processing Plant Semiannual Report of Production, Status, and Plans for Period Ending December 31, 1970	ORNL 4666	6/1971
P201	Current and Projected Liquid Low-Level Waste Generation at ORNL	ORNL/TM-13513	3/1998
P204	Transuranium Processing Plant Semiannual Report of Production, Status, and Plans for Period Ending June 30, 1972	ORNL 4833	1/1973
P205	Transuranium Processing Plant Semiannual Report of Production, Status, and Plans for Period Ending December 31, 1974	ORNL 5034, UC-4-Chemistry	7/1975
P206	Transuranium Processing Plant Semiannual Report of Production, Status, and Plans for Period Ending June 30, 1975	ORNL 5084, UC-4-Chemistry	3/1976
P207	Transuranium Processing Plant Semiannual Report of Production, Status, and Plans for Period Ending December 31, 1975	ORNL 5146, Dist. Category UC-4	10/1976
P208	Transuranium Processing Plant Semiannual Report of Production, Status, and Plans for Period Ending December 31, 1976	ORNL 5305 Dist. Category UC-4	10/1977
P209	Transuranium Processing Plant Semiannual Report of Production, Status, and Plans for Period Ending December 31, 1977	ORNL 5415, Distribution Category UC-4	08/1978
P210	Transuranium Processing Plant Semiannual Report of Production, Status, and Plans for Period Ending December 31, 1973	ORNL 4965, UC-4-Chemistry	11/1974
P211	Transuranium Processing Plant Semiannual Report of Production, Status, and Plans for Period Ending June 30, 1974	ORNL 4991, UC-4-Chemistry	2/1975
P216	The ORNL Chemical Technology Division 1950 - 1994	ORNL/M-2733, Rev. 1	10/1994
P222	RCRA Facilities Assessment (RFA) – Oak Ridge National Laboratory	ORNL/RAP-12/V1	3/1987
P223	Chemical Technology Division Annual Progress Report for Period Ending May 31, 1969	ORNL-4422	10/1969
P229	Solvent Extraction Studies of Coprocessing Flowsheets – Results from Campaigns 1 and 2 of the Solvent Extraction Test Facility (SETF)	ORNL/TM-7080, Dist. Category UC-86	7/1982
P239	TRU Waste Management –Past, Present, and Future at Oak Ridge National Laboratory	NA	3/01/2001
P240	Packaging and Disposition of Contact-Handled Transuranic Waste At the Radiochemical Engineering Development Center	REDC FO/WH 5100, Rev. 1 & 2	1/26/1995; 7/15/1998
P241	Oak Ridge National Laboratory Contact-Handled Transuranic Waste Certification Program Plan	ORNL/TM-10322/2, Rev. 2	8/1990
P242	Oak Ridge National Laboratory Contact-Handled Transuranic Waste Certification Program Plan	ORNL/TM-10322/R3, Rev. 3	6/1992
P244	Certification Document for Newly Generated Contact-Handled Transuranic Waste	ORNL-5985/R1, Rev. 1	5/1984
P245	Chemical Process Engineering in the Transuanium Processing Plant	CONF76110110	1976
P251	Box Breakdown Area Operations	CH-P-OP-003, Rev. 7	3/13/2007
P252	Glove Box Operations	CH-P-OP-004, Rev. 8	3/13/2007
P253	Drum Bag In/Bag Out and Glove Ports	CH-P-OP-011, Rev. 10	5/02/2007
P254	Contact Hanadled Waste Repackaging (Rewritten)	CH-P-OP-013, Rev. 6	4/30/2007
P255	Contact handled Waste Acceptance Criteria	T-CH-FW-X-AD-001, Rev. 5	10/19/2006
P256	TRU/Alpha Low Level Waste (LLW) Treatment Project Documented Safety Analysis	T-CM-FW-R-AD-001, Rev. 13	3/01/2007

Document Number	Title	Document Number	Date
P257	Waste Treatment at the Radiochemical Engineering Development Center	ORNL/CP-95432	10/20/1997
P258	Production, Distribution, and Applications of Californium-252 Neutron Sources	ORNL-CP-102600	10/03/1999
P259	Chemical Technology Division Segregation of Metals-Containing Wastewater by pH	ORNL/TM-11406	10/1990
P260	Radioactive Operations Committee Review of the Transuranium Processing Facility, Building 7920, and the Thorium-Uranium Recycle Facility Building 7930, March 10, 1986	ORNL/CF-86-265	8/13/1986
P261	Radioactive Operations Committee Review of the Transuranium Processing Plant (TPP), Building 7920	ORNL-CF-87/218	7/20/1987
P262	Radioactive Operations Committee Review of the Transuranium Processing Plant (TPP), Building 7920	ORNL-CF-88/225	8/01/1988
P263	TRU Operating Manual and Supporting Documentation	NA	10/10/1980
P272	Oak Ridge National Laboratory Waste Management Plan	ORNL/TM-11433, Rev. 1, 2, & 3	12/1991; 12/1992; 12/1993
P275	Radiochemical Engineering Development Center (REDC) Radioactive Solid Low-Level Waste (SLLW) Certification Procedure	REDC FO/WH 4010, Rev. 0	12/07/1994
P276	Determination of H2 Diffusion Rates through Various Closures on TRU Waste Bag-Out Bags	LA-13616-MS	6/1999
P277	Project Plan for the Evaluation of REDC Waste for TRU-Waste Radionuclides	ORNL/TM-13087	9/1996
P279	Safety Analysis for the Transuranium Processing Plant, Building 7920	ORNL-3954	4/1968
P280	Summary of the Campaign During July 1968 to Process Fourteen Irradiated HFIR Targets in the Transuranium Processing Plant	ORNL-TM-2434	12/1969
P281	Californium-252: A Remarkable Versatile Radioisotope	ORNL/TM-12706	10/10/1995
P282	Building 7920 Analytical Chemistry Procedures	Various	Various
P951	Advanced Fuel Cycle Initiative – AFCI Semiannual Review	NA	9/13/2007
P952	Global Nuclear Energy Partnership Technology Development Plan	GNEP-TECH-TR-PP-2007-00020, Rev. 0	7/25/2007
P953	Phased Construction Completion Report for the 22 TRU Trench Waste Retrieval Project at Oak Ridge National Laboratory, Oak Ridge, Tennessee	DOE/OR/01-2305&D1	8/2006
P1100	PCB Annual Report for Oak Ridge National Laboratory – 1986	ORNL/TM-10495	7/1987
P1101	PCB Annual Report for Oak Ridge National Laboratory – 1987	ORNL/TM-10858	10/1988
P1102	PCB Annual Report for Oak Ridge National Laboratory – 1988	ORNL/TM-11247	6/1988
P1103	PCB Annual Report for Oak Ridge National Laboratory – January 1, 1989-February 5, 1990	ORNL/TM-11665	7/1/1990
P1104	PCB Annual Report for Oak Ridge National Laboratory – January 1, 1991-December 31, 1991	ORNL/TM-12132 ORNL/TM-12132/R1	7/1/1992 3/29/1993
P1105	PCB Annual Report for Oak Ridge National Laboratory – February 6, 1990-December 31, 1990	ORNL/TM-11883/R1	10/15/1991
P1106	PCB Annual Report for Oak Ridge National Laboratory – 1982	ORNL/TM-9035	7/1984
P1107	PCB Annual Report for Oak Ridge National Laboratory – 1983	ORNL/TM-9371	7/1985

Document Number	Title	Document Number	Date
P1108	PCB Annual Report for Oak Ridge National Laboratory – 1984	ORNL/TM-9701	8/1985
P1109	PCB Annual Report for Oak Ridge National Laboratory – 1985	ORNL/TM-10121	8/1986
U011	Safety Analysis: Transuranium Processing Plant, Building 7920	ORNL/TM-7688, Draft	12/1984
U038	ORNL TRU Waste Historical Survey; Volumes 1, 2, and 3—Origins and Characteristics of Remote-Handled Transuranic Wastes (Trabalka report)	BJC/OR-395-V/1,2,3, Draft	9/2001
U039	Oak Ridge Reservation Transuranic Waste Acceptable Knowledge Summary Report for the Radiochemical Engineering Development Center: Newly Generated Contact-Handled Transuranic Waste from Isotope Production	ORNL-CH-AK-TBD/RA, Draft	7/12/2002
U041	Waste Stream Profile Sheet for 7920-HCAL-007R1 and Supporting Documentation	7920-HCAL-007R1	9/06/2002
U044	Weston Report: Acceptable Knowledge Summary Report for Oak Ridge National Laboratory Contact-Handled TRU Debris Waste Facility Maintenance Operations	NA	TBD
U045	Waste Stream Profile Sheet for Building 7920, Hot Cells and Analytical Labs	7920-HCAL-002	4/19/1999
U046	TRU Waste Processing Center RH Debris Waste Process Flow Description	RH-R-PR-001, Draft Revision 0	Undated Draft
U047	Transuranic Waste Processing Center at Oak Ridge National Laboratory Remote Handled Transuranic Waste Container Selection and Transfer Plan	RH-A-AD-002, Draft Revision 0	Undated Draft
U048	Remote Handled Transuranic Waste Transfer Project – Scope and Inventory Assessment	BJC/OR – Draft	October 2007 Draft
U049	Waste Stream Profile Sheet for 7920-HCAL-005 and Supporting Documentation	7920-HCAL-005	8/18/1999
U568	Coupled End-to-End Demonstration Project Task Sheets – Separations	N/A	5/2007

Figure 1. Map of Oak Ridge National Laboratory

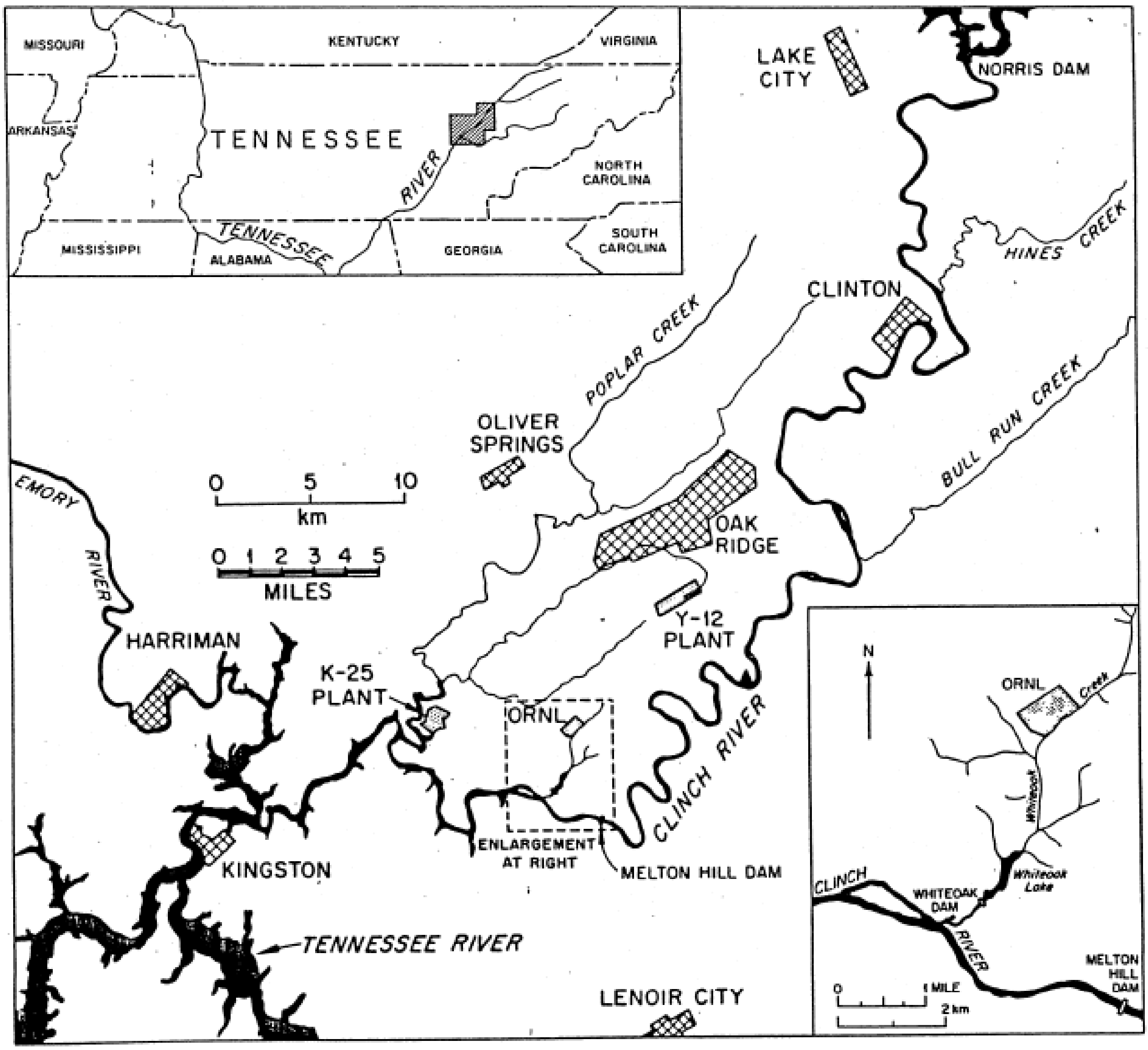

Figure 2. Map of Radiochemical Engineering Development Center, Transuranic Waste Processing Center, and Solid Waste Storage Areas

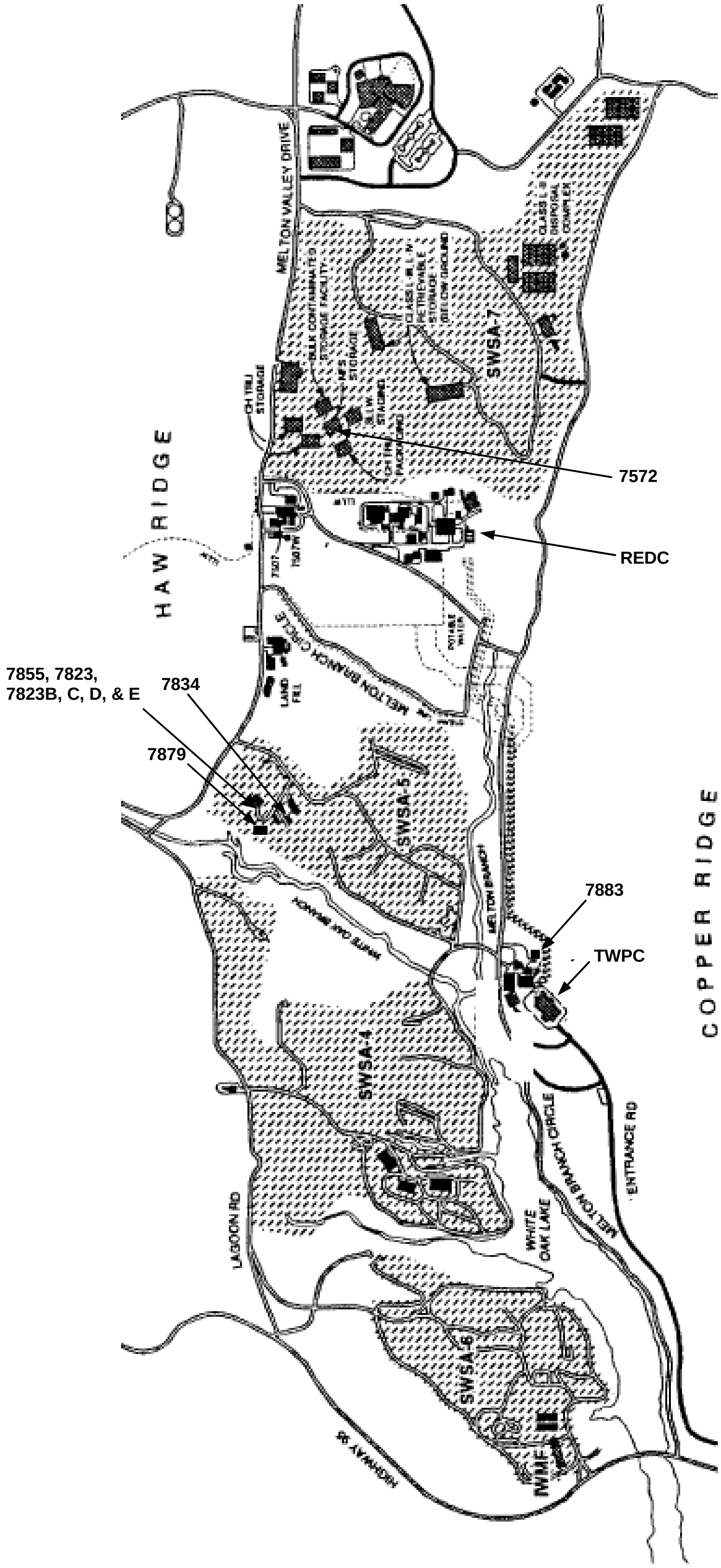

Figure 3. Location of Building 7920

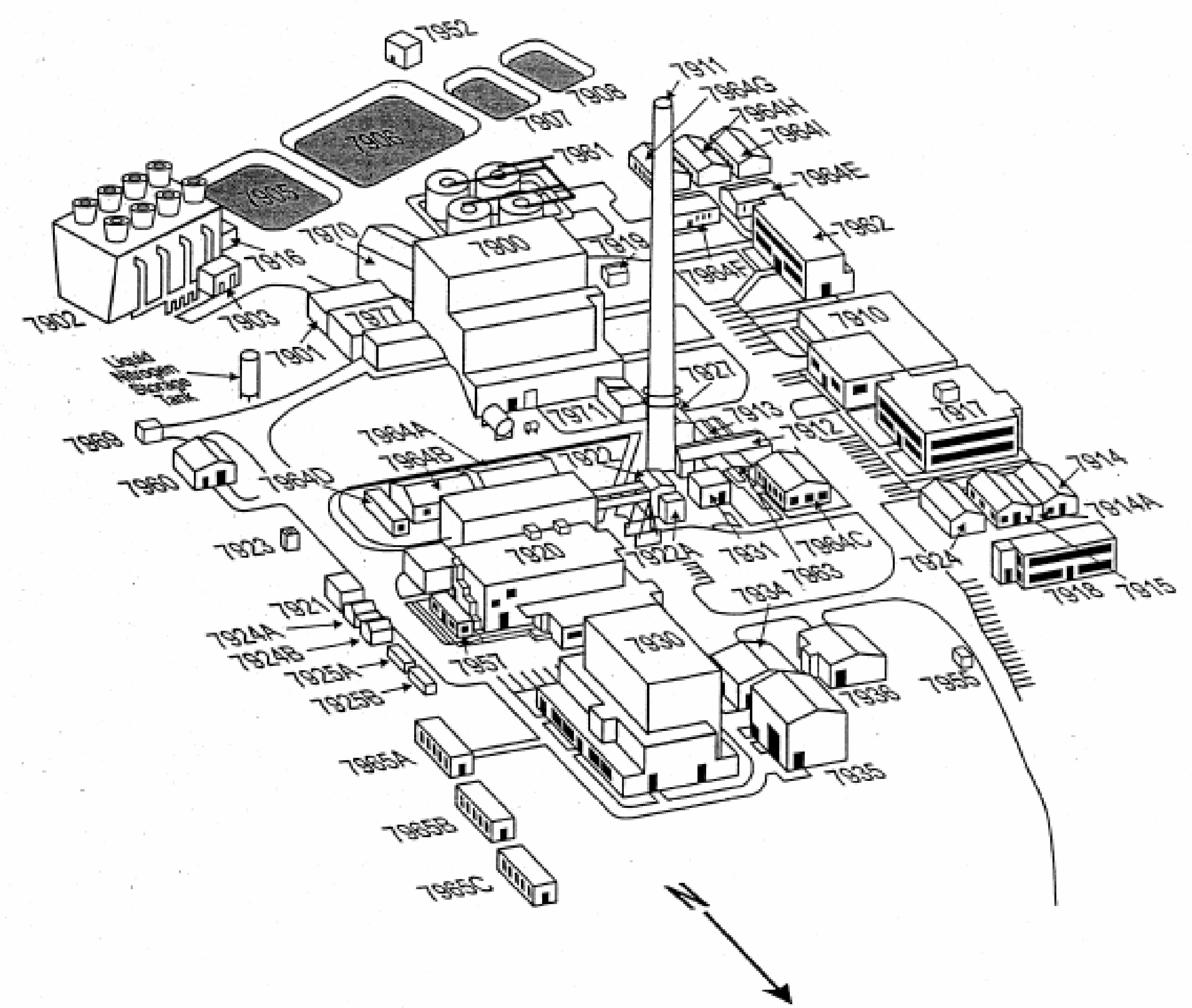

Figure 4. Transuranium Element Target Processing

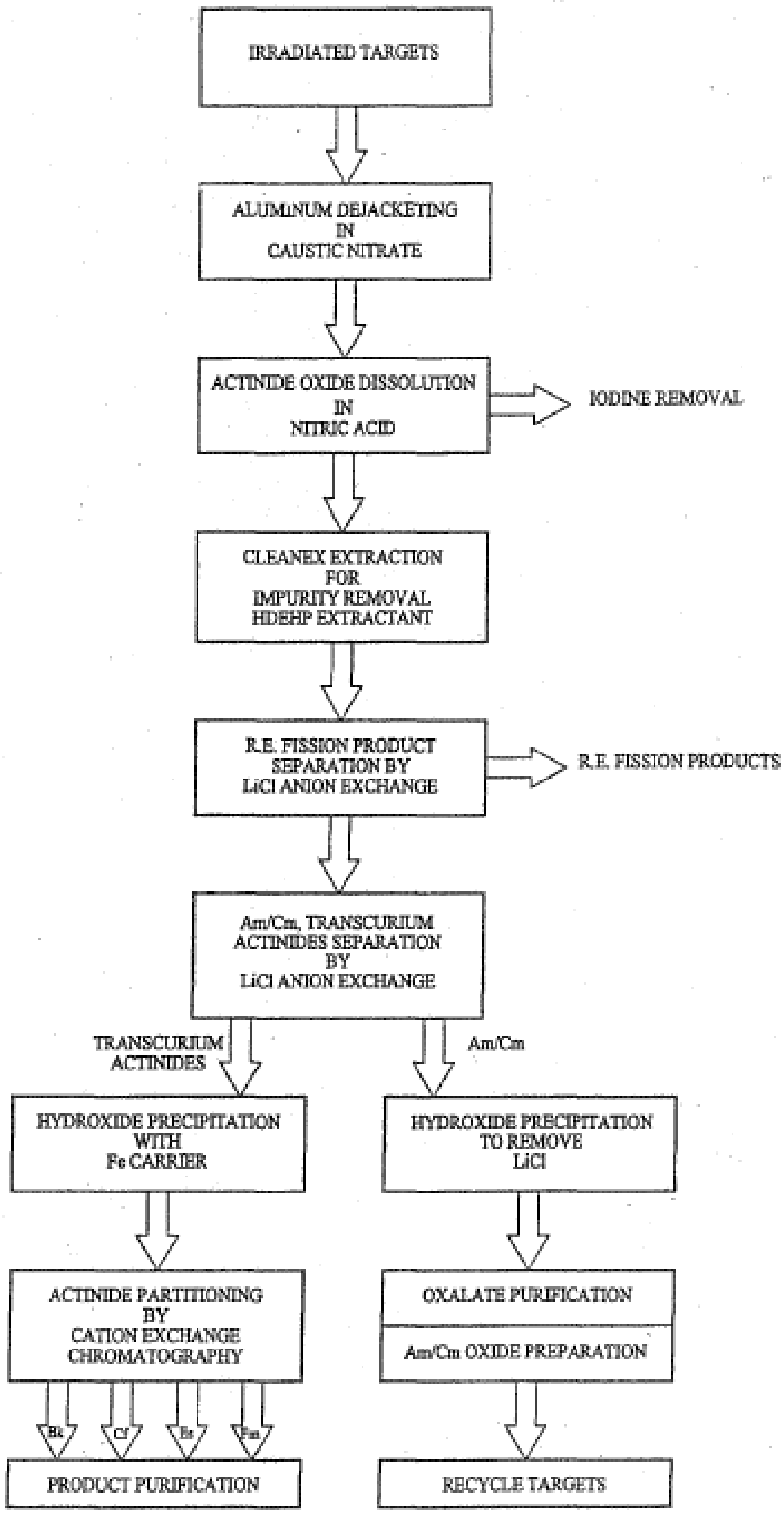

Figure 5. Solvent Extraction Test Facility Operations

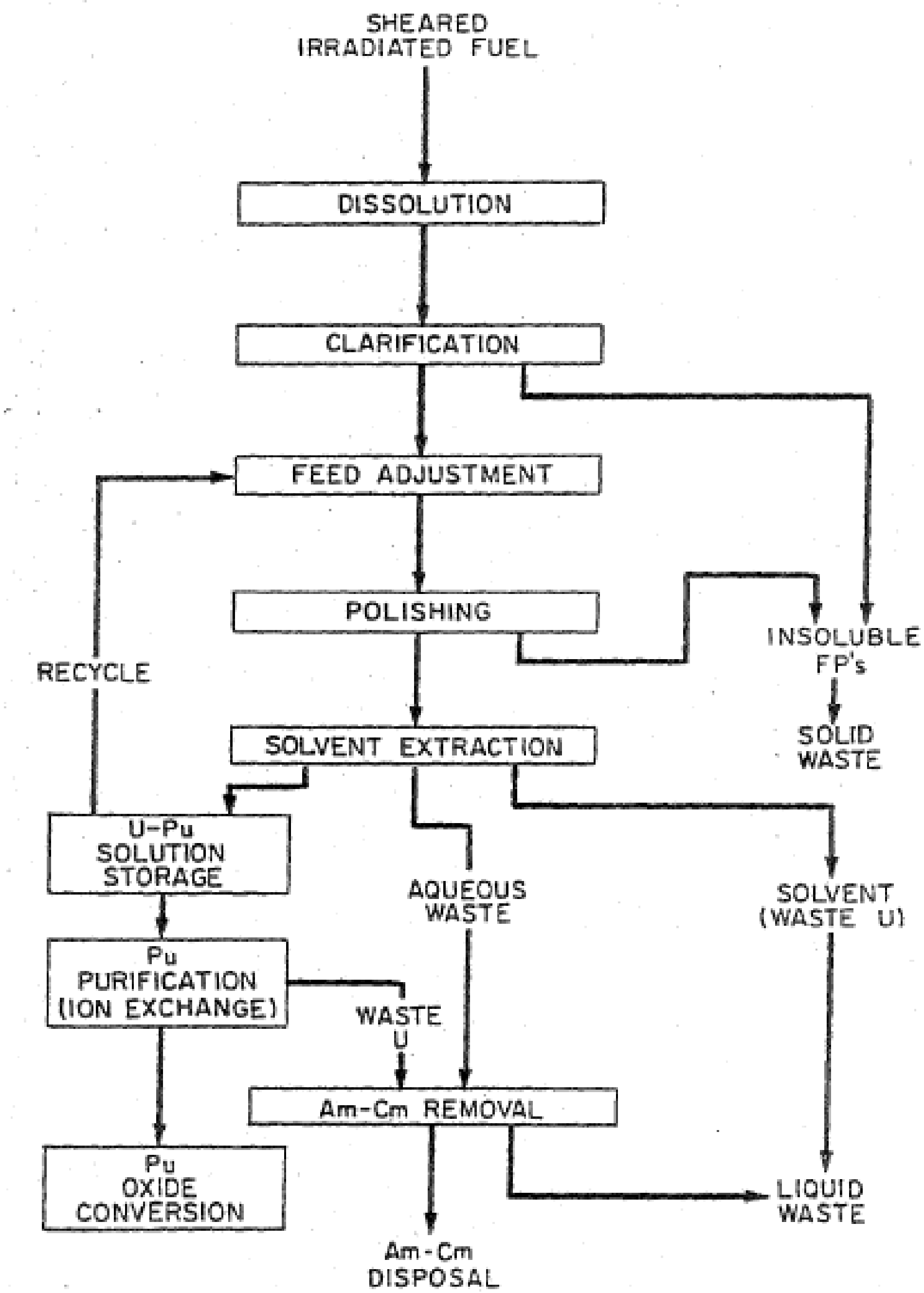

Figure 6. Mark-42 Processing

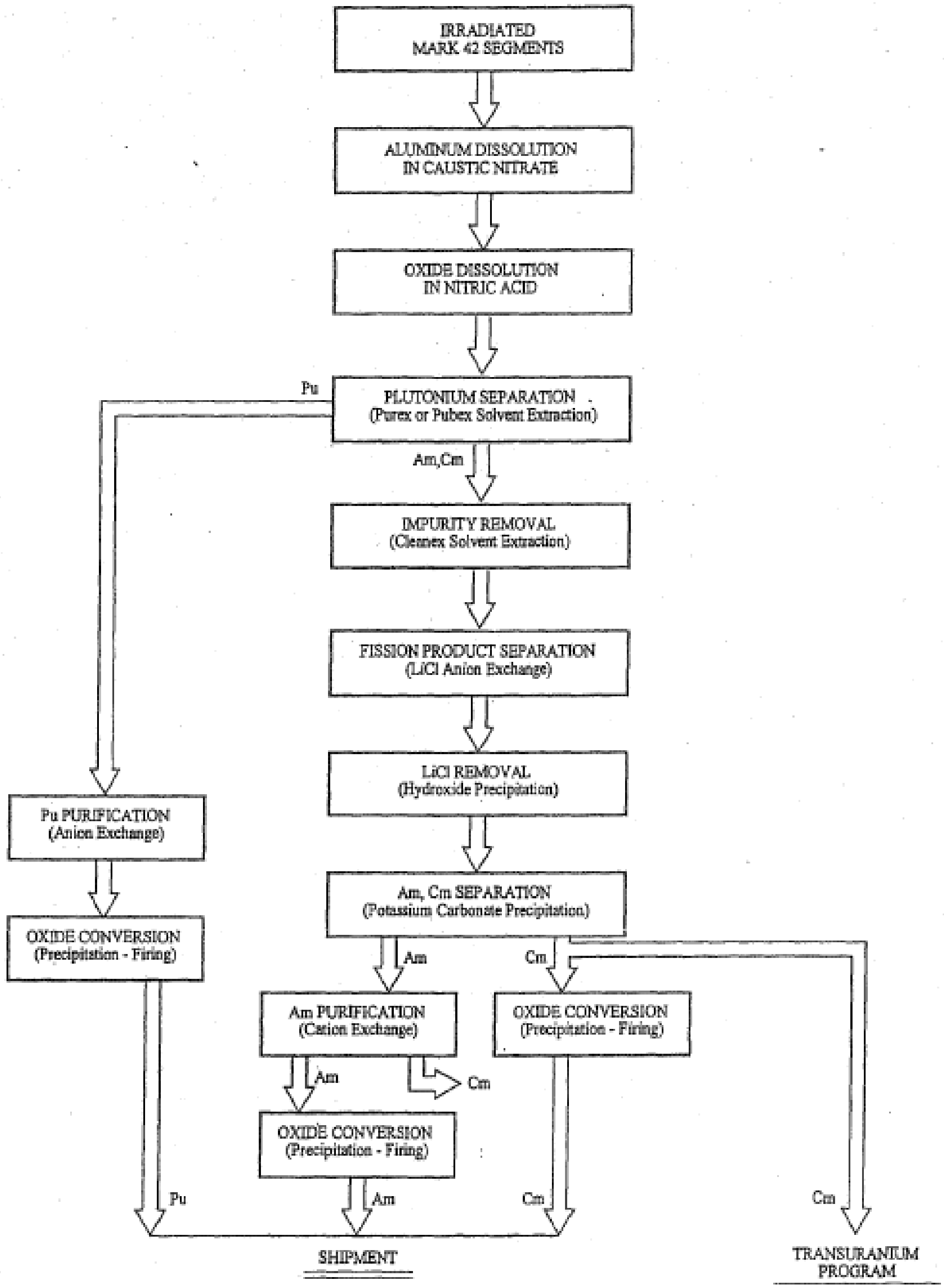

Figure 7. Pellet Fabrication

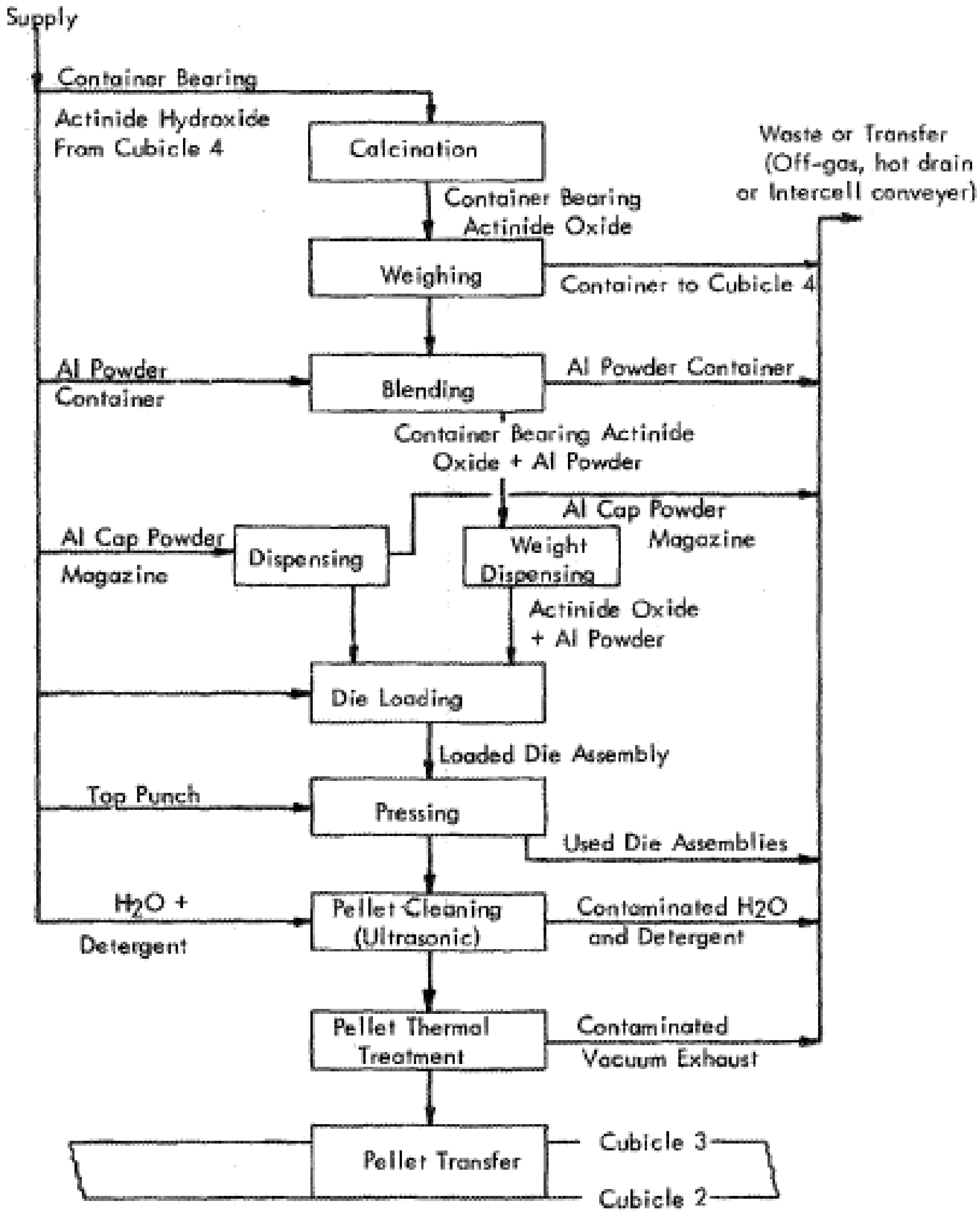

Figure 8. Target Tube Fabrication

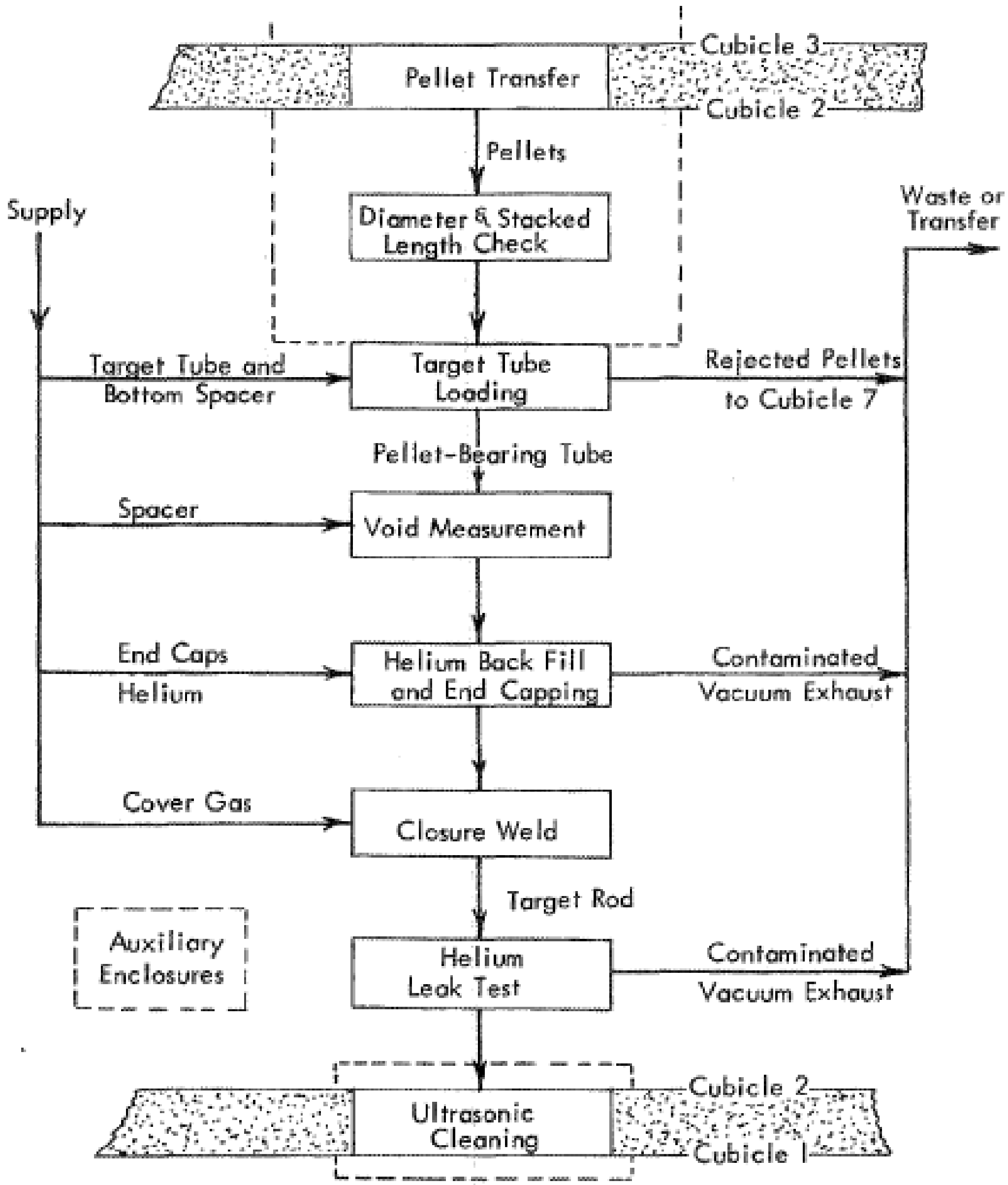

Figure 9. Target Assembly