ERDF-00011
Revision 1

# Environmental Restoration Disposal Facility Waste Acceptance Criteria

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

CH2MHILL
Plateau Remediation Company

**P.O. Box 1600**
**Richland, Washington 99352**

Approved for Public Release;
Further Dissemination Unlimited

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CH2M HILL Plateau Remediation Company

Date Published
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***By Lynn M. Ayers at 10:24 am, Jan 28, 2019***

Release Approval

Date

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# Signature Page

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# Revision History

| Revision | Date | Reason for Revision | Revision Initiator |
|---|---|---|---|
| 1 | 5/2018 | Clarified TRU components in Table 2. Moved paragraph regarding SWAC from Section 4.2.2 to Section 4.3. Added Hf-182 to Table C-1. Added Appendix D, "Revised ERDF Liner Compatibility Process." Replaced WCH references with applicable CHPRC references, and reformatted to CHPRC document format. The appendices were re-labeled to correspond to the order of citation in the text of the WAC. | D. B. Teachout |
| 0 | 11/2016 | Transitioned from WCH to CHPRC. Changed document number from WCH-191 to ERDF-00011, Rev. 0. No other changes. | M.A. Casbon |
| 4 | 4/2015 | Reference DOE M 435.1-1 in Section 4.1 and 4.1.4 per Low-Level Waste Federal Review Group Comment. New Appendix B added to list radionuclides that may be added to profiles as "other isotopes present." These are added per UDQ-2014-001-E, Rev. 0. The original Appendix B is now Appendix C. | M.A. Casbon |
| 3 | 1/2014 | Table 2 radionuclides were revised to reflect Tables E-1, E-3, and E4 of WCH-520 (ERDF Performance Assessment), changed to pCi/g basis, and incorporated inventory limits for certain radionuclides. These changes fulfill ERDF DAS Rev. 3, Condition 6. The Inventory Guidelines section was deleted. Chelating agents section was expanded. | M.A. Casbon |
| 2 | 10/2010 | Table 1: Removed total chromium from the table.<br>Section 4.2.3: Revised inventory guidelines for total uranium and carbon-14.<br>Section 4.3.5: Clarified restrictions on disposal of free liquids. | M.A. Casbon |
| 1 | 10/2009 | Section 4.2.2: Clarified the guidelines for the three radionuclides requiring special consideration with regard to ERDF reporting: technetium-99, carbon-14, and total uranium.<br>Section 4.2.2: Added Table 3, Total Curie Guidelines. | M.G. Peloquin |
| 0 | 01/2008 | Initial issuance. | N/A |

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# Terms

| | |
|---|---|
| CERCLA | *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* |
| CFR | *Code of Federal Regulations* |
| CHPRC | CH2M HILL Plateau Remediation Company |
| Ecology | Washington State Department of Ecology |
| EPA | U.S. Environmental Protection Agency |
| ERDF | Environmental Restoration Disposal Facility |
| ESD | explanation of significant difference |
| LDR | land disposal restriction |
| OWTF | Onsite Waste Tracking Form |
| PA | performance assessment |
| PCB | polychlorinated biphenyl |
| ppm | parts per million |
| RCRA | *Resource Conservation and Recovery Act of 1976* |
| RCW | *Revised Code of Washington* |
| RI/FS | remedial investigation/feasibility study |
| ROD | Record of Decision |
| SOF | sum-of-the-fractions |
| SWAC | supplemental waste acceptance criteria |
| TRU | transuranic |
| WAC | *Washington Administrative Code* |

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# 1 Introduction

The Environmental Restoration Disposal Facility (ERDF) is authorized to operate through a *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) Record of Decision (ROD) issued by the U.S. Environmental Protection Agency (EPA) (EPA/ROD/R10-95/100, *Record of Decision, U.S. DOE Hanford Environmental Restoration Disposal Facility, Hanford Site, Benton County, Washington*) (hereinafter referred to as the ERDF ROD). ERDF is designed to serve as a waste isolation structure for bulk soil, demolition debris, and miscellaneous contaminated material from Hanford Site remediation activities conducted under CERCLA authority. An explanation of significant difference (ESD) to the ERDF ROD was issued in 1996 (EPA et al., 1996, *USDOE Environmental Restoration Disposal Facility, Hanford Site, Benton County, Washington, Explanation of Significant Difference (ESD)*) to allow for disposal of investigation-derived waste. Following the issuance of the ESD, several ROD amendments have been approved and issued.

- 1997 ROD Amendment (EPA/AMD/R10-97/101, *EPA Superfund Record of Decision Amendment: U.S. Department of Energy Environmental Restoration Disposal Facility Hanford Site – 200 Area Benton County, Washington*), allows treatment of waste by encapsulation or stabilization and authorizing expansion of the ERDF.
- 1999 ROD amendment (EPA/AMD/R10-99/038, *EPA Superfund Record of Decision Amendment: U.S. Department of Energy Environmental Restoration Disposal Facility Hanford Site – 200 Area Benton County, Washington*), delisted ERDF leachate from *Resource Conservation and Recovery Act of 1976* (RCRA) hazardous waste regulations contingent upon meeting certain criteria and requirements.
- 2002 ROD amendment (EPA/AMD/R10-02/030, *Record of Decision Amendment: U.S. Department of Energy Environmental Restoration Disposal Facility Hanford Site – 200 Area Benton County, Washington*), authorizes further expansion of ERDF and allowed staging of remediation waste at ERDF pending treatment.
- 2007 ROD amendment (EPA et al., 2007, *U.S. Department of Energy Environmental Restoration Disposal Facility Hanford Site – 200 Area Benton County, Washington Amended Record of Decision, Decision Summary and Responsiveness Summary*), authorizes ERDF disposal of specific Hanford Site-only wastes in storage and created a "plug-in" approach for disposal of additional Hanford Site-only-generated waste in storage.
- 2009 ROD amendment (EPA et al., 2009, *U.S. Department of Energy Environmental Restoration Disposal Facility, Hanford Site – 200 Area, Benton County, Washington, Record of Decision Amendment Authorizing Supercells 9 & 10*), authorizes two additional disposal cells each with a new "supercell" configuration (two original-size cells constructed as a single cell).
- 2015 ROD amendment (EPA et al., 2015, *U.S. Department of Energy Environmental Restoration Disposal Facility, Hanford Site – 200 Area, Benton County, Washington, Record of Decision Amendment Authorizing Treatment of LLHH Waste Items in the ERDF Trench*), authorizes treatment of specific classes of hazardous debris items inside the trench.

## 1.1 Purpose

The purpose of this document is to establish the ERDF waste acceptance criteria for disposal of materials resulting from Hanford Site cleanup activities. Explanation of and compliance with the requirements of

this document will enable implementation of appropriate measures to protect human health and the environment, ensure the integrity of the ERDF liner system, facilitate efficient use of the available space at ERDF, and comply with applicable or relevant and appropriate requirements. To serve this purpose, this document defines responsibilities, identifies the waste acceptance process, and provides the primary acceptance criteria and regulatory citations to guide ERDF users. The information contained in this document is not intended to repeat or summarize the contents of all applicable regulations.

## 1.2 Scope

ERDF is designed to RCRA minimum technology requirements and *Toxic Substances Control Act of 1976* specifications for chemical landfills. The facility is authorized to accept waste resulting from Hanford Site environmental restoration activities. The process and criteria for waste acceptance established by this document apply to the ERDF management and operations team and all users of the facility.

# 2 Responsibilities

An EPA and Washington State Department of Ecology (Ecology) agreement has been developed for project management under a single regulatory agency. EPA serves as the lead regulatory authority for oversight of ERDF operations. The lead agency for operation and management of ERDF is the U.S. Department of Energy. CH2M HILL Plateau Remediation Company (CHPRC) and its subcontractors are responsible for managing and operating the ERDF on a day-to-day basis.

ERDF users are responsible for performing activities in accordance with this document and CHPRC policies and procedures. A system of checks and balances is in place to ensure that the appropriate level of coordination exists among ERDF and its various users. A series of interface points is designed to communicate waste receipt schedules, waste quantity and form, characterization information, waste certification, treatment requirements, packaging, transportation, documentation, receipt, and disposal. A general description of the system is presented below and is detailed in the CHPRC procedure system.

## 2.1 Environmental Restoration Disposal Facility Management and Operations Team

The ERDF management and operations team includes personnel assigned to provide oversight and to operate the facility and transport waste.

### 2.1.1 Personnel

The personnel assigned to the ERDF management and operations team are responsible for the following:

- Reviewing and approving/rejecting profiles provided by ERDF users of new waste based on health and safety, chemical and radiological characteristics, ERDF liner compatibility, physical form, applicable or relevant and appropriate requirements, requirements set forth in this document, and the ERDF RODs (as amended) (EPA/ROD/R10-95/100; EPA/AMD/R10-97/101; EPA/AMD/R10-99/038; EPA/AMD/R10-02/030; EPA et al., 2007, 2009, 2015)
- Managing ERDF subcontracts
- Integrating subcontractor services with ERDF users
- Maintaining a proactive quality assurance oversight program for timely identification of deficiencies and implementation of appropriate corrective actions

### 2.1.2 Environmental Restoration Disposal Facility Operations

The ERDF operations team is responsible for the following:

- Developing and maintaining waste acceptance plans, procedures, and supporting data to ensure consistency with ERDF waste acceptance criteria, applicable regulatory requirements, and terms of the contract
- Reviewing waste documentation against the waste acceptance criteria
- Transporting waste in compliance with applicable environmental regulations and in coordination with ERDF users
- Reviewing the waste shipment documentation against the waste profile information
- Performing waste management inspections, as appropriate
- Performing waste treatment at ERDF and maintaining cells and leachate systems
- Managing records associated with disposal of waste at ERDF

## 2.2 Environmental Restoration Disposal Facility Users

Users of ERDF are responsible for the following:

- Considering ERDF requirements during the remedial design/remedial action process
- Obtaining and/or confirming regulatory authority for disposal of waste at the ERDF and coordination at ERDF, if necessary
- Participating in routine planning, as necessary
- Developing, documenting, and implementing an appropriate sampling and analysis program approved by the lead regulatory agency, when required
- Characterizing waste to ensure proper documentation of types and quantities of radionuclides, dangerous/hazardous constituents, and physical and chemical characteristics
- Evaluating treatment options for waste disposal, when applicable
- Conducting treatment in accordance with the approved process plan
- Preparing the waste profile, designating the waste, and obtaining ERDF acceptance for each waste source or group of waste sources
- Preparing an Onsite Waste Tracking Form (OWTF) or equivalent documentation required for each waste shipment
- As required, interfacing with the ERDF management and operations team to ensure that packaging, labeling, and handling of each shipment is in compliance with the appropriate waste acceptance criteria and state/federal waste transport regulations

# 3 Waste Acceptance Process

Waste entering ERDF shall be controlled on the basis of source, physical form, and contaminant concentration and activity levels. A uniform and consistent waste acceptance process shall be implemented to include planning, waste certification, shipment, receipt, and disposal.

## 3.1 Planning

ERDF users should provide long-term and operational project schedules to ERDF management and operations team for use as a planning tool.

## 3.2 Waste Certification

Waste certification is the combination of characterization, designation, and verification in accordance with the requirements of PRC-PRO-WM-53829, *ERDF Waste Acceptance Process*, to ensure that applicable acceptance criteria are met.

### 3.2.1 Characterization

Characterization identifies the nature and extent of radioactive and dangerous/hazardous material contamination and describes the physical properties of the waste material. Characterization shall be performed in accordance with PRC-PRO-WM-53829 based on historical analytical data, process knowledge, sample collection and analysis, or a combination thereof. Characterization objectives for activities involving sample collection and analysis will be identified in accordance with PRC-PRO-SMP-53095, *Data Quality Objectives Planning Process*. Data quality will be ensured through oversight and assessment.

#### 3.2.1.1 *Radioactive Waste*

Radioactive waste constituents shall be adequately characterized to permit proper segregation, treatment, storage, and/or disposal. This characterization shall ensure that the major radionuclide content of the waste is known and recorded during the waste management process.

A major radionuclide is defined as any radionuclide that meets all of the following conditions:

- Has a half-life >2 years
- Is present in a concentration >1 pCi/g
- Is not in secular equilibrium with a parent nuclide[1]
- Is not a naturally occurring radionuclide at an activity level consistent with levels determined in DOE/RL-96-12, *Hanford Site Background: Part 2, Soil Background for Radionuclides*

#### 3.2.1.2 *Dangerous/Hazardous/Toxic or Mixed Waste*

Waste that is determined to be dangerous/hazardous/toxic shall be further evaluated to determine if the waste is prohibited and/or if the waste satisfies applicable treatment standards. Land disposal restriction (LDR) status of the waste shall be determined for dangerous/hazardous or mixed waste based on the requirements of 40 CFR 268, Subpart D, "Land Disposal Restrictions," "Treatment Standards"; and WAC 173-303-140, "Dangerous Waste Regulations," "Land Disposal Restrictions." This determination

[1] If both parent and daughter radionuclides are present in a waste stream and both have an inventory threshold listed in Table 2, both must be included in the profile covering that waste stream (e.g., uranium-233 and thorium-229).

may be satisfied by reference to existing waste characterization data through waste analysis or by citation of pertinent LDR waivers or variances, as approved by EPA or Ecology.

### 3.2.2 Waste Profile/Designation

Based on the characterization information, waste profiles and a waste designation shall be developed and approved for each waste source (or sufficiently similar group of waste sources) in accordance with the requirements specified in PRC-PRO-WM-53829. Waste profiles shall be provided to and approved by the ERDF management and operations team prior to any associated waste shipments to ensure compliance with the acceptance criteria and to facilitate planning of waste transportation and disposal actions.

Waste designation shall be confirmed through the verification program specified in Section 3.2.3. If a change to the waste designation is required as a result of verification activities, the ERDF management and operations team shall be notified.

### 3.2.3 Verification

All ERDF users shall implement a verification program to ensure that waste intended for disposal at ERDF is within the established waste profile. Verification activities may include application of process knowledge, observation, process monitoring, sample collection and analysis, or a combination thereof. Verification activities involving process monitoring or sample collection and analysis shall be planned and documented as specified in Section 3.2.1 and may include periodic ERDF oversight and assessment processes. For small waste streams (e.g., a single container or total volume from a spill), characterization and verification activities may consist of a single event.

If a determination is made through verification activities that the physical nature, constituents, or constituent concentrations are not covered or exceed those documented in the approved waste profile, the ERDF management and operations team shall be notified. After the project re-evaluates the assumptions used for waste profiling and characterization, the profile shall be revised to reflect the new values and submitted to the ERDF management and operations team.

## 3.3 Shipment

The shipment of waste for disposal at ERDF is subject to the requirements of PRC-PRO-WM-40223, *Environmental Restoration Disposal Facility Waste Process*, and applicable regulations.

### 3.3.1 Transportation and Packaging

All waste shipments on public roadways shall fully comply with applicable U.S. Department of Transportation regulations contained in 49 CFR, "Transportation." Where public roadways will not be used for waste transport, alternate packaging that meets safety standards equivalent to U.S. Department of Transportation requirements may be used.

### 3.3.2 Shipping Documentation

All waste shipments shall be accompanied with the associated documentation required for disposal at ERDF in accordance with PRC-PRO-WM-40223.

### 3.3.3 Authorization to Ship

A positive determination that a waste source meets ERDF waste acceptance criteria shall be made prior to the associated waste being transported to ERDF for disposal. Authorization to ship is provided through a waste disposal approval number that is obtained from the ERDF management and operations team on a per-shipment basis.

## 3.4 Receipt and Disposal

Waste received at ERDF that is within the profile approved by ERDF; meets ERDF-00003, *Supplemental Waste Acceptance Criteria for the Environmental Restoration Disposal Facility* (hereinafter referred to as the ERDF supplemental waste acceptance criteria [SWAC]); has been authorized for disposal by a regulatory agency-approved CERCLA or RCRA past-practice decision document (as described in Chapter 4.0); and is accompanied by appropriate documentation (specified in Section 3.3.2) shall be disposed in accordance with ERDF operations process.

### 3.4.1 Noncompliant Waste

Waste shipped to ERDF with noncompliant conditions shall require appropriate resolution prior to waste acceptance. Resolution alternatives may include, but are not limited to, correction of the noncompliant condition at ERDF, conditional acceptance of the waste at ERDF, or return of the waste to the source location for correction. Waste shall not be disposed at ERDF until the noncompliant condition is rectified. In addition to short-term rectification of the noncompliant condition to permit disposal, further steps shall be taken to determine the underlying cause of the problem and implement corrective actions as necessary to prevent recurrence. Noncompliance shall be addressed in a manner consistent with PRC-MP-QA-599, *Quality Assurance Program.*

# 4 Waste Acceptance Criteria

ERDF is authorized to accept low-level radioactive, hazardous/dangerous, asbestos, polychlorinated biphenyl (PCB), and mixed wastes only from cleanup of operable units within the 100, 200, and 300 Area National Priorities List sites of the Hanford Site in accordance with the ERDF Record of Decision, Explanation of Significant Differences, and associated amendments to the Record of Decision (as detailed in Chapter 1 of this document). As provided in these documents, inactive treatment, storage, and disposal; RCRA past-practice; and decontamination and decommissioning waste may be placed in ERDF through a remedial action ROD or removal action memorandum issued in accordance with CERCLA and 40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan." Waste that has not been subjected to the waste acceptance process defined in Chapter 3 shall not be accepted for disposal at ERDF.

## 4.1 Criteria Basis

The basis for acceptance criteria includes protection of human health and the environment; protection of the ERDF liner system; control of waste form; compliance with environmental regulations as authorized by the ERDF ROD, ESD, and ROD amendments, as well as compliance with DOE M 435.1-1, Chg 2, *Radioactive Waste Management Manual.*

### 4.1.1 Protection of Human Health and the Environment

Worker protection shall be provided by compliance with the requirements of the health and safety plans for ERDF; 29 CFR 1910, "Occupational Safety and Health Standards"; and applicable waste transportation regulations in 10 CFR, "Energy," and 49 CFR. Occupational exposure was evaluated in DOE/RL-93-99, *Remedial Investigation and Feasibility Study Report for the Environmental Restoration Disposal Facility* (hereinafter referred to as the ERDF remedial investigation/feasibility study [RI/FS]) and helped establish the necessary dangerous/hazardous constituent limits to ensure that occupational exposure is within required limits. The waste handling at ERDF shall be consistent with maintaining worker exposure as low as reasonably achievable. Workers shall be protected from direct

radiation and radioactive materials in accordance with the requirements of 10 CFR 835, "Occupational Radiation Protection."

The primary long-term routes of exposure to dangerous/hazardous constituents and the radionuclides that are of concern after placement of waste at ERDF include ingestion of contaminated groundwater or intrusion into the waste. The ERDF RI/FS (DOE/RL-93-99) evaluated the risk from dangerous/hazardous constituents. CP-60089, *Performance Assessment for the Environmental Restoration Disposal Facility, Hanford Site, Washington* (hereinafter referred to as the ERDF Performance Assessment [PA]), and the ERDF RI/FS (DOE/RL-93-99) evaluated the risk from radionuclides in the waste and established limits necessary to protect human health in accordance with the requirements of DOE O 435.1, Chg 1, *Radioactive Waste Management*. A crosswalk between the DOE O 435.1, Chg 1, waste acceptance criteria content requirements, this waste acceptance criteria, and additional documents, is included in Appendix A.

### 4.1.2 Protection of the ERDF Liner System

A compatibility study of materials proposed for the ERDF liner system and expected waste leachate was performed (BHI-00359, *Evaluation of Liner/Leachate Chemical Compatibility for the Environmental Restoration Disposal Facility*). The study concluded that the manufacturer-recommended limits associated with the high-density polyethylene geomembrane liners were several orders of magnitude higher than the estimated maximum ERDF leachate concentrations. Based on the results of the study, dangerous/hazardous constituent concentration limits were established to ensure liner integrity. The study did not show any threat to the liner from radionuclides.

Waste with constituents in sufficient concentration that could result in loss of liner integrity shall not be accepted. A revised ERDF liner compatibility evaluation process (Appendix B) reviewed 20 years of leachate sampling and information from liner manufacturers discussed in BHI-00359, and the process determined that a review of new chemicals (which was taking place) was no longer necessary, except where bulk (i.e., >23 kg [>50 lb]) quantities of organic chemicals exceeding 50 ppm in the as-disposed material are proposed for disposal at ERDF.

Specific chemical limits (other than liner compatibility) are discussed in Section 4.2.1.

### 4.1.3 Control of Waste Form

The physical form of the waste shall be controlled to minimize void space in ERDF and facilitate loading, transportation, unloading, and handling of waste. Additional implementation requirements regarding waste form are identified in the ERDF SWAC (ERDF-00003).

### 4.1.4 Compliance with Environmental Regulations

ERDF users shall determine whether waste is subject to LDR by completing a designation and, if designated as dangerous/hazardous, by evaluating concentrations for the constituents of concern against the applicable treatment standards or prohibition levels. Washington State LDR requirements are provided in WAC 173-303-140. The federal treatment standards and prohibition levels that apply to LDR waste are published in 40 CFR 268. For waste that is hazardous by characteristic, the underlying hazardous constituents specified in 40 CFR 268.48, "Universal Treatment Standards," that can reasonably be expected to be present at the point of generation of the hazardous waste shall also be evaluated. In the treatment of LDR waste, 40 CFR 268.3, "Dilution Prohibited as a Substitute for Treatment," prohibits diluting the waste as a substitute for adequate treatment. All waste analysis and supporting information relative to LDR compliance shall be retained at ERDF for a minimum of the life of the facility.

Waste profile and OWTF documentation for all dangerous/hazardous waste shipped to ERDF shall include information similar to that found in 40 CFR 268.7, "Testing, Tracking, and Recordkeeping Requirements for Generators, Treaters, and Disposal Facilities," including waste code and applicable treatment standard, subcategory, and underlying dangerous/hazardous constituents. If the treatment standard is expressed in terms of a concentration limit, the actual concentration of the restricted constituent shall also be reported. If the waste has no listed waste codes and no longer exhibits the characteristic of a dangerous/hazardous waste because it has been treated, the OWTF shall include a statement that the waste meets LDR. Wastes requiring treatment have automatically generated on the OWTF a watermark stating "Treatment Required."

An alternative to treatment of dangerous/hazardous waste to meet the LDR standards and allow for disposal of waste in ERDF is a treatability variance or receipt of a CERCLA waiver. Appropriate documentation is required before shipment of any dangerous/hazardous waste to ERDF that has previously been exempted from meeting the LDR treatment standard. Documentation may include an exclusion (or, for CERCLA onsite actions, demonstrating approved qualifications for an exclusion); a variance in accordance with 40 CFR 268.5, "Procedures for Case-by-Case Extensions to an Effective Date"; 40 CFR 268.6, "Petitions to Allow Land Disposal of a Waste Prohibited Under Subpart C of Part 268"; or 40 CFR 268.44, "Variance from a Treatment Standard"; or a waiver in accordance with 40 CFR 300.430(f)(1)(ii)(C), "Remedial Investigation/Feasibility Study and Selection of Remedy."

The treatment and performance standard for dangerous/hazardous debris is specified in 40 CFR 268.45, "Treatment Standards for Hazardous Debris." Dangerous/hazardous debris must be treated either by the waste-specific standards in 40 CFR 268.40, "Applicability of Treatment Standards," for each waste contaminating the debris or the standards presented in the alternative treatment standards for dangerous/hazardous debris table found in 40 CFR 268.45.

Waste acceptance criteria for radionuclide concentrations and inventory limits are developed in the ERDF PA (CP-60089). The ERDF PA was performed in compliance with DOE M 435.1-1, Chg 2.

## 4.2 Concentration Limits

Prior to consideration of concentration limits, the site-specific acceptance requirements must be met in accordance with the ERDF ROD ESD (EPA/ROD/R10-95/100; EPA et al., 1996). The ERDF concentration and performance limits for chemical constituents, radionuclides, and mixed wastes are provided in the following subsections.

### 4.2.1 Chemical Constituents

The LDR treatment standards for dangerous/hazardous waste codes are found in 40 CFR 268, Subpart D, and WAC 173-303-140 and should be consulted to confirm the most current LDR standard.

Secondary limits for various chemical constituents are identified in Table 1. Chemicals should be evaluated against the applicable standards in the LDR treatment standards before being evaluated against Table 1 criteria. Limits in Table 1 represent exposure limits determined by risk modeling in the ERDF RI/FS (DOE/RL-93-99). Liner compatibility (see Section 4.1.2) and worker exposure limits will be evaluated separately.

**Table 1. Chemical Concentration Limits**

| Constituent Name | Limit (mg/kg)[a] |
|---|---|
| **Semivolatile Organic Compounds** | |
| Benzo(a)pyrene | 2.5E+04 |
| Benzo(k)fluoranthene | 2.5E+04 |
| **Pesticides/PCBs** | |
| 4,4'DDD | 7.6E+05 |
| 4,4'DDE | 5.4E+05 |
| PCBs | 50 (liquids)[b] |
| Beta-BHC (Lindane) | 3.3E+03 |
| **Metals** | |
| Antimony | 1.9E+04 |
| Arsenic | 3.0E+03 |
| Barium | 9.4E+05 |
| Cadmium | 3.9E+04 |
| Chromium (VI) | 5.9E+04 |
| Manganese | 4.4E+05 |
| Selenium | 4.0E+05 |
| Silver | 3.5E+05 |
| Thallium | 5.6E+03 |
| Vanadium | 3.3E+05 |
| Zinc | 3.0E+05 |

a. Public exposure (DOE/RL-93-99, *Remedial Investigation and Feasibility Study Report for the Environmental Restoration Disposal Facility*) is limiting.

b. See Section 4.3.4.

BHC = benzene hexachloride

DDD = dichlorodiphenyldichloroethane

DDE = dichlorodiphenyldichloroethylene

#### 4.2.1.1 *Identification of Underlying Hazardous Constituents*

Wastes that would be designated as RCRA dangerous wastes must meet the LDR standards identified in 40 CFR 268 and WAC 173-303-140 *prior* to placement in ERDF. Dangerous wastes designated due to the presence of toxicity characteristic leaching procedure metals (waste codes D004 through D011) are generally required to meet the LDR treatment standards for underlying hazardous constituents in 40 CFR 268.48 if the waste is generated under a decision document signed after May 1998. Toxicity characteristic leaching procedure metal wastes associated with CERCLA decision documents signed prior to May 1998 may be "grandfathered," such that compliance with the treatment standards of 40 CFR 268 in effect at the time of the decision document may be used in lieu of the current standards.

### 4.2.2 Radionuclides

Concentration and total inventory limits established for radionuclides are identified in Table 2. All concentration limits are taken from the ERDF PA, Appendix E, Table E-1 (first column) (CP-60089). With regard to concentration limits, when two or more radionuclides are present in a waste, the sum-of-the-fractions (SOF) method shall be used to determine acceptability. Each constituent in the waste mixture must be divided by its limit from Table 2, with the sum being ≤1.0. Radionuclides having negligible impacts on dose scenarios in the PA were not assigned a concentration value and need not be included in SOF calculations.

Inventory limits (i.e., limits in total curies of particular radionuclides), where listed, are taken from the ERDF PA, Appendix E, Table E-4 (CP-60089), and are also subject to SOF calculations. Two separate SOF calculations are required. Radionuclides with inventory limits fall into one of two separate categories: (1) those contributing to the 25 mrem all-pathways limit (Table 2, footnote c), or (2) those contributing to the 10 mrem air pathway limit (Table 2, footnote d). The peak doses for the 25 mrem all-pathways and the 10 mrem air pathway occur at significantly different times and do not overlap. The 10 mrem air pathway peak occurs at <1,000 years and declines sharply afterward, while the 25 mrem all-pathways peak, which is primarily groundwater based, reaches its maximum value at 6,500 to 7,500 years. Therefore, separate SOF calculations will be performed for each category.

Some radionuclides are subject to greater than U.S. Nuclear Regulatory Commission Class C or transuranic (TRU) limits (Table 2, footnotes d and a, respectively). These two limits take precedence over the values given in Table 2. However, the PA-derived threshold concentration limits are shown for use in SOF calculations. Radionuclides with no values shown in the "Threshold Concentration" or "Total Inventory Limit" columns have no limits for purposes of SOF calculations. No special limits are set for activated metals. TRU limits (1.00E+05) are shown in addition to the SOF values.

**Table 2. Radionuclide Concentration and Inventory Limits**

| Constituent | Threshold Concentration (pCi/g) | Total Inventory Limit (Ci) | Footnotes |
|---|---|---|---|
| Ac-227 | 2.83E+03 | — | — |
| Ag-108m | 6.99E+04 | — | — |
| Am-241 | 8.25E+04[a] | — | a |
| Am-242m | 1.00E+05[a] | — | b, a |
| Am-243 | 6.49E+04[a] | — | a |
| Ba-133 | NL | — | b |
| Be-7 | NL | — | b |
| Bi-207 | NL | — | b |
| C-14 | 2.43E+05 | 2.43E+04 | c, d |
| Ca-41 | NL | — | e |
| Cd-113m | 1.00E+06 | — | — |
| Ce-144 | NL | — | b |
| Cf-249 | 1.00E+05[a] | — | b, a |

**Table 2. Radionuclide Concentration and Inventory Limits**

| Constituent | Threshold Concentration (pCi/g) | Total Inventory Limit (Ci) | Footnotes |
|---|---|---|---|
| Cf-252 | NL | — | b |
| Cl-36 | 4.32E+03 | 3.42E+02 | g |
| Cm-242 | NL | — | b, d |
| Cm-243 | 1.00E+05[a] | — | a |
| Cm-244 | 4.76E+06 | — | d |
| Cm-245 | 1.00E+05[a] | — | b, a |
| Cm-246 | 1.00E+05[a] | — | b, a |
| Cm-247 | 1.00E+05[a] | — | b, a |
| Cm-248 | 1.00E+05[a] | — | b, a |
| Co-58 | NL | — | b |
| Co-60 | 7.18E+09 | — | — |
| Cs-134 | NL | — | b |
| Cs-135 | NL | — | b |
| Cs-137 | 8.47E+05 | — | d |
| Eu-150 | NL | — | b |
| Eu-152 | 1.23E+07 | — | — |
| Eu-154 | 1.75E+08 | — | — |
| Eu-155 | NL | — | b |
| Fe-55 | NL | — | b |
| Fe-59 | NL | — | b |
| H-3 | 2.34E+11 | 1.15E+06 | c |
| I-129 | 3.63E+04 | 4.00E+00 | c, d |
| K-40 | NL | — | f |
| Kr-85 | NL | — | b |
| Mn-54 | NL | — | b |
| Mo-93 | 3.35E+05 | 8.11E+02 | g |
| Na-22 | NL | — | b |
| Nb-93m | 2.82E+09 | — | — |
| Nb-94 | 5.90E+04 | 3.49E+02 | g, d |
| Ni-59 | 2.48E+07 | — | d |
| Ni-63 | 1.97E+07 | — | d |

**Table 2. Radionuclide Concentration and Inventory Limits**

| Constituent | Threshold Concentration (pCi/g) | Total Inventory Limit (Ci) | Footnotes |
|---|---|---|---|
| Np-237 | 3.00E+04[a] | — | a |
| Pa-231 | 2.29E+03 | — | |
| Pb-210 | NL | — | b |
| Pd-107 | NL | — | b |
| Pm-147 | NL | — | b |
| Po-209 | NL | — | b |
| Pu-238 | 1.00E+05[a] | — | a |
| Pu-239 | 5.87E+04[a] | — | a |
| Pu-240 | 5.92E+04 | — | a |
| Pu-241 | 3.65E+08 | — | d |
| Pu-242 | 6.15E+04 | — | a |
| Pu-244 | 1.00E+05[a] | — | b, a |
| Ra-226 | 5.04E+03 | — | — |
| Ra-228 | 1.60E+03 | — | — |
| Re-187 | NL | — | b |
| Rn-222 | NL | — | f |
| Ru-103 | NL | — | b |
| Ru-106 | NL | — | b |
| Sb-125 | NL | — | b |
| Sb-126 | NL | — | b |
| Se-79 | 2.19E+05 | — | — |
| Sm-151 | 2.49E+08 | — | — |
| Sn-113 | NL | — | b |
| Sn-121m | 3.16E+06 | — | — |
| Sn-126 | 2.59E+04 | — | — |
| Sr-90 | 1.05E+05 | — | d |
| Tc-99 | 2.38E+04 | 7.24E+02 | g, d |
| Th-228 | NL | — | b |
| Th-229 | 5.13E+03 | — | — |
| Th-230 | 3.94E+04 | — | — |
| Th-232 | 2.26E+04 | — | — |

**Table 2. Radionuclide Concentration and Inventory Limits**

| Constituent | Threshold Concentration (pCi/g) | Total Inventory Limit (Ci) | Footnotes |
|---|---|---|---|
| Th-234 | NL | — | b |
| Ti-44 | NL | — | b |
| U-232 | NL | — | b |
| U-233 | 2.64E+05 | — | — |
| U-234 | 2.73E+05 | — | — |
| U-235 | 2.10E+05 | — | — |
| U-236 | 2.90E+05 | — | — |
| U-238 | 2.87E+05 | — | — |
| Zn-65 | NL | — | b |
| Zr-93 | 1.97E+07 | — | — |

Reference: CP-60089, *Performance Assessment for the Environmental Restoration Disposal Facility, Hanford Site, Washington.*

a. Evaluation of TRU criteria is required and may be limiting per Section 4.3.5. For TRU isotopes, the threshold concentration listed is the more restrictive of the performance assessment threshold concentration or 1.00E+05 pCi/g (100 nCi/g).

b. No limit calculated due to no, or negligible, inventory at closure; CP-60089, Appendix E, Table E-3.

c. Total inventory limits from CP-60089, Appendix E, Table E-4, 10 mrem/yr air pathway.

d. Evaluation of the NRC Class is required and may be limiting per Section 4.3.5.

e. Ca-41 screened out due to association with impurities present in graphite and silica gel desiccant in trace quantities and will not be available freely; CP-60089, Appendix E, Table E-3, footnote c.

f. No limit calculated per CP-60089, Appendix E, Table E-1, footnote a.

g. Total inventory limits from CP-60089, Appendix E, Table E-4, 25 mrem/yr all pathways (groundwater).

NL = no limit

NRC = U.S. Nuclear Regulatory Commission

TRU = transuranic

Additional radionuclides that may be encountered during cleanup activities, but which exist in insignificant (i.e., <1 Ci projected at closure) quantities or are merely relics of calculations or modeling (e.g., ORIGEN2), are assigned neither threshold concentrations nor inventory thresholds and may be added to profiles as "other isotopes present." A complete list is provided in Appendix C. Radionuclides may only be added to the list in Appendix C by evaluating them in the unreviewed disposal question process, as described in the ERDF PA (CP-60089) and ERDF-PRO-EN-54046, *Unreviewed Disposal Question (UDQ)*.

Waste sources with concentration levels above the limits identified in Table 2 are evaluated on a case-by-case basis in accordance with the approach agreed upon by EPA, Ecology, and the U.S. Department of Energy, Richland Operations Office (CHPRC-1701702, "ERDF Waste Acceptance Criteria Exceedance Basis"). If the integrated inventory concentration of the waste source is not greater than the Table 2 limits, the waste is then acceptable for transportation and disposal at ERDF.

### 4.2.3 Mixed Waste

The limits established for mixed waste are specified in Sections 4.2.1 and 4.2.2 for chemical components and radionuclides, respectively.

## 4.3 Special-Case Waste Types

Acceptance criteria and/or restrictions associated with special-case waste types are identified in the following sections. Centralized waste treatment consisting of stabilization or macroencapsulation may be performed at ERDF for specific sources in accordance with the 1997 ERDF ROD amendment (EPA/AMD/R10-97/101) to render a previously restricted waste acceptable for disposal. All substantive requirements governing hazardous waste treatment in containers, including provision of secondary containment, shall be met for waste treated at ERDF. Uncontainerized waste stored or treated at ERDF shall be managed in accordance with the corrective action management unit provisions delineated in the 2002 ERDF ROD amendment (EPA/AMD/R10-02/030). Users shall obtain authorization for waste treatment at ERDF from the management and operations team prior to shipment. In addition, remediation waste treatment requirements, including the specific treatment to be performed, must be documented in the regulatory agency-approved decision document for the operable unit or waste site of origination.

Additional criteria for removable surface contamination, fixed contamination, and activity levels are prescribed in the ERDF SWAC (ERDF-00003). Certain waste sources may require special handling to accommodate disposal at ERDF even though the radionuclide concentrations are less than the Table 2 limits. Handling requirements for these waste sources shall be evaluated on a case-by-case basis.

### 4.3.1 Asbestos

Asbestos-containing materials shall be managed in accordance with 40 CFR 61, Subpart M, "National Emission Standard for Asbestos." More detailed information for asbestos management is also provided in PRC-PRO-WM-53829 and the ERDF SWAC (ERDF-00003).

### 4.3.2 Ion-Exchange Resins and Granular-Activated Carbon

Ion-exchange resins and granular-activated carbon shall be thoroughly drained and stable before transport for disposal to prevent reaction with their surroundings and the generation of excessive heat. Containers shall be vented and/or a catalyst pack may be required if the material is capable of generating gas. Ion-exchange resins and granular-activated carbon may be subject to restrictions associated with organic carbonaceous compounds, as specified in Section 4.3.5.

### 4.3.3 Debris

The definition of debris is presented in Appendix D. Special requirements for debris are as follows:

- The initial determination of whether a waste is a dangerous/hazardous debris shall be made at the source in accordance with 40 CFR 268.45 and other applicable waste designation requirements. After the waste has been identified as dangerous/hazardous debris, it shall be so stated as part of the waste profile.
- Dangerous/hazardous debris shall comply with the debris treatment standards (40 CFR 268.45) or the otherwise applicable LDR treatment standard.
- Waste containing more than one type of debris or one hazardous constituent shall be treated to meet the standards for each hazardous constituent and each type of debris, as applicable.

### 4.3.4 Polychlorinated Biphenyl Compounds

Waste containing PCB concentrations >50 ppm shall be managed in accordance with 40 CFR 761, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions." Liquids containing PCBs at concentrations >50 ppm PCB at the point of origination are generally prohibited from disposal at ERDF, even if subsequently stabilized to eliminate free liquids. On a case-by-case basis with the approval of ERDF operations, PCB-bearing liquids from incidental sources (e.g., precipitation, condensation, leachate, or load separation associated with PCB articles or nonliquid PCB waste) with PCB concentrations <500 ppm may be disposed at ERDF in accordance with the requirements of 40 CFR 761.60(a)(3), "Disposal Requirements." Liquid waste containing PCB concentrations of >500 ppm cannot be disposed at ERDF.

Nonliquid PCBs in the form of contaminated soil, rags, other debris may be disposed at ERDF. This includes nonliquid waste with PCB concentrations >500 ppm.

### 4.3.5 General Restrictions

The following materials are prohibited from being disposed at ERDF:

- Waste capable of detonation, explosive decomposition, reaction at normal pressures and temperature, or explosive reaction with water. This includes unreacted alkali metal (e.g., sodium). Chemicals that react with atmospheric oxygen to form shock-sensitive organic peroxides are prohibited at concentrations that are capable of generating an explosive reaction.
- Waste capable of generating toxic gases, vapors, or fumes harmful to persons transporting, handling, and disposing the waste.
- Gaseous waste packaged at a pressure >1.5 atmospheres at 20°C (68°F).
- TRU waste (as defined in Appendix D).
- Spent nuclear fuel and high-level waste (as defined in Appendix D).

The following materials are restricted from disposal at ERDF until the listed conditions have been met:

- Wastes containing free liquids
  - Free liquid that is not a dangerous waste: Disposal of any free liquid waste (containerized or not) that is not a dangerous waste is prohibited. Such wastes must be sorbed or stabilized to a nonliquid form prior to disposal in ERDF (WAC 173-303-140(4)(b)).
  - Free liquid that is, or is associated with, a dangerous waste: Disposal of free liquids that are, or are within, a dangerous waste (containerized or not) is prohibited, except as provided below. Any free liquids associated with noncontainerized dangerous waste must be stabilized (not merely absorbed) prior to placement in ERDF. Any free liquids associated with containerized dangerous waste must be sorbed with a nonbiodegradable sorbent prior to placement in ERDF, except for the following:
    - Very small containers (e.g., ampules)
    - Containers designed to hold free liquids for use other than storage (e.g., a battery or capacitor)

    - Laboratory packs packaged in accordance with WAC 173-303-161, "Overpacked Containers (Labpacks)" (WAC 173-303-140(4)(b))

- Ignitable or reactive dangerous waste unless treated prior to disposal such that the resultant mixture no longer exhibits the ignitable or reactive characteristic, except for waste disposed as a labpack in accordance with WAC 173-303-161 (40 CFR 264.312, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Special Requirements for Ignitable or Reactive Waste").

- Incompatible wastes or materials shall not be placed in close proximity to each other in the same landfill cell unless such action is done in a manner that prevents adverse reactions that could result in generation of extreme heat, flames, violent reactions, gases, toxic fumes, dusts or gases; pose a fire or explosion risk; damage the structural integrity of the facility; or, through other like means, threaten human health or the environment (40 CFR 264.313, "Special Requirements for Incompatible Wastes").

- Unless they are very small (e.g., an ampule), containers must not be disposed unless they are at least 90% full when placed in the landfill, or they are crushed, shredded, or similarly reduced in volume to the maximum practical extent before burial (40 CFR 264.315, "Special Requirements for Containers").

- Pyrophoric waste, unless treated, prepared, and packaged to be nonflammable prior to being disposed (10 CFR 61.56, "Licensing Requirements for Land Disposal of Radioactive Waste," "Waste Characteristics").

- Solid acid waste that exhibits the characteristic of low pH under the corrosivity test of WAC 173-303-090(6)(a)(iii), "Dangerous Waste Characteristics," unless exempted pursuant to WAC 173-303-140 or RCW 70.105.050(2), "Hazardous Waste Management," "Disposal at Other than Approved Site Prohibited—Disposal of Radioactive Wastes."

- Refrigerant-bearing equipment containing chlorofluorocarbons, unless chlorofluorocarbon removal has been completed (40 CFR 82, "Protection of Stratospheric Ozone").

- Waste, materials, or containers that may adversely affect waste handlers or compromise facility or waste container performance.

- Bulk organic chemicals in excess of 23 kg (50 lb) in a waste stream. ERDF Engineering shall be notified and grant specific approval prior to waste profile generation.

- Dangerous/hazardous waste with >10% organic/carbonaceous compounds, unless exempted pursuant to WAC 173-303-140 or RCW 70.105.050(2). (Note: The Hanford Site has a global exemption from this requirement for disposal of *radioactive* mixed waste in ERDF.)

- Waste exceeding the Class C limit, as defined in 10 CFR 61.55, "Waste Classification," unless justified by a specific PA.

- Extremely hazardous waste, unless exempted pursuant to WAC 173-303-140 or RCW 70.105.050(2). This includes the Washington State-only extremely hazardous wastes for toxic and persistent compounds (waste codes WT01, WP01, or WP03) as defined in WAC 173-303-100, "Dangerous Waste Criteria." Waste that is excluded from disposal at ERDF because of its classification under waste code WT01 may be tested using bioassay methods to show that the waste actually should be classified as WT02, which can be accepted at ERDF.

- Waste containing biological, pathogenic, or infectious material (including "any substance that may harbor or transmit pathogenic organisms" [e.g., septic tank sludge]) unless disinfected (10 CFR 61.56).
- Waste containing >1% chelating compounds by weight, unless the waste has been solidified or stabilized. Waste containing >1% chelating compounds may be approved for disposal on a case-by-case basis if evidence is provided that the chelating agents will not result in mobilization of radioisotopes. PNNL-13774, *Radionuclide-Chelating Agent Complexes in Low-Level Radioactive Decontamination Waste; Stability, Adsorption and Transport Potential*, provides evidence that weaker binding organic complexants (e.g., picolinate, citrate, and oxalate) will not appreciably mobilize metals, even in high pH environments such as cementitious waste forms. Therefore, these chelating agents are excluded from the 1% limit. Other weak chelating agents may be excluded on a case-by-case basis.
- Dangerous/hazardous waste carrying the F020, F021, F022, F023, F026, or F027 waste codes, unless authorized by an EPA-approved management plan that addresses the substantive requirements of 40 CFR 264.317, "Special Requirements for Hazardous Waste Codes F020, F021, F022, F023, F026, and F027."

## 4.4 Physical Limits

Packaged waste shall be structurally stable for disposal at ERDF to limit potential subsidence. Packaged waste that is not structurally stable may be accepted at ERDF on a case-by-case basis and stabilized before and during disposal. Depending on the waste stream, stabilization may be accomplished by using soil, cement-based or other stabilization agents with acceptable structural characteristics, size reduction, a mixture of biodegradable waste and stabilizing agents, and/or voids filled with stabilization agents. Additional physical limits for waste forms including concrete, steel plate, piping and tube steel, building debris, structural steel, containerized waste, equipment, soft waste, and rebar are defined in the ERDF SWAC (ERDF-00003).

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PRC-PRO-SMP-53095, *Data Quality Objectives Planning Process*, Revision 0, Change 0, CH2M HILL Plateau Remediation Company, Richland, Washington

PRC-PRO-WM-40223, 2018, *Environmental Restoration Disposal Facility Waste Process*, Revision 7, Change 2, CH2M HILL Plateau Remediation Company, Richland, Washington.

PRC-PRO-WM-53829, 2016, *ERDF Waste Acceptance Process*, Revision 0, Change 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

RCW 70.105, "Hazardous Waste Management," *Revised Code of Washington*, Olympia, Washington. Available at: http://apps.leg.wa.gov/RCW/default.aspx?cite=70.105.

105.050, "Disposal at Other than Approved Site Prohibited—Disposal of Radioactive Wastes."

*Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq. Available at: https://elr.info/sites/default/files/docs/statutes/full/rcra.pdf.

*Toxic Substances Control Act of 1976*, Pub. L. 107-377, as amended, 15 USC 2601, et seq. Available at: http://uscode.house.gov/view.xhtml?path=/prelim@title15/chapter53&edition=prelim.

WAC 173-303, "Dangerous Waste Regulations," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-303.

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303-161, "Overpacked Containers (Labpacks)."

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# Appendix A

# ERDF Performance Assessment Waste Acceptance Criteria Review Criteria Matrix

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## Table

Table A-1. Review Matrix for ERDF Performance Assessment Waste Acceptance Criteria..... A-1

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# A1 ERDF Performance Assessment Waste Acceptance Criteria Review Criteria Matrix

The waste acceptance criteria format and content are preserved for usability. A matrix is presented in Table A-1 as a crosswalk for the waste acceptance criteria and other documents to those provided in Chapter 6, "Waste Acceptance Criteria Guide," of DOE-STD-5002-2017, *Disposal Authorization Statement and Tank Closure Documentation.*

**Table A-1. Review Matrix for ERDF Performance Assessment Waste Acceptance Criteria**

| Section | Performance Assessment Review Criteria | ERDF Waste Acceptance Criteria Section |
|---|---|---|
| 1.0 | The waste acceptance criteria must provide a brief "background" discussion and the technical basis upon which the criteria are based. | Chapter 1.0, Introduction<br>Section 4.2, Concentration Limits |
| 2.0 | The waste acceptance criteria must specify acceptable radiological limits. | Section 4.2.2, Radionuclides<br>ERDF SWAC[a]<br>PRC-PRO-WM-53829, *ERDF Waste Acceptance Process*[b] |
| 3.0 | The waste acceptance criteria must specify acceptable waste form criteria. | Section 4.1.3, Control of Waste Form (points to ERDF SWAC[a])<br>Section 4.3, Special Case Waste Types<br>Section 4.3.5, General Restrictions<br>Section 4.4, Physical Limits<br>PRC-PRO-WM-53829, *ERDF Waste Acceptance Process*[b]<br>ERDF SWAC[a] |
| 4.0 | The waste acceptance criteria must specify acceptable packaging criteria. | Section 3.3.1, Transportation and Packaging (very brief, points to DOT)<br>Section 4.4, Physical Limits<br>PRC-PRO-WM-53829, *ERDF Waste Acceptance Process*[b]<br>ERDF SWAC[a] |
| 5.0 | The waste acceptance criteria must specify acceptable waste transfer and transportation requirements. | Section 3.3.1, Transportation and Packaging (very brief, points to DOT)<br>Section 3.3.3, Authorization to Ship<br>PRC-PRO-WM-53829, *ERDF Waste Acceptance Process*[b]<br>ERDF SWAC[a] |

**Table A-1. Review Matrix for ERDF Performance Assessment Waste Acceptance Criteria**

| Section | Performance Assessment Review Criteria | ERDF Waste Acceptance Criteria Section |
|---|---|---|
| 6.0 | The waste acceptance criteria must specify acceptable documentation requirements. | Section 3.3.2, Shipping Documentation (very brief, points to PRC-PRO-WM-53829[b])<br>Section 4.1.4, Compliance with Environmental Regulations<br>PRC-PRO-WM-53829, *ERDF Waste Acceptance Process*[b]<br>ERDF SWAC[a] |
| 7.0 | The waste acceptance criteria must specify the process for evaluating and accepting waste shipments. | Section 3.4, Receipt and Disposal (points to Section 3.3.2 and ERDF SWAC[a])<br>ERDF-PRO-EN-54026, *ERDF Engineering Waste Acceptance Review*[c]<br>PRC-PRO-WM-53829, *ERDF Waste Acceptance Process*[b] |

a. ERDF-00003, *Supplemental Waste Acceptance Criteria for the Environmental Restoration Disposal Facility*, latest revision, CH2M HILL Plateau Remediation Company, Richland, Washington.

b. PRC-PRO-WM-53829, *ERDF Waste Acceptance Process*, Revision 0, Change 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

c. ERDF-PRO-EN-54026, *ERDF Engineering Waste Acceptance Review*, Revision 0, Change 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

DOT = U.S. Department of Transportation

ERDF = Environmental Restoration Disposal Facility

SWAC = supplemental waste acceptance criteria

## A2 Reference

DOE-STD-5002-2017, 2017, *Disposal Authorization Statement and Tank Closure Documentation*, U.S. Department of Energy, Washington, D.C. Available at https://www.standards.doe.gov/standards-documents/5000/5002-astd-2017/@@images/file.

# Appendix B

# Revised ERDF Liner Compatibility Evaluation Process

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## Contents

**B1 Revised ERDF Liner Compatibility Evaluation Process ..... B-1**

**B2 Background ..... B-1**

**B3 Discussion ..... B-2**

**B4 Conclusions and Recommendations ..... B-3**

**B5 References ..... B-3**

## Terms

| | |
|---|---|
| ERDF | Environmental Restoration Disposal Facility |
| HDPE | high-density polyethylene |

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# B1 Revised ERDF Liner Compatibility Evaluation Process

Historically, whenever a new chemical constituent is identified for proposed disposal at the Environmental Restoration Disposal Facility (ERDF), an evaluation has been performed to assess potential impacts to the facility disposal cell liners. The cell liners (and associated liquid collection sumps) are constructed from high-purity, high-density polyethylene (HDPE) plastics. The liners form the primary barrier to any discharge of liquids to the underlying soils. A liner compatibility review for all new chemicals identified for disposal to ERDF is currently specified by ERDF-PRO-EN-54026, *ERDF Engineering Waste Acceptance Review.*

Based on analysis of more than 20 years of waste disposal and leachate sampling activities at ERDF, as well as information from liner manufacturers, the existing evaluation process can be simplified and streamlined to the point that only limited chemical compounds would need formalized review and acceptance.

# B2 Background

HDPE was chosen as the liner material for ERDF as the most chemically inert material commercially available. Initial detailed investigation of potential effects to HDPE liners was documented in BHI-00359, *Evaluation of Liner/Leachate Chemical Compatibility for the Environmental Restoration Disposal Facility*. The document contains recommendations from three manufacturers for maximum concentrations for a large number of compounds commonly encountered in HDPE-lined disposal facilities. The most conservative evaluations in the document assigned 50 ppm to some compounds as a maximum allowable concentration to ensure inconsequential effects to the liner for leachate in continual contact with the liner. BHI-00359 also contains manufacturers' discussion of the potential effects of different chemical compound groups. Halogenated organics (e.g., carbon tetrachloride, chlorobenzene, and methyl bromide) were identified as the chemical class with the greatest potential to degrade HDPE (lowest allowed maximum concentrations). Comments from the manufacturers pertaining to halogenated organics include the following:

- Deleterious effects are generally reversible if the exposure is terminated.
- The effects (of exposure) increase with increasing temperature. While extreme temperatures could rapidly reduce the usefulness of HDPE as a structural component (e.g., HDPE pipe), the effects should not seriously affect the performance as a containment membrane.
- One manufacturer stated no reaction or degradation would be observed at ambient conditions. All three manufacturers stated that the effects of organic chemicals on HDPE increase with increasing temperature.

Dust suppression water and rain/snowmelt are the primary sources for liquid ultimately reaching the liner/sump system. As water passes through the waste body, soluble compounds can dissolve in the water. The primarily soluble compounds present in Hanford Site-derived waste disposed at ERDF are inorganic salts. Total dissolved solids levels in the leachate average approximately 2,000 ppm (2,000,000 ppb). Easily detectable levels of highly soluble radionuclides (e.g., tritium or technetium-99) are also present in the leachate. Direct disposal of liquid wastes is prohibited at ERDF; liquids are either solidified or absorbed before disposal, thus, direct contact of liquid wastes with the liner cannot occur. Solidification/absorption will inhibit dissolution of any organics into the leachate.

Routine analysis of the leachate has been scheduled at least twice each year since 1999 (currently performed quarterly). An extensive list of analytes (>300 total) is requested on a biennial basis, and organic screening analyses are performed for each sampling event. To date, >6,600 specific organic compound analyses have been performed on leachate samples. Only 134 detected results have been reported, of which 48 results may be discounted as associated with laboratory-introduced contamination. Over 85% of all organic detections were reported at <10 ppb, and none of the results were >100 ppb. Since 2007, routine analysis has included specific screening for halogenated organics as total organic halides. The total organic halides results have remained <80 ppb, with the majority <50 ppb (three orders of magnitude below the maximum allowable concentration to ensure inconsequential effects to the liner).

## B3 Discussion

During more than 20 years of ERDF operations, no organics of any kind have been detected in the leachate at concentrations >0.2% of the most conservative concentrations defined for potential impact to the liner material when in continuing contact. Detections for halogenated organics were <0.1% of conservative concentration limits. Although the data effectively represent average concentrations for the leachate, unexpected "spikes" would not be anticipated. Other highly soluble materials (notably, soluble radionuclides) have resulted in relatively broad peaks (ranging from months to years in width) in trended leachate concentrations following large-quantity additions to ERDF. In addition, any spikes (if present) should have minimal long-term contact with the liner or sumps (as the sumps are typically pumped weekly).

More than 3,000 individual compounds potentially present (from trace to major concentrations) have been identified in waste profiles for materials disposed at ERDF to date. Evaluation of these profiles have not identified potentially significant impacts to liner integrity. The level of conservatism inherent in the approaches to defining waste profiles yields a significant potential for overstating true constituent concentrations, quantities, or both in the wastes to be disposed. The low organic concentration found in the leachate samples supports typical overestimation in waste profiles. Future profiles will identify new compounds, but it is unlikely that Hanford Site activities (all cleanup-related) will identify sources for large quantities of halogenated organics or other compounds with high potential for line impact.

Precise data do not exist on actual dissolution rates of stabilized organics in ERDF, but rates are likely to be relatively slow. Based on a nominal cell leachate generation of 100,000 gal/yr (the 2016 cell generation ranged from 340,687 to 2,195,538 L [90,000 to 580,000 gal]), approximately 23 kg (50 lb) of any specific organic released over the year in a given cell would not exceed 50 ppm concentration in the leachate.

ERDF liners without any waste placed on them are insulated with at least 1.2 m (4 ft) of earthen material. This will mitigate environmental temperature effects on the liners (at least -12°C [10°F] below surface temperatures). Once covered with waste, the liners should tend to assume the ambient temperature of the earth at their burial depth. With 3.7 m (12 ft) minimum of cover, the liner temperature should be at least -7°C (20°F) below surface maximums (with a typical 3-month lag). For a full cell, the depth will be at least 21.3 m (70 ft) at the sumps. Soil temperatures below 9.1 m (30 ft) typically remain constant. In eastern Washington State, the constant temperature at depth ranges from between 11°C and 14°C (52°F and 57°F).

A study by the Consortium for Risk Evaluation with Stakeholder Participation/University of Virginia personnel (Tian et al., 2017, "Antioxidant Depletion and Service Life Prediction for HDPE Geomembranes Exposed to Low-Level Radioactive Waste Leachate") estimated the potential service life of liner material used for low-level and mixed waste disposal facilities. The study included extensive

testing using synthetic leachates both with and without radionuclide contamination. One objective of the study was to determine if the presence of radionuclides in the leachate could significantly impact liner life. The chemical composition of the test solutions used were very similar to nominal ERDF values. The study may be an excellent model for determining long-term performance of the ERDF liners. The study generated the following conclusions:

- Oxidation reactions with the liner material provide the primary source for degradation of in-service liners. Liners incorporate antioxidants as part of the manufacturing process.
- No statistical impacts were identified associated with radionuclide contaminants potentially present in the leachate.
- Degradation rates for sites similar to ERDF will likely be slower than municipal solid waste facilities. This is due to much lower levels of surfactants present in sites similar to ERDF, which would (if present) enhance solubility of compounds that react and deplete the antioxidants in the liner.
- A conservative estimate projects liner service life >1,400 years.

## B4 Conclusions and Recommendations

ERDF has been operational for more than 20 years, and constituent concentrations in the leachate have never risen above an insignificant fraction of any value that could cause potential impact to the cell liners or sumps. Continuing operations are not expected to be significantly different, and there is little realistic potential for leachate components to significantly impact liner/sump integrity. Routine detailed constituent evaluations for potential liner impacts should not be necessary. The following actions are recommended:

1. Revise ERDF-PRO-EN-54026 to require additional review and consultation with the U.S. Environmental Protection Agency prior to approving a waste profile that proposes disposal of bulk (i.e., >23 kg [>50 lb]) quantities of organic chemicals unless the waste profile indicates that organic concentrations will not exceed 50 ppm in the as-disposed material.
2. Discontinue the process of evaluating new chemicals in waste profiles with the exception of (1) listed above.

## B5 References

BHI-00359, 1995, *Evaluation of Liner/Leachate Chemical Compatibility for the Environmental Restoration Disposal Facility*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

ERDF-PRO-EN-54026, 2017, *ERDF Engineering Waste Acceptance Review*, Revision 0, Change 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

Tian, Kuo, Craig. H. Benson, James, M. Tinjum, and Tuncer B. Edil, 2017, "Antioxidant Depletion and Service Life Prediction for HDPE Geomembranes Exposed to Low-Level Radioactive Waste Leachate," *Journal of Geotechnical and Geoenvironmental Engineering* 143(6): 04017011. Available at: http://ascelibrary.org/doi/pdf/10.1061/(ASCE)GT.1943-5606.0001643.

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# Appendix C

# Noninventory Data Package Waste Management Information System Radionuclides

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# Tables

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Table C-2. Half-Life Less than 6 Years..... C-2

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# C1 Noninventory Data Package Waste Management Information System Radionuclides

The radionuclides listed below are included in the Waste Management Information System but were not included in WCH-479, *Inventory Data Package for ERDF Waste Disposal*. The radionuclides listed in Table C-1 are those with a half-life >6 years and insignificant (i.e., <1 Ci) projected inventory upon future closure of the Environmental Restoration Disposal Facility. Table C-2 lists those radionuclides with a half-life <6 years. Radionuclides may only be added to the list after they have been evaluated in the unreviewed disposal question process, as described in CP-60089, *Performance Assessment for the Environmental Restoration Disposal Facility, Hanford Site, Washington*, and ERDF-PRO-EN-54046, *Unreviewed Disposal Question (UDQ)*. Hf-182 was subsequently added to the table in 2017 as described in CHPRC, 2017, *UDQ-2017-002-S*.

**Table C-1. Radionuclides with Half-Life Greater than 6 Years**

| Radionuclide | Half-Life (yrs) |
|---|---|
| Ar-39 | 269 |
| Ar-42 | 32.9 |
| Be-10 | 1.513E+6 |
| Bk-247 | 1379 |
| Cf-250 | 13.09 |
| Cf-251 | 900.6 |
| Cm-250 | 8304.8 |
| Fe-60 | 1.49E6 |
| Gd-152 | 1.081E+14 |
| Hf-182 | 8.9E+06 |
| Nb-91 | 681.8 |
| Si-32 | 132.2 |
| Sm-147 | 1.062E+11 |
| Te-123 | 5.993E+14 |

**Table C-2. Radionuclides with Half-Life Less than 6 Years**

| Radionuclide | Half-Life (days) |
|---|---|
| Ac-228 | 0.25541667 |
| Ag-108 | 0.001646 |
| Ag-109m | 0.0004609 |
| Ag-110 | 0.0002826 |
| Ag-110m | 249.8 |
| Al-28 | 0.001556 |
| As-75m | 1.85185E-14 |
| Au-195 | 186.1 |
| Ba-137m | 0.001772222 |
| Ba-140 | 12.74 |
| Bi-212 | 0.04208 |
| Bi-214 | 0.01368 |
| Bk-250 | 0.13425 |
| Ca-45 | 162.7 |
| Cd-109 | 462.6 |
| Ce-141 | 32.5 |
| Co-56 | 77.3 |
| Co-57 | 271.8 |
| Cr-51 | 27.71 |
| Cs-136 | 13.16 |
| Es-254 | 275.5 |
| Ga-68 | 0.04745 |
| Gd-153 | 242 |
| Gd-155m | 7.35E-14 |
| Gd-162 | 0.007222 |
| Ge-68 | 270.8 |
| Hf-175 | 70 |
| Hf-181 | 42.38 |
| Hg-203 | 46.6 |
| I-123 | 0.5425 |
| I-125 | 59.43 |

**Table C-2. Radionuclides with Half-Life Less than 6 Years**

| Radionuclide | Half-Life (days) |
|---|---|
| I-131 | 8.04 |
| In-113m | 0.06908333 |
| La-140 | 1.678 |
| Lu-175m | 4.97685E-16 |
| Nb-94m | 4.35E-03 |
| Nb-95 | 34.98 |
| Nb-95m | 3.608 |
| Nd-147 | 10.98 |
| P-32 | 14.26 |
| P-33 | 25.4 |
| Pb-207m | 1.516E-15 |
| Pb-208m | 1.968E-16 |
| Pb-212 | 0.4435 |
| Pb-214 | 0.01861111 |
| Po-210 | 138.4 |
| Pr-144 | 0.01201 |
| Pt-195m | 4.02 |
| Pu-236 | 1059 |
| Ra-224 | 3.665 |
| Rb-82 | 0.000868056 |
| Rb-83 | 86.2 |
| Rb-84 | 32.77 |
| Rb-86 | 18.66 |
| Rh-103m | 0.03897222 |
| Rh-106 | 0.000344907 |
| S-35 | 87.5 |
| Sb-122 | 2.681 |
| Sb-124 | 60.24 |
| Sb-126m | 0.01319444 |
| Sc-44 | 0.16363 |
| Sc-46 | 83.82 |

**Table C-2. Radionuclides with Half-Life Less than 6 Years**

| Radionuclide | Half-Life (days) |
|---|---|
| Sc-47 | 3.422 |
| Se-75 | 119.6 |
| Si-31 | 0.10923611 |
| Sn-119m | 293 |
| Sn-123m | 0.02783 |
| Sr-82 | 25.56 |
| Sr-85 | 64.85 |
| Sr-87m | 0.116875 |
| Sr-89 | 50.52 |
| Ta-181m | 1.25E-13 |
| Ta-182 | 114.7 |
| Ta-183 | 5 |
| Tb-162 | 0.005389 |
| Te-121 | 16.78 |
| Te-125m | 58 |
| Te-127 | 0.3896 |
| Te-127m | 109 |
| Te-129 | 0.04826 |
| Te-129m | 33.8 |
| Ti-51 | 0.004028 |
| Tl-203m | 3.218E-15 |
| Tl-204 | 1384 |
| Tl-208 | 0.00212 |
| Tm-170 | 128.6 |
| U-237 | 6.75 |
| V-49 | 330 |
| W-183m | 0.0000625 |
| W-185 | 75.1 |
| Xe-129m | 1.157E-14 |
| Xe-131m | 11.9 |
| Xe-133 | 5.245 |

**Table C-2. Radionuclides with Half-Life Less than 6 Years**

| Radionuclide | Half-Life (days) |
|---|---|
| Y-87 | 3.3458333 |
| Y-88 | 106.6 |
| Y-90 | 2.669 |
| Yb-170m | 1.852E-14 |
| Zr-95 | 64.03 |

## C2 References

CHPRC, 2017, *UDQ-2017-001-S*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

CP-60089, 2013, *Performance Assessment for the Environmental Restoration Disposal Facility, Hanford Site, Washington*, latest revision, CH2M HILL Plateau Remediation Company, Richland, Washington.

ERDF-PRO-EN-54046, 2017, *Unreviewed Disposal Question (UDQ)*, Revision 0, Change 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

WCH-479, 2013, *Inventory Data Package for ERDF Waste Disposal*, Rev. 1, Washington Closure Hanford, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0083702.

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# Appendix D

# Definitions

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## Contents

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**D2 References** ..... **D-3**

## Terms

| | |
|---|---|
| ERDF | Environmental Restoration Disposal Facility |
| RCRA | *Resource Conservation and Recovery Act of 1976* |

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# D1 Definitions

**Carbonaceous waste:** Dangerous/hazardous waste that contains combined concentrations of >10% organic/carbonaceous constituents. Organic/carbonaceous constituents are those substances that contain carbon-hydrogen, carbon-halogen, or carbon-carbon chemical bonding.

**Dangerous/hazardous debris:** Debris that contains a dangerous/hazardous waste listed in 40 CFR 261, Subpart D, "Identification and Listing of Hazardous Waste," "Lists of Hazardous Wastes," or that exhibits a characteristic of dangerous/hazardous waste identified in 40 CFR 261, Subpart C, "Characteristics of Hazardous Waste."

**Dangerous waste:** Solid waste designated under the dangerous waste lists, characteristics, or criteria set forth in Washington State's authorized *Resource Conservation and Recovery Act of 1976* (RCRA) program (WAC 173-303-070, "Dangerous Waste Regulations," "Designation of Dangerous Waste," through WAC 173-303-100, "Dangerous Waste Criteria") as either dangerous or extremely hazardous waste.

**Debris:** Solid material exceeding a 60 mm particle size that is intended for disposal and is a manufactured object, plant or animal matter, or natural geologic material. However, the following materials are not considered to be debris: any material for which a specific treatment standard is provided in 40 CFR 268, Subpart D, "Land Disposal Restrictions," "Treatment Standards," namely lead acid batteries, cadmium batteries, and radioactive lead solids; process residuals such as smelter slag and residues from the treatment of waste, wastewater, sludge, or air emission residues; and intact containers of dangerous/hazardous waste that are not ruptured and that retain at least 75% of their original volume. A mixture of debris and other material that has not been treated to the standards provided by 40 CFR 268.45, "Treatment Standards for Hazardous Debris," is subject to regulation as debris if the mixture is composed primarily of debris, by volume, based on visual inspection.

**Disinfection:** A process that inactivates pathogenic organisms by chemical oxidants or equivalent agents.

**Free liquids:** Liquids that can readily separate from the solid portion of a waste under ambient temperature and pressure. EPA Method 9095, "Paint Filter Liquids Test" (SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update V*), is used to determine if a waste contains free liquids.

**Hazardous substances:** Any material designated as such pursuant to the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, including all RCRA hazardous wastes, radionuclides, and a variety of other chemical substances; and any material identified as a hazardous substance pursuant to WAC 173-340 "Model Toxics Control Act—Cleanup," including petroleum, petroleum products, and all dangerous wastes.

**Hazardous waste:** Waste designated as hazardous by U.S. Environmental Protection Agency regulations (40 CFR 261) and that is regulated under RCRA.

**High-level waste:** Highly radioactive waste 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 is determined, consistent with existing law, to require permanent isolation.

**Infectious waste:** Wastes containing living organisms that, when present, could endanger human health or the health of domestic animals or wildlife by extending the range of biological pests, viruses, pathogenic micro-organisms, or other agents capable of infesting, infecting, or extensively and permanently altering the normal populations of organisms.

**Low-level waste:** Radioactive waste that is not high-level radioactive waste, spent nuclear fuel, transuranic waste, byproduct material (as defined in Section 11e.(2) of the *Atomic Energy Act of 1954*, as amended), or naturally occurring radioactive material.

**Mixed waste:** Waste containing both radioactive and dangerous/hazardous components, as defined by the *Atomic Energy Act of 1954* (as amended) and WAC 173-303, respectively.

**Onsite Waste Tracking Form:** A shipping form used to identify the quantity, composition, origin, routing, and destination of waste while the waste is being transported to the Environmental Restoration Disposal Facility (ERDF) for disposal. The Onsite Waste Tracking Form is similar to the Uniform Hazardous Waste Manifest.

**Radioactive waste:** Any garbage, refuse, sludge, and other discarded material, including solid, liquid, semi-solid, or contained gaseous material that must be managed for its radioactive content (adapted from 40 CFR 240, "Guidelines for the Thermal Processing of Solid Wastes").

**Secular equilibrium:** A state of parent-daughter equilibrium achieved when the half-life of the parent is much longer than the half-life of the daughter. In this case, if the two are not separated, the daughter will eventually be decaying at the same rate at which it is being produced. At this point, both parent and daughter will decay at the same rate until the parent is essentially exhausted.

**Solidification:** A technique that limits the solubility and mobility of dangerous/hazardous waste constituents through physical means.

**Spent nuclear fuel:** Fuel that has been withdrawn from a nuclear reactor following irradiation but that has not been reprocessed to remove its constituent elements.

**Stabilization:** A technique that limits the solubility and mobility of dangerous/hazardous waste constituents by bonding or chemically reacting with the stabilizing material.

**Structural stability:** A structurally stable waste form will generally maintain its physical dimensions and its form under the expected disposal conditions, such as weight of overburden and compaction equipment, the presence of moisture and microbial activity, and internal factors such as radiation effects and chemical changes for a period of over 300 years. Structural stability can be provided by the waste form itself, processing the waste to a stable form, or placing the waste in a disposal container or structure that provides stability after disposal.

**Supplemental waste acceptance criteria:** Acceptance criteria established for operational radiological controls and physical limits for bulk shipments at ERDF.

**Transuranic waste:** Radioactive waste containing more than >100 nCi (3,700 Bq) of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than >20 years.

**Treatment:** Any method, technique, or process designed to change the physical or chemical character of waste to render it less hazardous; make the waste safer to transport, store, or dispose; or reduce the waste in volume.

**Waste shipment:** Refers to a discernible volume of waste materials for which representative characterization information has been compiled. A small waste shipment may consist of a single truckload, while larger waste shipments may require several truckloads to transport the entire shipment to ERDF. For large waste shipments, the same representative characterization information may be used on all associated waste tracking forms for that particular shipment, provided that the information represents the actual waste contents.

## D2 References


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