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

REVISION 0

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LIST OF ACRONYMS AND ABBREVIATIONS

AK	Acceptable Knowledge
CCP	Central Characterization Project
CFR	Code of Federal Regulations
CH	Contact-handled
Ci	Curie
DOD	Department of Defense
DOE	Department of Energy
EPA	Environmental Protection Agency
HEPA	High Efficiency Particulate Air
HFIR	High Flux Isotope Reactor
HLW	High-level waste
HWNs	Hazardous Waste Numbers
kg	Kilogram
LAA	Limited Access Area
LANL	Los Alamos National Laboratory
MSDS	Material Safety Data Sheet
NWPA	Nuclear Waste Policy Act of 1982
ORNL	Oak Ridge National Laboratory
PCB	Polychlorinated biphenyl
ppm	parts-per-million
RCRA	Resource Conservation and Recovery Act
RTR	Real-Time Radiography
REDC	Radiochemical Engineering Development Center
SETF	Solvent Extraction Test Facility
SNF	Spent Nuclear Fuel
SRS	Savannah River Site
TA	Transfer Area
TRU	Transuranic
TRUCON	TRUPACT-II Content Code
TWBIR	Transuranic Waste Baseline Inventory Report
TWPC	Transuranic Waste Processing Center
VE	Visual Examination
WIPP	Waste Isolation Pilot Plant
WIPP-WAC	WIPP Waste Acceptance Criteria
WIPP-WAP	WIPP Hazardous Waste Facility Permit Waste Analysis Plan
WIR	Waste Incidental to Reprocessing
WSPS	Waste Stream Profile Sheet

1.0 EXECUTIVE SUMMARY

This Acceptable Knowledge (AK) Summary Report addresses the AK requirements of the NM 4890139088-TSDF, *Waste Isolation Pilot Plant Hazardous Waste Facility Permit Waste Analysis Plan* (WIPP-WAP) (Reference 2) and DOE/WIPP 02-3122, *Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant* (WIPP-WAC) (Reference 5).

This report has been prepared for the Central Characterization Project (CCP) for contact-handled (CH) transuranic (TRU) waste generated at the Oak Ridge National Laboratory (ORNL) in Oak Ridge, Tennessee. The waste described in this report was generated by the Radiochemical Engineering Development Center (REDC) located in Building 7920. The waste will be characterized prior to shipment to the Waste Isolation Pilot Plant (WIPP).

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

Waste stream OR-REDC-CH-HET currently includes CH-TRU waste originating in the REDC hot cell facility and analytical chemistry laboratories. There are several process development laboratories in the REDC that have also generated CH-TRU waste. The waste from the process development labs is currently not included in this waste stream and will be evaluated at a later date.

This report, along with referenced supporting documents, provide a defensible and auditable record of AK for the designated REDC waste streams. The source documents listed at the end of this AK Summary Report and cited throughout the report are identified by alphanumeric designations (i.e., C001, I001, M001, P001, U001, and DR004) corresponding to the Source Document Tracking Number using the following convention:

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

The CCP is tasked with certification of CH TRU waste for transportation to and disposal at WIPP. The procedure CCP-TP-005, *CCP Acceptable Knowledge Documentation* (Reference 1), describes how AK is initially compiled by the CCP and how AK is updated using data generated by CCP characterization activities. The CCP is responsible for AK development in accordance with CCP procedures and will review, approve, and maintain this AK Summary Report and supporting AK source documentation as CCP Quality Assurance records. The CCP maintains responsibility for all referenced documentation, which will be stored at the CCP Records Center, Carlsbad, New Mexico.

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.

Facility Mission

Since 1966, the primary mission of Building 7920 has been the fabrication of target rods containing plutonium (before or about 1970), americium and curium, and to separate and purify the heavy actinide isotopes including berkelium (Bk-249), californium (Cf-252), einsteinium (Es-253), and fermium (Fm-257) 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 4.3).

Waste Streams

2.1 Waste Stream OR-REDC-CH-HET

Summary Category Group:	S5000
Waste Matrix Code Group:	Heterogeneous Debris
Waste Matrix Code:	S5400, Heterogeneous Debris
TRUPACT-II Content Code (TRUCON):	OR 125/225, SQ 154
Maximum Layers of Confinement:	Three

Waste Stream Description: Waste stream OR-REDC-CH-HET is comprised primarily of organic and inorganic debris waste items and generally consists of cellulosics, plastic, rubber, glass, and metal. Some of the specific waste items include aluminum foil, metal cans, hand tools, hardware (e.g., washers), light bulb bases, piping, planchets, plates, spray cans (punctured), lead, concrete, glass bottles, glass thermometers, light bulbs (incandescent and mercury vapor), absorbent pads, cloth, paper towels, personnel protective equipment (e.g., shoe covers), rags, wipes, plastic bags, bottles, caps, latex gloves, manipulator boots, pipette tips, sleeving, tape, tubing, rubber gloves and hose, equipment (e.g., electrical devices containing circuit boards and electric motors), grouted ion-exchange resin, and absorbent (e.g., vermiculite) (Refer to Section 5.4.1).

The two most prevalent radionuclides in this waste stream are Pu-239 and Pu-240 by mass and Cm-244 and Sr-90 by activity (Refer to Section 5.4.2).

The Environmental Protection Agency (EPA) hazardous waste numbers (HWNs) assigned to this waste stream are D005, D006, D007, D008, D009, D010, D011, D019, F002, and F005 (Refer to Section 5.4.3).

Prohibited items that may be present in this waste stream include liquids, un-punctured spray cans, and sealed containers greater than 4 liters (Refer to Section 5.4.4).

3.0 ACCEPTABLE KNOWLEDGE DATA AND INFORMATION

TRU waste destined for disposal at the WIPP must be characterized prior to shipment. The WIPP-WAP permits use of knowledge of the materials and processes that generate and control the waste, provided a clear and convincing argument about the characteristics of the waste is achieved (Reference 2). The WIPP-WAC requires generator sites to use AK to determine if the TRU waste streams to be disposed at WIPP meet the definition of TRU “defense” waste, and to provide information concerning the radiological composition of a waste stream (Reference 5).

The AK characterization documented herein complies with the AK requirements in the WIPP-WAP and WIPP-WAC. This AK Summary Report was developed in accordance with the applicable requirements of CCP-PO-001, *CCP TRU Waste Characterization Quality Assurance Project Plan* (Reference 3), CCP-PO-002, *CCP Transuranic Waste Certification Plan* (Reference 8), and CCP-TP-005 (Reference 1).

This waste was characterized using AK from a variety of sources, including operating procedures, safety analysis reports, research project reports, waste management and packaging procedures, waste packaging and shipping forms, site databases, and various correspondence.

The DOE/TRU-2006-3344, *Transuranic Waste Baseline Inventory Report (TWBIR) – 2004*, identifies four waste streams for ORNL CH TRU waste (Reference 9):

- OR-W201, CH-TRU Heterogeneous Solids – Non-mixed
- OR-W202, CH-TRU Heterogeneous Solids – Mixed
- OR-W203, CH-TRU Hot Cell Debris Waste
- OR-W204, CH-TRU PCB-Contaminated Debris

The TWBIR waste streams that apply to waste stream OR-REDC-CH-HET are OR-W201, OR-W202, and OR-W203. The basis and rationale for delineating this waste stream is provided in Section 4.7.2.

4.0 REQUIRED PROGRAM INFORMATION

This section provides the waste management program information required by Section B4 of the WIPP-WAP (Reference 2). Included are a brief history of the REDC, a summary of its missions, a discussion of the operations associated with the generation of TRU waste, and a description of the TRU waste management program. Attachment 1 for waste stream OR-REDC-CH-HET (created in accordance with procedure CCP-TP-005) provides a list of TRU waste management program information required to be developed as part of the AK record (Reference 1). This document satisfies those requirements.

4.1 Facility Location

ORNL is located on the Department of Energy (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 Figures 1, 2, and 3 at the end of this report (References P014, P161, P272).

CH-TRU waste generated in Building 7920 is currently stored in Buildings 7572, 7574, 7834, 7879, and 7883 which are also located in the Melton Valley area of ORNL (References M012, P272). A map denoting the locations of the TRU waste storage buildings is shown in Figure 2 (Reference P272).

The Transuranic Waste Processing Center (TWPC) is located in Building 7880 within an approximate 5-acre area in the Melton Valley area of ORNL. Processing of CH-TRU waste is limited to characterization, sorting, segregation, size reduction and repackaging as required to produce waste suitable for disposal at WIPP (Reference P256). The location of Building 7880 is shown in Figure 2 (References P256, P272).

4.2 Facility Description

Building 7920 contains a bank of hot cells, laboratories with gloveboxes and caves, and the support services and equipment for these facilities.

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 from 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 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).

4.3 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 plutonium (before or about 1970), americium, and curium have been 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 were packaged for shipment. The Cf-252 was 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 that were 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 include many of the same operations steps that are used in transuranium element target processing which permits dual use of the same hot cell equipment (Reference P161).

The four alpha laboratories are used for transuranium element product finishing operations and for fundamental research and chemical process development. Small-scale processes and operations similar in type or identical to those done in the hot cell 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).

4.4 Defense Waste, Spent Nuclear Fuel, and High-Level Waste

4.4.1 Defense Waste Assessment

The WIPP-WAC (Reference 5) requires generator sites to use AK to determine if the TRU waste streams to be disposed at WIPP meet the definition of TRU "defense" waste. Based on guidance from the DOE, a TRU waste is eligible for disposal at 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) (References 5, 6, and 7).

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 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 were not segregated from waste generated by the HFIR target campaigns (Reference I044).

These operations can be categorized into several of the defense activities listed in the NWPA, but the activity that best describes them is "defense nuclear materials production" because the Cf-252 was produced for neutron sources used for defense applications (References 5, 6, and 7).

4.4.2 Spent Nuclear Fuel and High-Level Waste Assessment

The WIPP Land Withdrawal Act bans the disposal of spent nuclear fuel (SNF) and high-level waste (HLW), as defined by the NWPA, at WIPP. 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 were 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 CH-TRU waste stream (References P161, P279, U011, U044). Therefore, this waste stream does not contain SNF (References 6 and 7).

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 other decontamination work-related materials); and

- laboratory clothing, tools, and equipment

The Foster Wheeler TRU Waste Project has evaluated the CH-TRU waste from the Building 7920 hot cell cubicles (described in Section 5.4.1) and determined that it corresponds 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).

4.5 Description of Waste Generating Operations

The following sections provide an overview of the Building 7920 operations including chemical processing, target fabrication, analytical laboratory, and process development.

4.5.1 Chemical Processing

4.5.1.1 Transuranium Element Target Processing

Transuranium element target 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 remote fabrication of new targets. The general sequence of steps used to process transuranium element targets in the hot cells is shown in Figure 4 (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).

4.5.1.2 Solvent Extraction Test Facility

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 (Reference U011).

4.5.1.3 Mark-42 Processing

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 (Reference P161).

4.5.1.4 Special Projects

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).

4.5.2 Target Fabrication

Actinide oxide 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 Figures 7, 8, and 9 (Reference P279).

4.5.3 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).

4.5.4 Process Development

The process development 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).

4.5.5 Maintenance Operations

The processing equipment in the 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 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 (Reference U011).

4.6 Waste Identification and Categorization

4.6.1 Physical Form

Waste generators completed a UCN-2109 form in which a waste description was recorded. The waste description indicates that wastes were not segregated by material type (e.g., plastic, metal, glass). Included with the UCN-2109 is 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 was the UCN-2822. The UCN-2822 includes waste type codes and provides a brief waste description as well as the volume of combustible waste. The waste type codes include (Reference M005):

- 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. 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 (Reference U011).

4.6.2 Chemical Form

In approximately 1987, Building 7920 implemented a program for the identification and segregation of hazardous waste regulated by the Resource Conservation and Recovery Act (RCRA), Title 40 of the Code of Federal Regulations (CFR) Part 261 (References 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 was RCRA-regulated (Reference M005).

Even with implementation of a RCRA program in 1987, the earliest generation date of waste assigned EPA hazardous waste numbers was in 1994. The EPA hazardous waste numbers assigned by generators are D006 (cadmium), D008 (lead), D009 (mercury), and D011 (silver) based on the presence of batteries (nickel/cadmium), 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. These drums were identified as such based on a 2003 EPA inspection in which EPA pointed out numerous instances of waste in storage that had not been characterized. Much of the waste was suspected of containing incidental hazardous waste items and presumed to be RCRA hazardous (References M005, M012). In addition to the EPA hazardous waste numbers listed above, several other RCRA hazardous materials have been identified in this waste stream (see Section 5.4.3).

4.6.3 Radiological Form

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 M005, 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 MicroShield modeling. Activity values were then assigned to each nuclide in the drum based on the surface dose rate of the inner package or drum (References M005, U041, U045). In December 2004, ORNL updated the radiological characterization of the waste generated before 1999 using the isotopic distribution and original surface dose rate measurement of the drum (References I044, M005).

4.7 TRU Waste Management

4.7.1 Types of Quantity of TRU Waste Generated

The waste stream described by this report is characterized as TRU mixed waste under the RCRA. The specific containers in this waste stream are provided in the *Waste Containers List* which is maintained as a quality record as required by procedure CCP-TP-005 (Reference 1). The number of containers in the waste stream are provided in Table 4-1, Waste Stream Volumes.

Table 4-1. Waste Stream Volumes

Waste Stream	Number of 55-Gallon Drums	Volume (m^3)
OR-REDC-CH-HET	170	35.4

4.7.2 Correlation of Waste Streams Generated from the Same Building and Process

The WIPP-WAP defines a waste stream as waste material generated from a single process or from an activity that is similar in material, physical form, and hazardous constituents. One CH-TRU waste stream has been delineated for the Building 7920 waste according to this definition. The basis and rationale for delineating this waste stream is as follows:

- The activity in Building 7920 that generated this waste stream is production of the heavy actinide elements Bk-249, Cf-252, Es-253, and Fm-257, and those operations that support this activity (process development, analytical chemistry, and facility maintenance)(refer to Sections 4.5 and 5.3).

- The waste stream is similar in material and physical form in that it is comprised of a variety of organic and inorganic debris waste items. Wastes were not segregated by material type, and the volume percent combustible in each drum is highly variable (refer to Sections 4.6.1 and 5.4.1).

- The waste generator has characterized TRU waste from Building 7920 as either mixed waste regulated under RCRA, non-mixed waste (i.e., no RCRA-hazardous constituents), or suspect RCRA. Because of inaccuracies in waste characterization, the entire population of CH-TRU debris waste from Building 7920 is conservatively characterized as RCRA-hazardous waste under 40 CFR Part 261 (refer to Sections 4.6.2 and 5.4.3).

4.8 Waste Certification Procedures

In the CCP program under which the subject waste stream will be certified for shipment to WIPP, CCP-TP-005 (Reference 1), directs compilation of AK. CCP certifies TRU waste under the program described in CCP-PO-002.

5.0 REQUIRED WASTE STREAM INFORMATION: OR-REDC-CH-HET

This section presents the mandatory AK for waste stream OR-REDC-CH-HET required by Section B4 of the WIPP-WAP (Reference 2). Attachment 1 for waste stream OR-REDC-CH-HET (created in accordance with procedure CCP-TP-005) provides a list of TRU waste stream information required to be developed as part of the AK record (Reference 1).

5.1 Area and Building of Generation

Waste stream OR-REDC-CH-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) is also included (References M005, M012, P161).

Drums originating from the Building 7920 process development laboratories (Rooms 111, 211, 109, and 209) are currently not included in the waste stream. These drums will be evaluated for inclusion in this waste stream at a later date (Reference DR003).

5.2 Waste Stream Volume and Period of Generation

Waste stream OR-REDC-CH-HET includes 170 55-gallon drums generated from February 1978 to February 2005 (References M005, M012). The specific container numbers are provided in the *Waste Containers List* which is maintained as a quality record as required by procedure CCP-TP-005 (Reference 1). Based on the volume of CH-TRU waste generated in Building 7920 over the last five years, it is assumed that this waste stream will be generated indefinitely at the rate of approximately 10 drums per year (Reference M012).

5.3 Waste Generating Activities

5.3.1 Hot Cell Cubicle Operations

Wastes are generated in the Building 7920 hot cell cubicles during the process operations and maintenance activities described in Section 4.5. The waste items are removed from the cubicles through connecting gloveboxes in the TA, LAA, and decontamination glovebox room (Reference P161).

CH-TRU waste from hot cell operations packaged in drums, originated mostly from the TA (Reference M005). In the hot cell cubicles, waste items are typically placed into small containers (e.g., plastic or metal buckets) 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. Some waste items are also 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 (e.g., no free liquid, compressed gases, etc.). 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 P161).

Several CH-TRU waste drums also originated from the LAA and decontamination room (Reference M005). LAA waste generating activities include general maintenance of equipment and systems, including tank and filter pits (Reference P161). The decontamination room includes the decontamination and equipment repair gloveboxes used for maintenance, repair, and decontamination of hot cell equipment. Materials are transferred in and out of the gloveboxes using bagging ports. Large pieces of equipment are transferred in and out of the glovebox through the roof door using the equipment transfer case. Liquid wastes are transferred out of the gloveboxes through liquid waste lines (References P161, U011).

5.3.2 Glovebox Laboratory Operations

Wastes are generated in the Building 7920 glovebox laboratories during the process operations described in Section 4.5. Glovebox operations are performed using neoprene 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. 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 devises in which materials are placed in cardboard ice-cream cartons (References P161, U011).

5.3.3 Transuranic Waste Processing Center

As necessary, drums containing CH-TRU waste in storage are moved individually to the TWPC (Building 7880) glovebox airlock. Once inside the glovebox airlock, the drum is moved to the drum tipper where the lid is removed and the drum contents are emptied into sorting trays. The waste articles are manually sorted and segregated via glove ports to remove prohibited items and repackaged at one of the four load-out stations along the glovebox. Currently, repackaging of containers with liquid greater than one percent of container volume, pressurized gases, explosives, or pyrophorics are not allowed (References P254, P255, P256). Glovebox internal walls are periodically wiped down using damp rags. Secondary wastes created during waste processing, such as rubber glovebox gloves and tools, are placed into TRU waste drums. A process flow diagram for the TWPC is shown in Figure 10 (References P252, P253).

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-CH-HET.

5.4.1 Materials Related to Physical Form

Waste stream OR-REDC-CH-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 waste includes cellulosics, plastic, rubber, metal, and glass (Reference M005). Specific waste items present in this waste stream are as follows (References M005, P161):

- Aluminum-based metal items such as foil
- Iron-based metal items including cans, hand tools, hardware (e.g., washers), light bulb bases, piping, planchets, plates, and spray cans (punctured)
- Other metals such as lead
- Other inorganic materials including concrete, glass bottles, glass thermometers, and light bulbs (incandescent and mercury vapor)
- Cellulosic items such as absorbent pads, cloth, paper towels, PPE (e.g., shoe covers), rags, and wipes
- Plastic items including bags, bottles, caps, latex gloves, manipulator boots, pipette tips, sleeving, tape, and tubing
- Rubber items such as gloves and hose
- Equipment including electrical devices containing circuit boards and electric motors
- Grouted ion-exchange resin (organic matrix) and absorbent (e.g., vermiculite)

5.4.1.1 Waste Matrix Code

As shown in the previous section, waste stream OR-REDC-CH-HET is comprised primarily of numerous 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. The UCN-2109 records an estimate of the volume percent combustible which ranges from 0 to 100 with an average of about 62 percent for the drums in this waste stream. The UCN-2822 provides total volume and combustible volume in cubic feet. The calculated volume percent combustible ranges from 0 to 100 with an average of about 54 percent. The container log sheets provide an estimate of the volume percent combustible for each package in the drum. An average was calculated for each drum and an overall average for all of the drums with container log sheets. The calculated volume percent combustible ranges from 33 to 98 with an average of about 65 percent. A few drums may contain grouted ion-exchange resin, which is considered a homogeneous waste, but individual drums are expected to contain less than 50 percent, by volume, of this waste (Reference M005).

Due to the high degree of variability in the amount of combustible waste, Waste Matrix Code S5400, Heterogeneous Debris, is applied to this waste stream. The definition of this Waste Matrix Code is provided in the DOE/LLW-217, *DOE Waste Treatability Group Guidance* (Reference 4). 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). This evaluation is documented in a memorandum (included with Attachment 6 completed per CCP-TP-005) (Reference 1).

5.4.1.2 Waste Material Parameters

Based on the waste items identified in Section 5.4.1, the waste material parameters expected to be present in waste stream OR-REDC-CH-HET are:

- Aluminum-based Metals/Alloys
- Iron-based Metals/Alloys
- Other Metals/Alloys
- Other Inorganic Materials
- Cellulosics
- Plastics
- Rubber
- Organic Matrix

Section B4-3b of the WIPP-WAP requires that an estimate of material parameter weights be provided for each container. The only quantitative data available for this waste stream is the volume percent combustible discussed in the previous section.

Weight percent combustible is not provided, and without an estimate of the void space in the drum, the combustible volume cannot converted to weight with any certainty. In addition, there is no information on the amount of the different waste material parameters (e.g., the drum may indicate the presence of metal, but it does not specify if the metal is aluminum, iron, or other metal).

As of late September 2007, only three drums from Building 7920 have been examined by real-time radiography (RTR) at the TWPC. One of the drums is from the analytical labs, but this drum assayed as low-level waste and is not included in the waste stream. The other two drums are from the process development labs and are currently not included in the waste stream. Therefore, there are not adequate data to estimate waste material parameter weights for each drum. However, according to Section B4-1 of the WIPP-WAP, if AK alone is insufficient to accurately characterize a waste, RTR and/or visual examination (VE) may be used to complete the waste characterization process (Reference 2). Once RTR and/or VE data are available for this waste stream, this section will be revised to include an estimate of the waste material parameter weights to meet this WIPP-WAP requirement. This evaluation is documented in a memorandum (included with Attachment 6 completed per CCP-TP-005) (Reference 1).

5.4.2 Radiological Characterization

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). Based on the mainstream operation process, the REDC isotopic waste profile is expected to contain a similar type of actinides, fission, and activation products present in irradiated targets processed at 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.

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 M005, P240). 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 did not included information to demonstrate whether the TRU concentration was less than or greater than 100 nCi/g (Reference P058).

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 MicroShield modeling. Activity values were then assigned to each nuclide in the drum based on the surface dose rate of the inner package or drum. The radiological distribution has not been decay corrected for these values (References M005, U041, U045). In December 2004, ORNL updated the radiological characterization of the waste generated before 1999 using the isotopic distribution and original surface dose rate measurement of the drum (References I044, M005).

5.4.2.1 1999 Radiological Characterization

On April 1, 1999, ORNL finalized and began implementation of the Waste Stream Profile Sheet (WSPS) 7920-HCAL-002 for the radiological characterization of waste generated at Building 7920 Hot Cell and Analytical Laboratories. The following information is a summary of the data flow used in development of the WSPS (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.

The isotopic distribution developed by WSPS 7920-HCAL-002 and the measured dose rates associated with waste packages were used to report the radiological content of each drum in waste stream OR-REDC-CH-HET between 1999 and 2002 (Reference M016 and U045).

5.4.2.2 Re-characterization of Pre-1999 Waste

During 2005, the REDC historical hot cell operational information, combined with characterization approach described in Section 5.4.2.1 above, were used to re-evaluate the radiological characteristics of CH TRU waste generated from REDC from 1977 until 1999. The re-evaluation was used to reconcile, modify, and update the characterization of 645 CH TRU waste drums contained in the Waste Information Tracking System. The

Re-characterization approach evaluated and developed radiological characteristics for 3 distinct timeframes (References I044, M005, and M012):

- Timeframe 1: Prior to September 1, 1979; and between April 1, 1986 and April 30, 1991
- Timeframe 2: Between September 1, 1979 and March 31, 1986,
- Timeframe 3: Between May 1, 1991 and January 14, 1999.

The timeframes were segregated based on processing campaign timelines and other historical operational considerations. The re-evaluation updated the radiological characterization of the target group of drums using one the three isotopic distributions and original surface dose rate measurement of the drum (References I044, M005, and M012).

5.4.2.3 2002 Radiological Characterization

During 2002, ORNL completed a revision to the radiological approach and issued WSPS 7920-HCAL-007 and 007R1 for the radiological characterization of waste generated at Building 7920 Hot Cell and Analytical Laboratories. The following information is a summary of the data flow used in development of the WSPS 7920-HCAL-007R1 (Reference U041):

1. Microshield model using the gamma emitters from item #2 below was constructed over 7 weight ranges to adjust for the various densities from the total waste matrix inside the package. A curie to dose conversion factor was calculated for the gamma emitters to determine the curie content for each respective gamma emitter. The non-gamma emitters are calculated using scaling factors from the fraction contribution to the total activity of the distribution.

2. Twenty-eight in-cell smears samples were collected and analyzed. The analysis reported 19 nuclides; 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.

3. 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.

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. 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 Pu isotopic distribution was analyzed on the MK-42 targets by mass spectrometry.

6. Data on waste organic solutions from eight HFIR target processing campaign recoveries conducted between April 17, 1996 through February 11, 1999 provided the isotopic content for Pu-238, -239, -240, -241, -242, and -244. The data was averaged over the eight campaigns to determine the overall distribution. The Pu-238 value determined from the smear samples was used as the base to calculate the content of Pu-239 and -240. The Pu-242 content was taken from the in-cell smears.

5.4.2.4 Generator Reported Radionuclides for Waste Stream OR-REDC-CH-HET

To determine isotopic ratios for waste stream OR-REDC-CH-HET as a whole, the total gram value for each individual radionuclide was divided by the total mass of all radioactive constituents in the waste stream and converted to a percentage. This result is listed as "Total Nuclide Weight%." To determine the radionuclide weight percent range for individual containers, the radiological mass in each container in the waste stream 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 Drums." The same process was applied to determine "Total Nuclide Curie%" and "Nuclide Ci% Range for Individual Drums[4]." As shown in Table 5-1, Waste Stream OR-REDC-CH-HET Radiological Characterization, Pu-239 and Pu-240 are the two most prevalent radionuclides by mass, and Cm-244 and Sr-90 are the two most prevalent radionuclides by activity. It should be noted that only three radionuclides are reported for two drums (X10C9312882 and X10C9312373), including Pu-239. The Pu-239 value represents over 93 percent by mass of the total Pu-239 for this waste stream. Without these two drums, Cm-246 and Pu-240 would be the predominant radionuclides for this waste stream. The radiological evaluation for this waste stream is documented in the NDA Memorandum as required by CCP-TP-005 (References 1 and M012).

Table 5-1. Waste Stream OR-REDC-CH-HET Radiological Characterization

Nuclide	Drums with Reported Nuclide	Total Nuclide Weight%[1]	Total Nuclide Curie%[2]	Nuclide Weight% Range for Individual Drums[3]	Nuclide Ci% Range for Individual Drums[4]	Expected Present (Yes/No)
WIPP Required Radionuclides						
Am-241	168	1.28%	0.56%	0.00% - 5.57%	0.00% - 0.57%	Yes
Pu-238	168	0.19%	0.42%	0.00% - 0.45%	0.00% - 0.42%	Yes
Pu-239	170	**48.52%**	0.39%	1.94% - 92.12%	0.01% - 76.00%	Yes

Nuclide	Drums with Reported Nuclide	Total Nuclide Weight%[1]	Total Nuclide Curie%[2]	Nuclide Weight% Range for Individual Drums[3]	Nuclide Ci% Range for Individual Drums[4]	Expected Present (Yes/No)
Pu-240	163	**15.62%**	0.46%	0.00% - 54.41%	0.00% - 23.78%	Yes
Pu-242	168	10.18%	0.01%	0.00% - 21.08%	0.00% - 0.01%	Yes[5]
U-233	Not Reported					No
U-234	Not Reported					Yes[5,6]
U-238	Not Reported					Yes[6]
Cs-137	168	0.19%	2.09%	0.00% - 0.82%	0.00% - 2.13%	Yes
Sr-90	166	0.88%	**15.36%**	0.00% - 2.31%	0.00% - 17.02%	Yes[5]
Additional Radionuclides						
Co-60	166	Trace[7]	0.02%	0.00% - 0.00%	0.00% - 0.02%	Yes
Nb-95	9	Trace	0.04%	0.00% - 0.00%	0.00% - 5.22%	Yes
Zr-95	168	Trace	0.25%	0.00% - 0.01%	0.00% - 5.38%	Yes
Ru-103	168	Trace	0.48%	0.00% - 0.01%	0.00% - 12.85%	Yes
Ru-106	168	Trace	1.99%	0.00% - 0.24%	0.00% - 23.61%	Yes
Ag-110m	168	Trace	0.03%	0.00% - 0.00%	0.00% - 0.42%	Yes
Sm-125	166	Trace	0.11%	0.00% - 0.00%	0.00% - 0.11%	Yes
Cs-134	168	Trace	0.17%	0.00% - 0.03%	0.00% - 1.25%	Yes
Ce-141	168	Trace	0.92%	0.00% - 0.01%	0.00% - 7.95%	Yes
Ce-144	168	Trace	0.38%	0.00% - 0.20%	0.00% - 18.63%	Yes
Eu-152	166	Trace	0.06%	0.00% - 0.01%	0.00% - 0.06%	Yes
Eu-154	166	0.01%	0.30%	0.00% - 0.02%	0.00% - 0.30%	Yes
Eu-155	166	Trace	0.22%	0.00% - 0.01%	0.00% - 0.22%	Yes
U-235	Not Reported					Yes[6]
U-236	Not Reported					Yes[6]
Np-239	166	Trace	0.08%	0.00% - 0.00%	0.00% - 0.08%	Yes
Pu-241	168	0.38%	5.01%	0.00% - 0.90%	0.00% - 5.07%	Yes
Am-243	168	1.56%	0.04%	0.00% - 6.83%	0.00% - 0.04%	Yes
Cm-242	168	Trace	0.31%	0.00% - 0.00%	0.00% - 0.31%	Yes
Cm-244	169	6.63%	**68.77%**	0.00% - 15.67%	0.00% - 69.47%	Yes
Cm-246	168	12.17%	0.48%	0.00% - 28.72%	0.00% - 0.49%	Yes
Cm-248	168	2.36%	Trace	0.00% - 5.57%	0.00% - Trace	Yes
Cf-249	168	Trace	Trace	0.00% - 0.01%	0.00% - Trace	Yes
Cf-250	168	Trace	0.03%	0.00% - 0.01%	0.00% - 0.03%	Yes
Cf-251	168	Trace	Trace	0.00% - 0.00%	0.00% - Trace	Yes
Cf-252	169	0.02%	1.04%	0.00% - 0.07%	0.00% - 16.69%	Yes

1. This listing indicates the total weight percent of each radionuclide over the entire Waste Stream.
2. This listing is the weight percent range of each radionuclide on a container-by-container basis. Some containers with "0" listed as the lower range, will not contain the specified radionuclide.
3. This listing indicates the total activity (curie) percent of each radionuclide over the entire Waste Stream.
4. This listing is the curie percent range of each radionuclide on a container-by-container basis.
5. Pu-242, U-234, and Sr-90 cannot be accurately quantified by nondestructive assay. Quantification of these nuclides is described in the NDA Memorandum for this waste stream.
6. U-234, U-235, U-236, and U-238 where not reported but are expected present due to SETF fuel work performed in waste generating areas.
7. "Trace" indicates <0.01 weight percent or activity percent for that radionuclide.

5.4.2.5 Considerations for Radiological Characteristics by Timeframe

As described in Section 5.4.2.2 above, the radionuclide distributions used to characterize waste generated prior to 1999 included consideration of the timeframe of generation relative to processing campaign timelines (Reference I044). This section summarizes conditions and activities that might contribute to mixing radionuclides between campaigns and time periods of waste generation.

Solid wastes have not been segregated according to programmatic source during the waste accumulation and packaging operations conducted to date at either Bldg. 7920 or Bldg. 7930. This includes laboratory wastes, which are typically CH-wastes and which are packaged in glove-box operations. 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).

Restrictions imposed by (1) the physical configuration of the cell-based facilities, (2) the characteristics of the processing, (3) efforts to maintain dose rates as low as reasonably achievable and to minimize waste generation, and (4) the presence of high levels of internal radioactive contamination in the cubicles resulting from past and current operations have resulted in cross-contamination and mixing of wastes. Specifically, mixing of waste occurs due to the following (Reference U038):

1. transfer of smaller waste items between the cubicles in Bldg. 7920 by way of a common inter-cell conveyor or mixing of items in large plastic bags before removal via the cubicle roof plugs;

2. accumulation of most waste items in a common staging and packaging area (Cubicle 9) in Bldg. 7920 without regard to source;

3. accumulation of contamination from numerous campaigns on common waste materials such as HEPA filters and off-gas filter beds;

4. accumulation of wastes over a significant period of time, resulting in mixing of materials from each campaign conducted during the period of accumulation when they are packaged;

5. periodic recycling of materials in waste solvents (rework solutions) generated in prior campaigns into products and new targets; and

6. the presence of airborne particulate contamination within the cubicles that represents an integration of materials released over the entire history of operations.

5.4.3 Chemical Content Identification – Hazardous Constituents

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

Table 5-2. Waste Stream OR-REDC-CH-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 REDC operations. A comprehensive list of materials and chemicals identified during this assessment are provided in Table 5-3, Waste Stream OR-REDC-CH-HET Material and Chemical Inputs. HWNs were conservatively assigned to all the containers in the stream 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-CH-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, U01	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 extration.	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]
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.	P151, U011	D005
Benzene	REDC organic chemical inventory.	C078	F005

Chemical/Material	Use/Description/Location	AK Source	EPA HWNs
Beryllium	Electroplating microgram quantities of transplutonium elements on beryllium foil targets and source plate.	P223	NA
Cadmium	Californium product solution impurity. D006 assigned by generator to REDC containers (flashlight batteries and electronic equipment).	M005, M012, 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
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

Chemical/Material	Use/Description/Location	AK Source	EPA HWNs
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, P233, 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, M005, M012, P151, 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, P233, P279, P282, U011	NA
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, P161, U038,	D009
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

Chemical/Material	Use/Description/Location	AK Source	EPA HWNs
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]
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
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

Chemical/Material	Use/Description/Location	AK Source	EPA HWNs
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, P233, 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. Based on a review of the REDC chemical processing operations, and process liquid waste management practices, and container documentation for container in waste stream OR-REDC-CH-HET, no ignitable, corrosive, or reactive materials were disposed of in the waste stream. Drums containing prohibited liquids identified during RTR will not be eligible for WIPP disposal without being remediated.

5.4.3.1 F-Listed Constituents

Based on review of AK relative to REDC chemicals usage and chemical inventory information, waste stream OR-REDC-CH-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 were 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 McCoy’s RCRA Unraveled (Reference 10).

Large-scale degreasing operations were not conducted in the REDC, and therefore, EPA HWN F001 is not assigned to this waste stream. Waste stream OR-REDC-CH-HET is assigned F-listed EPA HWN F002 for 1,1,2-trichloroethane, and trichloroethylene and EPA HWN F005 for benzene, methyl ethyl ketone, and toluene (Reference DR005).

5.4.3.2 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-CH-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 1).

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-CH-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-CH-HET (Reference DR005).

5.4.3.3 U-, P-, and K- 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-CH-HET. The only specific source identified for beryllium was 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 will be present in the debris waste, P015 is not assigned to the waste stream. Hydrofluoric acid was 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-CH-HET (References M005 and P224).

The material in waste stream OR-REDC-CH-HET is not a hazardous waste from any of the sources specified in 40 CFR 261.32. Waste stream OR-REDC-CH-HET is therefore not assigned a K-listed HWN.

5.4.3.4 Ignitables, Corrosives, and Reactives

Potentially ignitable, corrosive, and reactive waste materials were prohibited during the packaging of the TRU waste in the REDC. Additionally, the processing solutions prepared with the reagents identified in Table 5-3 were prepared outside of the cubicles and introduced into the closed loop process tanks with the resulting waste liquids being piped out of the facility and not included in this waste stream. For this reason, the materials in this waste stream do not meet the definition of ignitability as defined in 40 CFR 261.21. The materials are not liquid and RTR and/or VE will be performed to ensure prohibited amounts of residual liquids were not added to the containers during packaging. This material will not cause fire through friction, absorption of moisture, or spontaneous chemical changes. This material is not a compressed gas as defined in 49 CFR 173.151. This material is not an oxidizer as defined in 49 CFR 173.300. Prior to WIPP disposal, prohibited quantities of liquids identified during RTR or VE will be removed and/or immobilized. Waste stream OR-REDC-CH-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 RTR and/or VE will be performed to ensure liquids were not added to containers during packaging prior to WIPP disposal. Prohibited quantities of liquids identified during RTR or VE will be removed and/or immobilized. Waste stream OR-REDC-CH-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. Prior to WIPP disposal, prohibited quantities of liquids identified during RTR or VE will be removed and/or immobilized. Waste stream OR-REDC-CH-HET is therefore not reactive (HWN D003) (References P161 and U011).

5.4.3.5 Polychlorinated Biphenyls

Based on a review of the AK record, incandescent bulbs, mercury-vapor bulbs, and lighting fixtures (bases) were identified in 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; however the ORNL waste management practices described in the AK record did not historically identify PCB materials as prohibited items for CH waste containers. If drums are found to contain fluorescent light ballasts or other potential PCB-containing items during RTR or VE, these containers will be managed in accordance with CCP Waste Certification Program (References 3, 8, M005, M012, P240, and P263).

5.4.4 Prohibited Items

According to TRU waste packaging procedures for Building 7920, liquids were removed from the waste or absorbed onto a solid such as vermiculite, and semi-liquid waste forms such as a sludge were 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 drums. 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 (References P161, P279, U011). However, small amounts of liquids (e.g., in spray cans) could be present.

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 (Reference M005). However, as described in Section 5.5 below, sealed containers greater than 4 liters will be present in waste generated before this date.

Certified RTR and/or VE are performed by CCP to ensure the waste does not contain prohibited items in accordance with the WIPP-WAC and WIPP-WAP.

5.5 Waste Packaging

Several inner packaging configurations may be present, including plastic bags, small cardboard ice-cream cartons, one-gallon paint cans, 1.5-gallon metal cans, and 2- or 3-gallon plastic buckets (References C098, C103, C148, P093, P263). The 1.5-gallon metal cans were slip-lid cans. Tape was wrapped around the sealing surface of the lid, but the lid has a hole in it (References C148, 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-1990, the bucket lids were snapped in place, not heat-sealed (References C098, P161, P240). The buckets that are not heat-sealed were 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 CH-TRU waste packages were placed into 55-gallon drums. The drums were lined with a single poly drum liner bag; rigid liners were not used. Drum liners may or may not be sealed with tape (References C148, P263).

5.5.1 Drum Filter Vents

The drums in this waste stream were generated between February 1978 and February 2005, so some of the drums will have filter vents installed. However, each drum will be inspected to ensure all drums have approved filter vents installed.

5.5.2 Layers of Confinement

Based on the above packaging description, the maximum number of confinement layers is three. A review of UCN-2109 forms indicates that the maximum number of confinement layers is also three; however, most of the UCN-2109 forms indicates two layers and some with one layer (Reference M005).

6.0 CONTAINER SPECIFIC INFORMATION

The primary forms completed by ORNL waste generators were the UCN-2109 and UCN-2822. The UCN-2822 is the predecessor to the UCN-2109 which has been is use since about 1993. The UCN-2109 has changed several times since its inception (Reference M005). The types of information included on these forms is as follows:

Form UCN-2822

- Container number
- Generation date
- Origin of waste (building)

- Total volume and combustible volume (cubic feet)
- Weight
- Waste type code
- Container type
- Radiological data
- Waste description

Form UCN-2109

- Container number
- Origin date
- Origin facility (building)
- Origin room/area
- Container type
- Waste description
- Radiological data
- Prohibited items
- Heat-sealed bags
- Ion-exchange resins
- Beryllium
- Combustible material
- Layers of confinement
- Sealing method
- EPA hazardous waste numbers

7.0 REFERENCES

1. CCP-TP-005, *CCP Acceptable Knowledge Documentation*.
2. *Waste Isolation Pilot Plant Hazardous Waste Facility Permit, Waste Analysis Plan,* NM4890139088-TSDF, New Mexico Environment Department, Santa Fe, New Mexico.
3. CCP-PO-001, *CCP TRU Waste Characterization Quality Assurance Project Plan*.
4. DOE/LLW-217, *DOE Waste Treatability Group Guidance*, Idaho Falls, Idaho, INEL-Lockheed Idaho Technologies.
5. DOE/WIPP-02-3122, *Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant*, Carlsbad, New Mexico, U.S. Department of Energy.
6. *Waste Isolation Pilot Plant Land Withdrawal Act* (as amended), Public Law 102-579.
7. 42 U.S.C 10141, *Nuclear Waste Policy Act*.
8. CCP-PO-002, *CCP Transuranic Waste Certification Plan.*
9. DOE/TRU-2006-3344, Transuranic Waste Baseline Inventory Report – 2004.
10. McCoy and Associates, Inc. 2002. McCoy's RCRA Unraveled. Second Edition.
11. 40 CFR Part 261, (CFR, Part 261, Identification and Listing of Hazardous Waste, U.S. EPA)

8.0 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
DR003	Generation Location Discrepancies	NA	TBD
DR004	Radiological Discrepancies	NA	TBD
DR005	EPA Hazardous Waste Number Discrepancies	NA	TBD
I002	REDC Programs Through the Years	NA	2/25/1998
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
M023	REDC Defense Determination	NA	TBD

Document Number	Title	Document Number	Date
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
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

Document Number	Title	Document Number	Date
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
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
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

Document Number	Title	Document Number	Date
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
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

Document Number	Title	Document Number	Date
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
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

Figure 1. Map of Oak Ridge National Laboratory

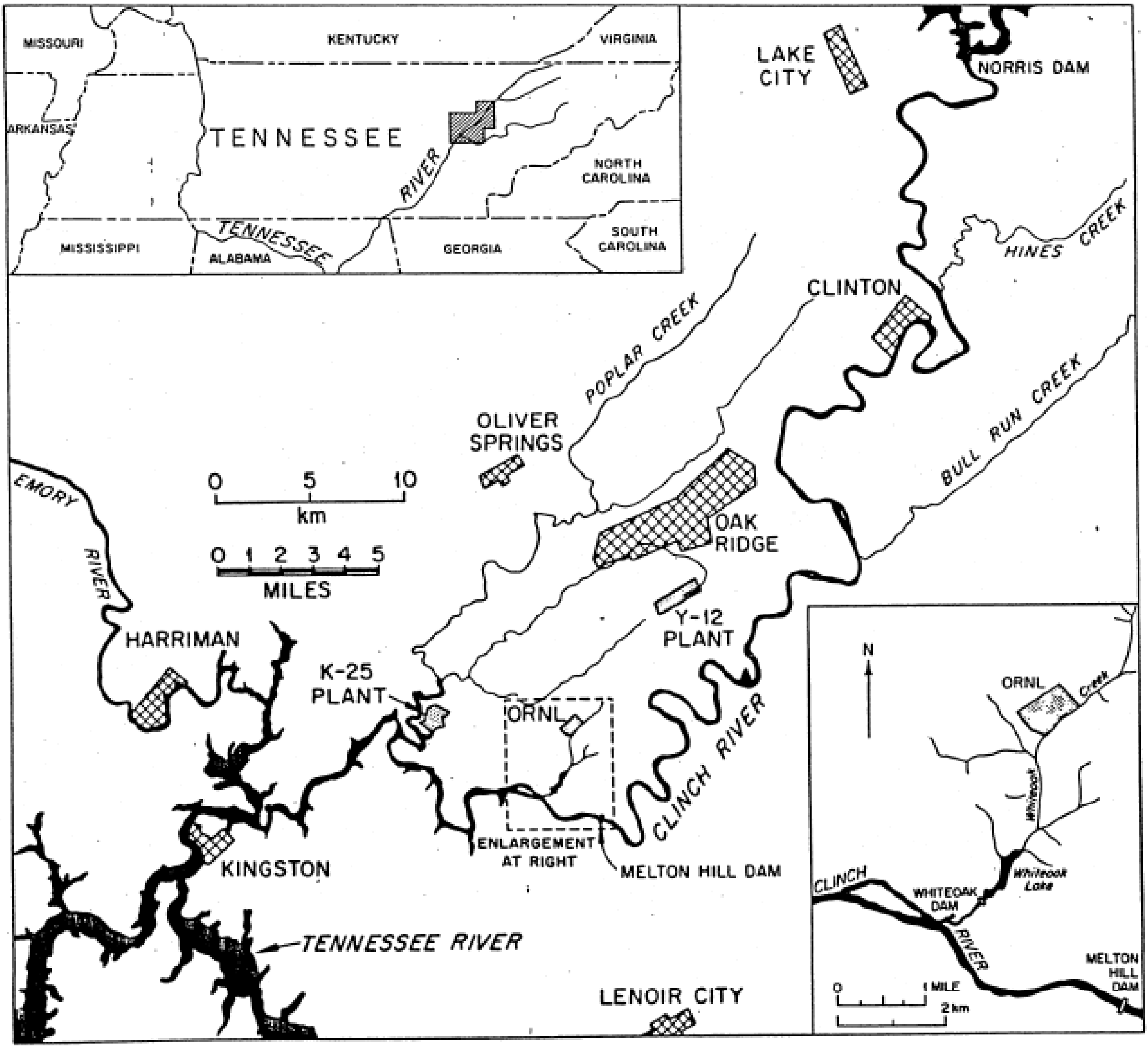

Figure 2. Map of Radiochemical Engineering Development Center, Transuranic Waste Processing Center, and Solid Waste Storage Areas

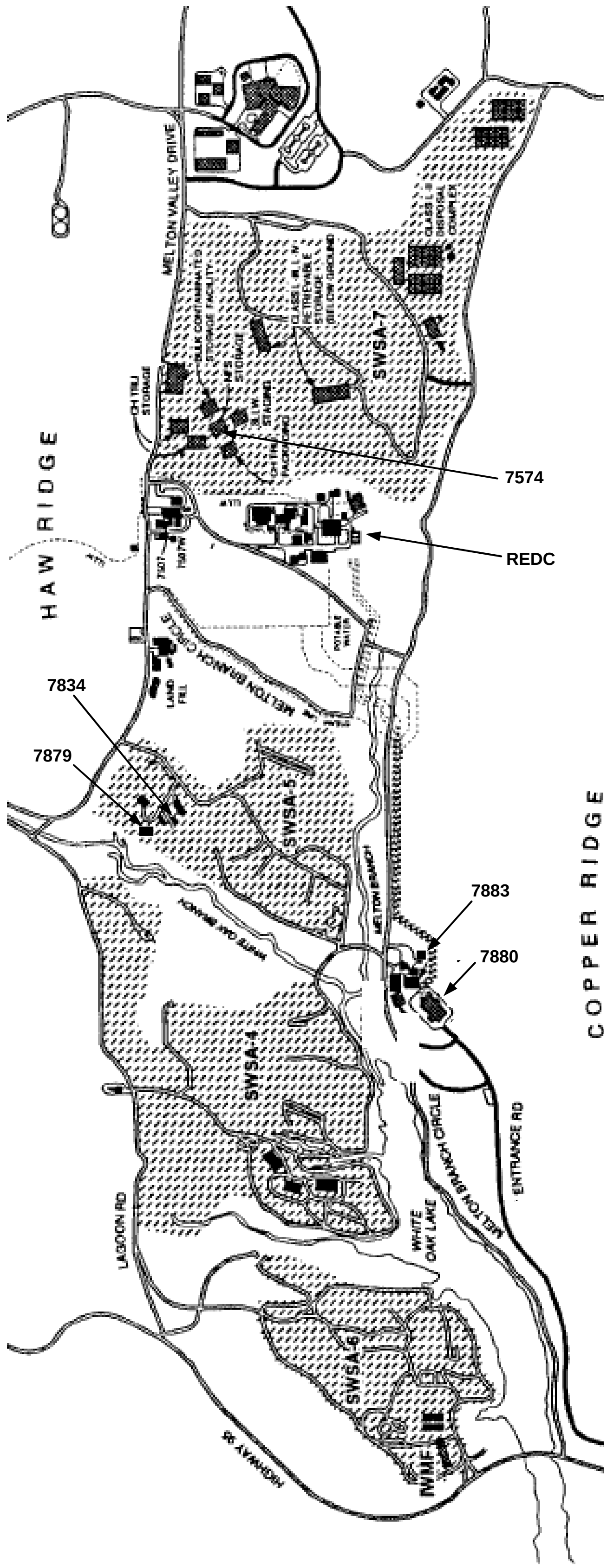

Figure 3. Location of Building 7920

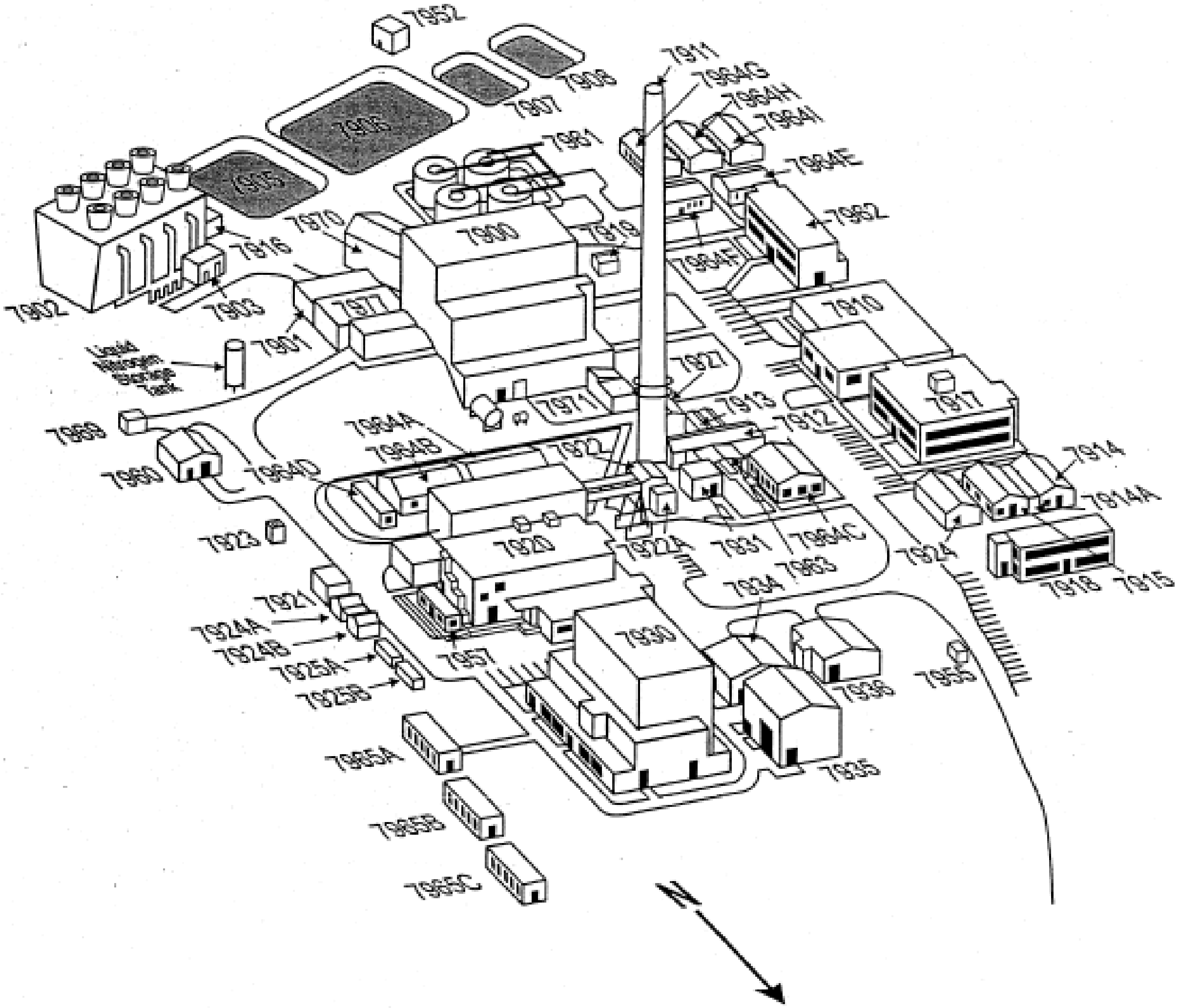

Figure 4. Transuranium Element Target Processing

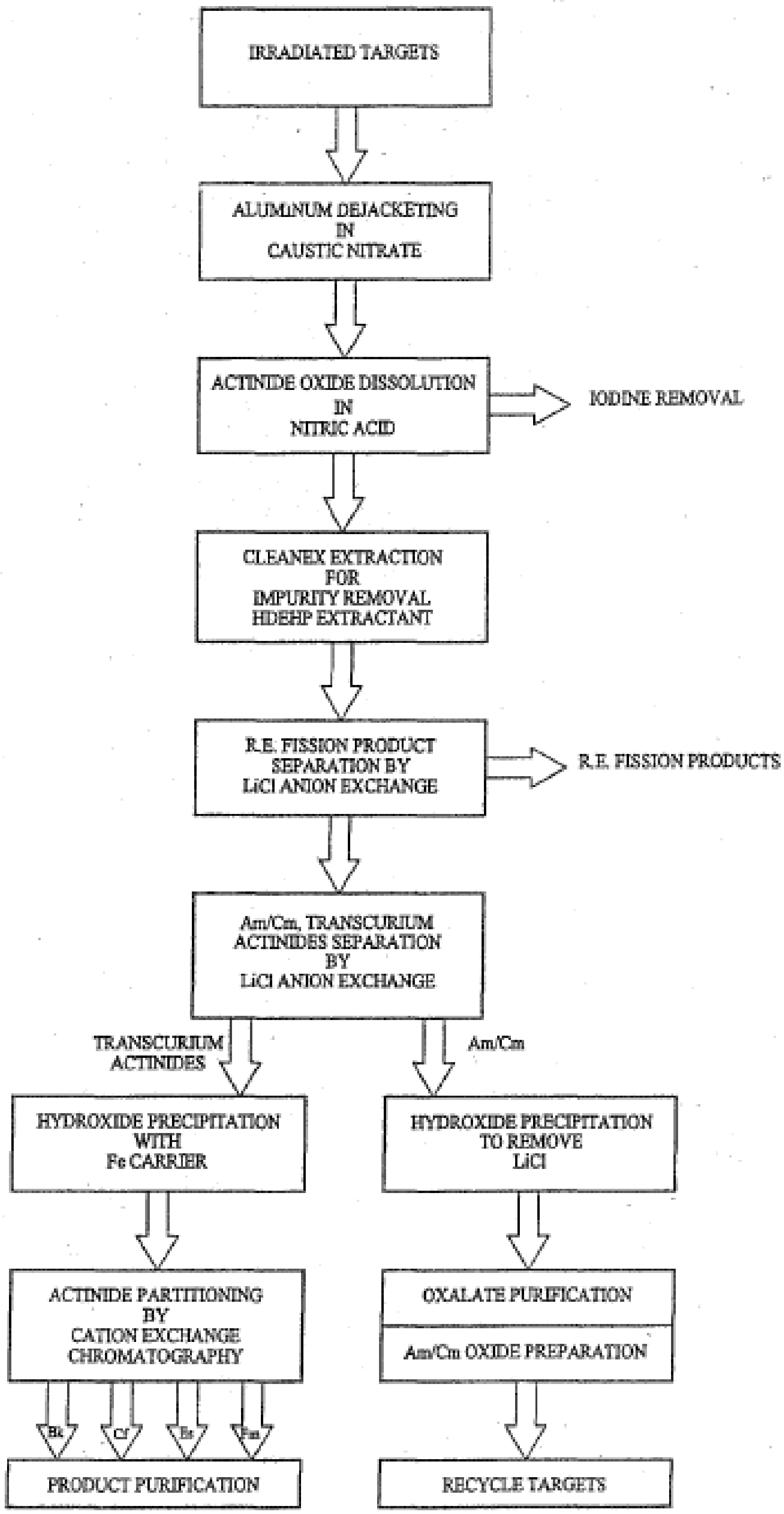

Figure 5. Solvent Extraction Test Facility Operations

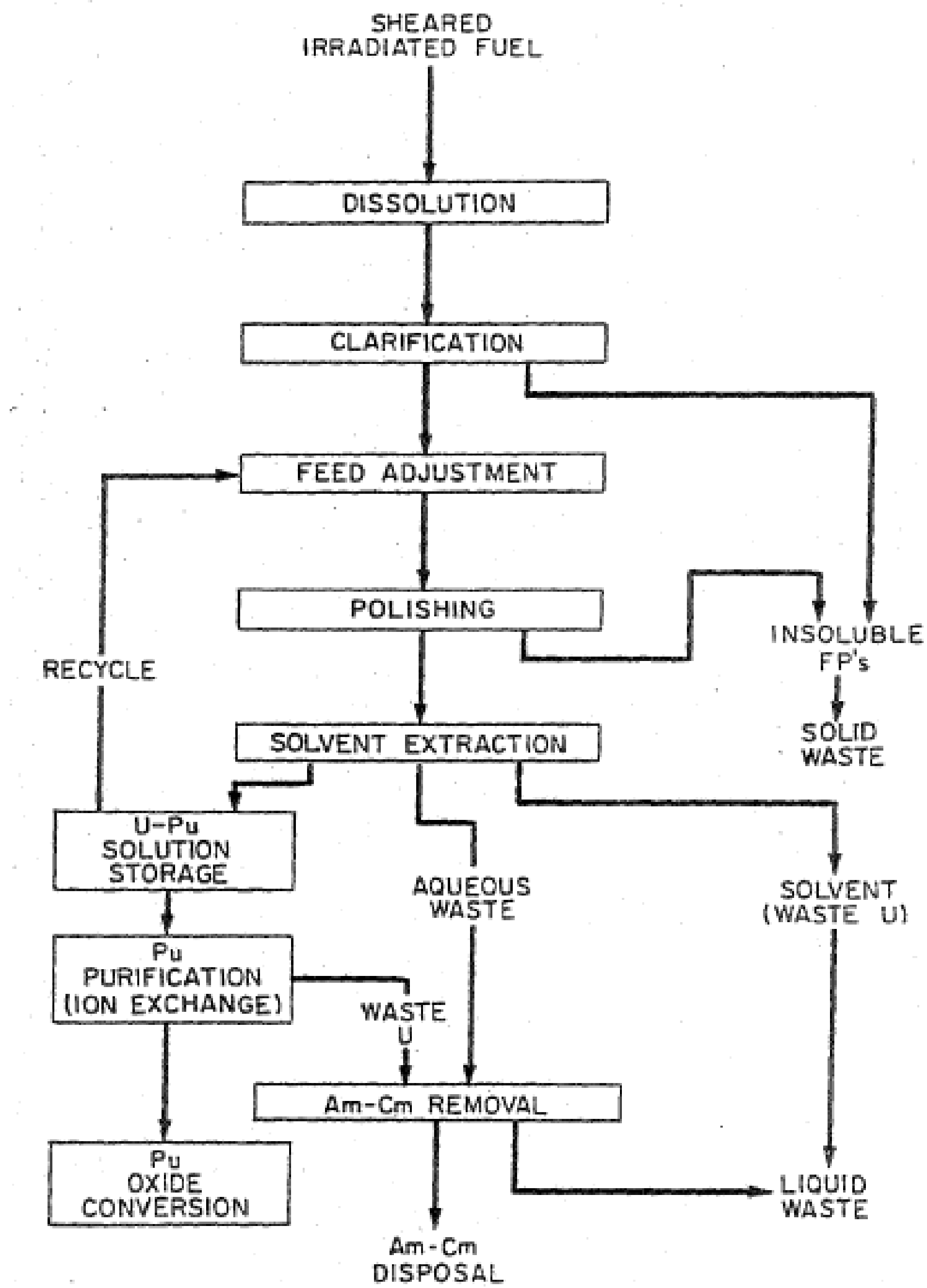

Figure 6. Mark-42 Processing

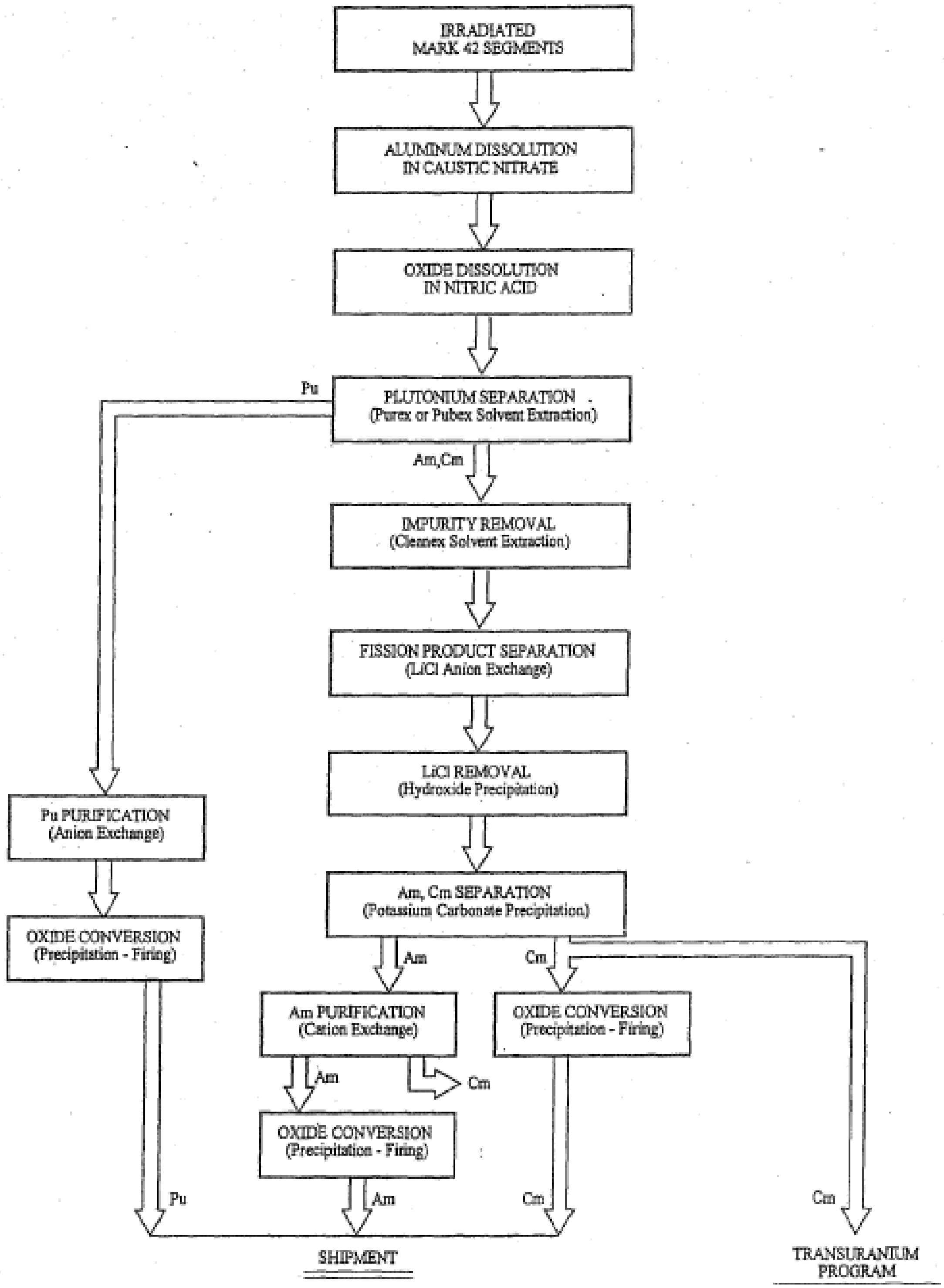

Figure 7. Pellet Fabrication

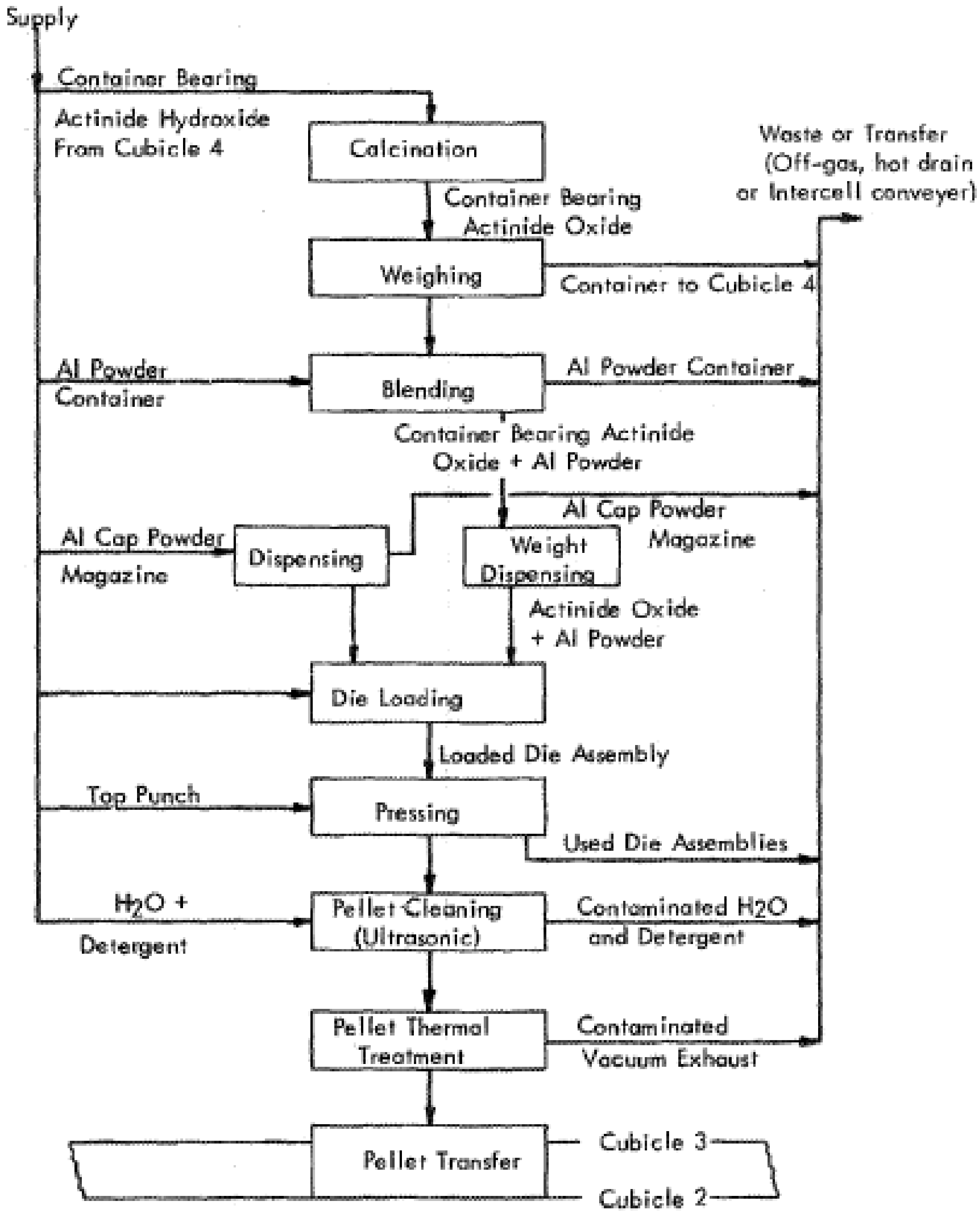

Figure 8. Target Tube Fabrication

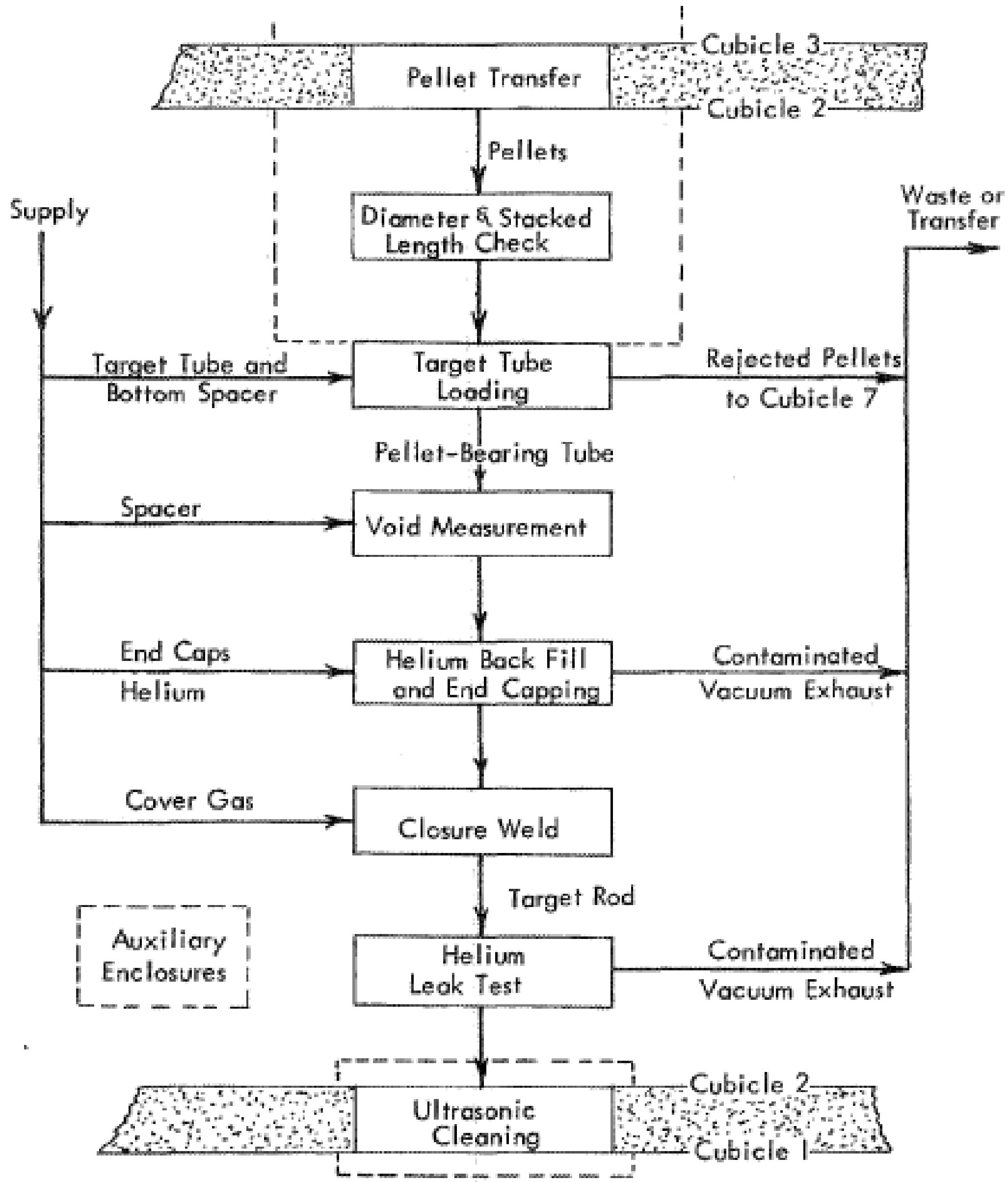

Figure 9. Target Assembly

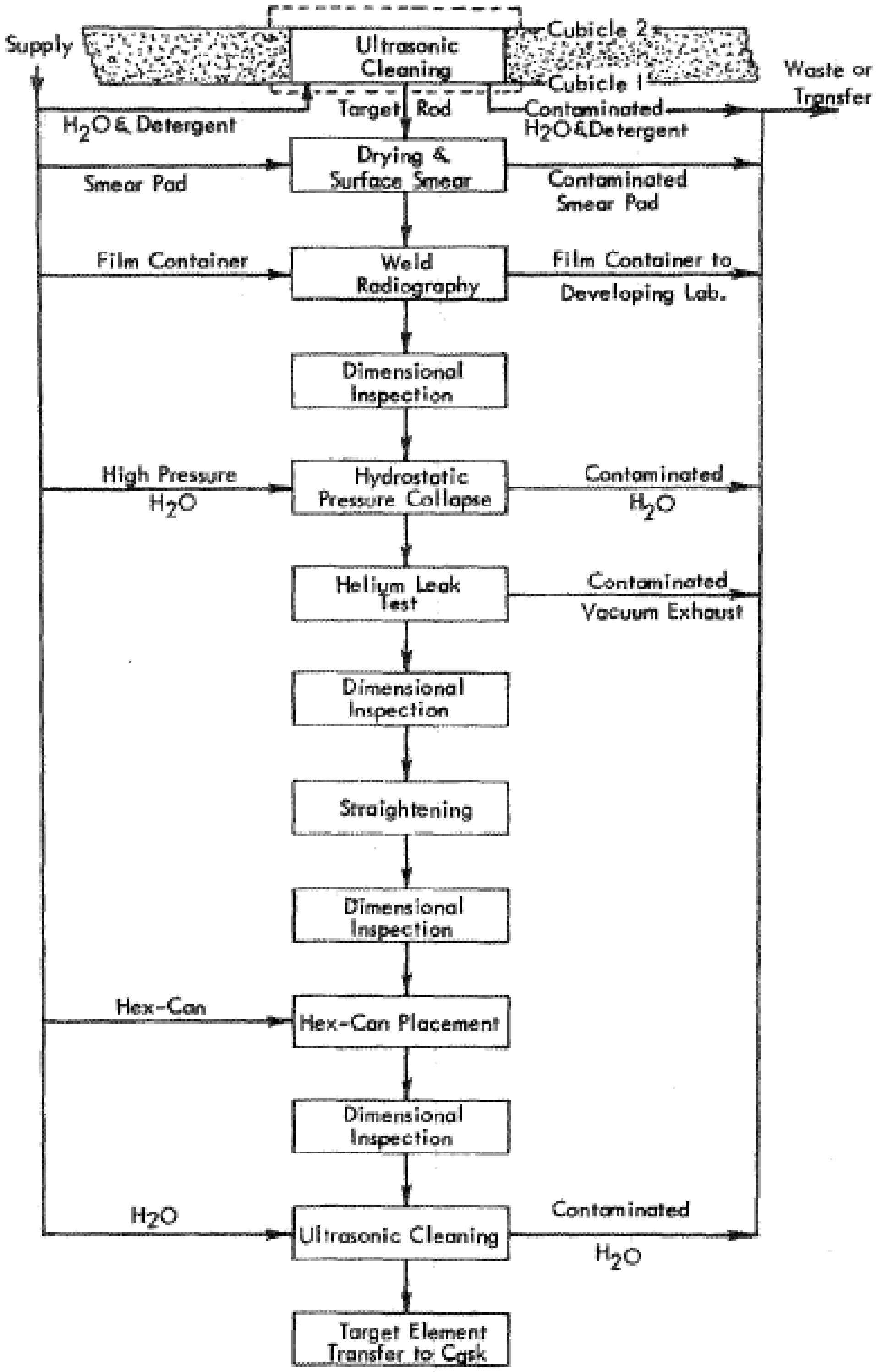

Figure 10. Transuranic Waste Processing Center CH Solid Waste Flow Diagram