

Review of Generation and Flow of Recycled Uranium at Hanford

Table Of Contents

| | <u>Page</u> |
|--|-------------|
| Executive Summary | |
| • Hanford Recycled Uranium Project | 1 |
| • Background | 1 |
| • Hanford's Role in Recycled Uranium | 1 |
| • Data Examination..... | 2 |
| • Significant Information..... | 2 |
| Section | |
| 1.0 Hanford Uranium Mass Balance Project | |
| 1.1 <u>Project Overview</u> | 1 |
| 1.2 <u>Purpose and Scope</u> | 1 |
| 1.3 <u>Project Implementation Strategy</u> | 2 |
| 1.4 <u>Assumptions</u> | 3 |
| Section 1 References | 4 |
| 2.0 Hanford Site Historical Overview | |
| 2.1 <u>Site Description</u> | 1 |
| 2.2 <u>Key Uranium Processing Facilities</u> | 3 |
| 2.2.1 T-Plant..... | 5 |
| 2.2.1.1 Plant Description | 5 |
| 2.2.1.2 T-Plant Material Flowsheet..... | 5 |
| 2.2.1.3 Feed Specifications | 7 |
| 2.2.1.4 Product Specifications..... | 7 |
| 2.2.1.5 Operating History..... | 7 |
| 2.2.1.6 Current Status..... | 7 |
| 2.2.2 B-Plant..... | 8 |
| 2.2.2.1 Plant Description | 8 |
| 2.2.2.2 Material Flowsheet | 8 |
| 2.2.2.3 Feed Specifications | 9 |
| 2.2.2.4 Product Specifications | 9 |
| 2.2.2.5 Operating History | 9 |
| 2.2.2.6 Current Status | 9 |
| 2.2.3 U-Plant | 10 |
| 2.2.3.1 Plant Description..... | 10 |
| 2.2.3.2 Material Flowsheet..... | 10 |
| 2.2.3.3 Feed Specifications..... | 11 |
| 2.2.3.4 Product Specifications | 12 |
| 2.2.3.5 Operating History..... | 12 |
| 2.2.3.6 Current Status..... | 12 |

Table of Contents

| | | |
|------------|---|----------|
| 2.2.4 | UO ₃ Plant | 13 |
| 2.2.4.1 | Plant Description | 13 |
| 2.2.4.2 | Material Flowsheet..... | 14 |
| 2.2.4.3 | Feed Specifications | 17 |
| 2.2.4.4 | Product Specifications | 17 |
| 2.2.4.5 | Operating History | 19 |
| 2.2.4.6 | Current Status | 21 |
| 2.2.5 | REDOX Plant | 21 |
| 2.2.5.1 | Plant Description | 22 |
| 2.2.5.2 | Material Flowsheet | 22 |
| 2.2.5.3 | Feed Specifications | 23 |
| 2.2.5.4 | Product Specifications | 23 |
| 2.2.5.5 | Operating History | 24 |
| 2.2.5.6 | Current Status | 24 |
| 2.2.6 | PUREX Plant..... | 25 |
| 2.2.6.1 | Plant Description | 25 |
| 2.2.6.2 | Material Flowsheet | 26 |
| 2.2.6.3 | Feed Specifications | 29 |
| 2.2.6.4 | Product Specifications | 29 |
| 2.2.6.5 | Operating History | 29 |
| 2.2.6.6 | Current Status | 31 |
| 2.2.7 | Fuel Fabrication Complex..... | 32 |
| 2.2.7.1 | Facility Description | 32 |
| 2.2.7.2 | Material Flowsheet | 34 |
| 2.2.7.3 | Feed Specifications | 37 |
| 2.2.7.4 | Product Specifications | 38 |
| 2.2.7.5 | Operating History | 38 |
| 2.2.7.6 | Current Status | 38 |
| 2.2.8 | Other Uranium Handling Facilities..... | 39 |
| 2.2.8.1 | 308 Building Mixed Oxide Fuel Fabrication..... | 39 |
| 2.2.8.2 | 306 Building..... | 39 |
| 2.2.8.3 | 234-5Z Plutonium Finishing Plant (PFP)..... | 39 |
| 2.2.8.4 | 321 Building..... | 39 |
| 2.2.8.5 | 303-M Uranium Oxide Facility..... | 39 |
| 2.3 | <u>Activity Summary</u> | 40 |
| | Section 2 References | 42 |
| 3.0 | Recycled Uranium (see appendices for expanded detail)..... | 1 |
| 3.1 | <u>Uranium Recycle Description</u> | 1 |
| 3.1.1 | Hanford Key Interfaces for Recycled Uranium..... | 1 |
| 3.1.2 | Beginning of Hanford In-Scope Recycled Uranium Transactions..... | 8 |
| 3.1.2.1 | Key Hanford Historical Dates for Recycled Uranium..... | 8 |
| 3.1.2.2 | Production Channel Material Transactions..... | 8 |
| 3.1.2.2.1 | Shipments..... | 8 |
| 3.1.2.2.2 | Receipts..... | 16 |

Table of Contents

| | | |
|---------|--|----|
| 3.1.3 | Out of Scope Uranium Transactions..... | 16 |
| 3.1.3.1 | Hanford Production Channel..... | 16 |
| 3.1.3.2 | Out-of-Scope Research and Development Programs..... | 17 |
| 3.1.3.3 | Recycled Uranium Timeframe Summary..... | 18 |
| 3.1.4 | Data Presentation – Isolation of Specific Timeframes..... | 18 |
| 3.1.5 | Hanford Historical Timeline References..... | 19 |
| 3.1.6 | Key Dates/Assumptions for Uranium Transactions..... | 21 |
| 3.1.6.1 | Beginning Shipment of Recycled Depleted Uranium Trioxide (UO ₃) .. | 21 |
| 3.1.6.2 | Initial Shipments of Recycled Low-Enriched Uranium Trioxide (UO ₃)..... | 21 |
| 3.2 | <u>Recycle Uranium Receipts</u> | 22 |
| 3.2.1 | Uranium Forms Received from Offsite..... | 22 |
| 3.2.2 | Initial Recycled Uranium Receipts into Hanford..... | 22 |
| 3.2.3 | Receipts Prior to July 1952 (Out of Scope)..... | 23 |
| 3.2.4 | Beginning Receipts of Recycled Uranium at Hanford..... | 23 |
| 3.2.5 | Quantities of Recycled Uranium Received from July 1952 – March 30, 1999..... | 23 |
| 3.2.6 | Hanford Receipts of Recycled Uranium from Paducah..... | 24 |
| 3.2.7 | Hanford Receipts of Recycled Uranium from Fernald and RMI (Ashtabula)..... | 24 |
| 3.2.8 | Hanford receipts of Recycled Uranium from Oak Ridge..... | 24 |
| 3.3 | <u>Recycle Uranium Shipments</u> | 24 |
| 3.3.1 | Recycled Uranium Streams Shipped Offsite..... | 24 |
| 3.3.2 | Uranium Shipments from 300 Area Fuel Fabrication Facilities..... | 28 |
| 3.3.3 | Hanford Shipments of Recovered Uranium and Trioxide Product..... | 32 |
| 3.3.3.1 | UO ₃ Finished Product..... | 32 |
| 3.3.3.2 | Introduction of Fission Products..... | 32 |
| 3.3.4 | Out-of-Scope Research and Development Spent Fuel..... | 33 |
| 3.3.5 | Post Fiscal Year 1970 Shipments..... | 35 |
| 3.3.6 | Shipment Packaging and Scheduling..... | 35 |
| 3.3.7 | Transaction Material Control and Accountability (MC&A)..... | 35 |
| 3.3.8 | Sample Exchange Program and Sample Shipments..... | 35 |
| 3.4 | <u>Recycle Uranium Scrap, Waste, and Conversion</u> | 36 |
| 3.4.1 | Introduction..... | 36 |
| 3.4.2 | Reactor Fuel Element Fabrication..... | 36 |
| 3.4.2.1 | Scrap Returned to Fernald..... | 38 |
| 3.4.2.2 | Liquid Effluent - Chemical Waste Containing Uranium..... | 38 |
| 3.4.2.3 | Airborne Effluents..... | 40 |
| 3.4.2.4 | Solid Waste..... | 40 |
| 3.4.2.5 | 300 Area Process Trenches..... | 40 |
| 3.4.3 | Hanford Separation Plants..... | 40 |
| 3.4.4 | Recovery of Uranium in the U-Plant..... | 41 |
| 3.4.5 | Uranium Trioxide (UO ₃) Plant..... | 41 |
| 3.4.6 | Summary of Uranium Discharged to Wastes at Hanford..... | 42 |
| 3.4.7 | Uranium Losses Through Transmutation and Fission..... | 43 |
| 3.5 | <u>Overall Recycled Uranium Site Material Balance</u> | 43 |

Table of Contents

| | |
|--|----------|
| Section 3 References..... | 48 |
| 4.0 Contaminants in Recycled Uranium | 1 |
| 4.1 <u>UO₃ Process Specifications</u> | 1 |
| 4.1.1 Feed Specifications..... | 1 |
| 4.1.2 Product Specifications..... | 2 |
| 4.1.3 Proposed Specifications..... | 2 |
| 4.1.4 Non-Radiological Contaminants..... | 3 |
| 4.2 <u>Recycle UO₃ Processing</u> | 4 |
| 4.2.1 Processing Issues..... | 5 |
| 4.2.2 Typical Hanford Responses..... | 5 |
| 4.3 <u>Analytical Laboratories</u> | 7 |
| 4.3.1 UO ₃ Product Sampling and Subsampling..... | 7 |
| 4.3.2 Analytical Procedures..... | 8 |
| 4.3.3 Analytical Methods and Errors..... | 10 |
| 4.3.4 Quality Assurance..... | 11 |
| 4.3.4.1 Quality Assurance Program..... | 11 |
| 4.3.4.2 In-House Standards Program..... | 12 |
| 4.4 <u>UO₃ Analyses</u> | 13 |
| 4.4.1 Impurity Concentrations in UNH..... | 13 |
| 4.4.2 Analyses Performed and Results..... | 13 |
| 4.4.3 Storage/Shipment of UO ₃ | 14 |
| 4.4.4 Storage of UO ₃ at Hanford..... | 15 |
| 4.4.5 UO ₃ Processed In/After 1984 Restart of PUREX/UO ₃ Plants..... | 18 |
| 4.5 <u>Neptunium-237</u> | 18 |
| 4.5.1 Neptunium Concentration in Recycled Uranium..... | 18 |
| 4.5.2 Neptunium-237 (²³⁷ Np) Formation..... | 18 |
| 4.5.3 Predicted vs. Actual ²³⁷ Np Production..... | 20 |
| 4.5.4 Enhancing Production of Neptunium..... | 20 |
| 4.6 <u>Technetium-99 Analytical Results</u> | 22 |
| 4.6.1 Technetium-99 Concentration in Recycled Uranium..... | 22 |
| 4.6.2 Hanford Technetium Measurements..... | 22 |
| 4.6.3 Paducah Measurements of Technetium-99 in Recycled Uranium from Hanford..... | 23 |
| 4.6.4 Fernald Measurements of Technetium-99 in Recycled Uranium from Hanford..... | 23 |
| 4.7 <u>Uranium Isotopic Composition</u> | 23 |
| 4.7.1 Natural Uranium..... | 23 |
| 4.7.2 Normal Uranium..... | 24 |
| 4.7.3 Low Enriched Uranium (LEU)..... | 24 |
| 4.7.4 Typical Recovered LEU Uranium Oxide..... | 24 |
| 4.8 <u>Contaminants in Uranium Metal</u> | 27 |
| 4.8.1 Non-radiological Composition..... | 27 |
| 4.8.2 Metallographic Testing..... | 28 |
| 4.8.3 Radiological Contaminants..... | 28 |
| 4.8.4 Direct Blending..... | 29 |

Table of Contents

| | | |
|---------------------------|---|-----------|
| Section 4 References..... | | 31 |
| 5.0 | Current Inventory of Recycled Uranium | 1 |
| 5.1 | <u>Current Hanford Management Contractor (PHMC) Inventory of Recycled Uranium.....</u> | 1 |
| 5.2 | <u>Pacific Northwest National Laboratories(PNNL) Current Inventory of Recycled Uranium.....</u> | 2 |
| 6.0 | Discussion and Conclusions | 1 |
| 6.1 | <u>Recycled Uranium Shipped and Received.....</u> | 1 |
| 6.1.1 | Operating History..... | 1 |
| 6.1.2 | Recycled Uranium Specifications..... | 1 |
| 6.1.3 | Recycled Uranium Shipments and Receipts..... | 1 |
| 6.1.4 | Current Inventory..... | 2 |
| 6.1.5 | Shipper/Receiver Differences..... | 2 |
| 6.1.6 | Inventory Difference..... | 2 |
| 6.2 | <u>Typical Impurities and Isotopic Composition</u> | <u>3</u> |
| 6.2.1 | Plutonium..... | 3 |
| 6.2.2 | Neptunium and Technetium..... | 3 |
| 6.3 | <u>Activity Assessment and Occupational Potential Exposure.....</u> | <u>4</u> |
| 6.4 | <u>Data Validation.....</u> | <u>10</u> |
| 6.4.1 | Recycled Uranium Shipped from Hanford..... | 10 |
| 6.4.2 | Impurities Shipped with UO ₃ from Hanford | 10 |
| 6.4.3 | Discussion of Pu Differences Between K-25 and Hanford | 11 |
| Section 6 References..... | | 16 |

Table of Contents

Tables

Section 3

| | | |
|------------|--|----|
| Table 3-1 | Total Recycled Uranium Received from Offsite Sources | 24 |
| Table 3-2 | Hanford Receipts from Paducah | 25 |
| Table 3-3 | Hanford Receipts from Fernald | 26 |
| Table 3-4 | Hanford Receipts from Oak Ridge (K-25 & Y-12) | 27 |
| Table 3-5 | Summary of Recycled Uranium Shipments from Hanford | 28 |
| Table 3-6 | Hanford Uranium Shipments to Paducah | 29 |
| Table 3-7 | Hanford Summary Shipments to Fernald in MTU | 30 |
| Table 3-8 | Hanford Summary Shipment to Oak Ridge (K-25 & Y-12) | 31 |
| Table 3-9 | Uranium Waste at Hanford | 42 |
| Table 3-10 | Hanford Mass Balance-Total In-Scope & Out-of-Scope | 45 |

Section 4

| | | |
|------------|--|----|
| Table 4-1 | UO ₃ Process Specifications | 3 |
| Table 4-2 | Summary of UO ₃ Shipments in 1952 and LEU 1967-1972 | 14 |
| Table 4-3 | Summary of Drummed UO ₃ Product | 16 |
| Table 4-4 | Analyses of UO ₃ Produced In/After 1984 at Hanford | 19 |
| Table 4-5 | Special Process Batch | 20 |
| Table 4-6 | Calculated Production of Neptunium in Hanford Reactors | 20 |
| Table 4-7 | Neptunium Analyses on UNH | 22 |
| Table 4-8 | Typical Uranium Isotopic Ratio of LEU Produced In/After 1970 | 25 |
| Table 4-9 | Deeply Depleted UO ₃ Isotopic Data | 25 |
| Table 4-10 | ²³⁵ U Isotopic Data of Pre-1972 Product or Depleted UO ₃ | 26 |
| Table 4-11 | Chemical Specifications for Uranium Metal Billets | 27 |
| Table 4-12 | Transuranic Content in Ingot Composites | 30 |

Section 6

| | | |
|-----------|--|---|
| Table 6-1 | Assessment of Activities at Hanford Where Workers Were Most Likely to Contact Recycled Uranium | 5 |
|-----------|--|---|

Table of Contents

Figures

| | | |
|-------------------|--|----|
| Section 1 | | |
| Figure 1-1 | Hanford Recycled Uranium Project Functional Breakdown | 3 |
| | | |
| Section 2 | | |
| Figure 2-1 | The Hanford Site, Richland, Washington | 2 |
| Figure 2-2 | Hanford Major Process Flows and Facility Interfaces | 4 |
| Figure 2-3 | T-Plant Process Flow Diagram | 6 |
| Figure 2-4 | Simplified U-Plant Tributyl Phosphate (TBP) Process Flow Diagram | 11 |
| Figure 2-5 | UO ₃ Plant Process Diagram Involving Batch Pot Calciners | 14 |
| Figure 2-6 | UO ₃ Plant Process Diagram Involving Continuous Calciners | 15 |
| Figure 2-7 | UO ₃ Product Loadout System | 16 |
| Figure 2-8 | Copy of Early UO ₃ Product Specification | 19 |
| Figure 2-9 | REDOX Process Flow Diagram (Simplified) | 23 |
| Figure 2-10 | PUREX Process Flow Diagram (Excluding the Plutonium Production and Rework Facilities) | 27 |
| Figure 2-11 | Example of PUREX Production Specification | 30 |
| Figure 2-12 | Early Photograph of Fuel Fabrication Facilities in the 300 Area | 33 |
| Figure 2-13 | Fuel Fabrication Process for Single-Pass Reactors | 35 |
| Figure 2-14 | N Reactor Fuel Fabrication Process | 36 |
| Figure 2-15 | 303-M Uranium Oxide Facility | 40 |
| Figure 2-16 | Operating Intervals During Which Major Hanford Facilities Processed Recycled Uranium | 41 |
| | | |
| Section 3 | | |
| Figure 3-1 | Major "Tier 1" Sites for Hanford Recycled Uranium Transactions | 2 |
| Figure 3-2 | Major DOE Field Facilities | 3 |
| Figure 3-3A | Material Flow-Manhattan Engineer District: 1942-1946 | 4 |
| Figure 3-3B | Material Flow-Atomic Energy Commission: 1946-mid 1950s | 5 |
| Figure 3-3C | Material Flow-Atomic Energy Commission: mid 1950s-mid 1960s | 6 |
| Figure 3-3D | Material Flow-Atomic Energy Commission/Energy Research and Development Agency/Department of Energy: mid 1960s-late 1980s | 7 |
| Figure 3-4A | First Hanford Shipment of UO ₃ Containing Transuranics & Analytical Data | 9 |
| Figure 3-4B | Second Hanford Shipment Containing Transuranics and Analytical data | 11 |
| Figure 3-5 | Example of Historical Transfer Forms-Cover Page | 13 |
| Figure 3-5 (Cont) | Example of Historical Transfer Form for Shipment from Hanford to Paducah (circa 1971) | 14 |
| Figure 3-6 | Product Acceptance Form Hanford Depleted UO ₃ to Paducah (circa 1971) | 15 |
| Figure 3-7 | 1949 Schematic Diagram Showing Uranium Flow in 300 Area | 17 |

Table of Contents

| | | |
|------------------|---|----|
| Figure 3-8 | Typical Metal Billet Receipt Inbound from RMI/Fernald in the 1980s | 22 |
| Figure 3-9 | UO ₃ T-Hoppers at Hanford Rail Spur, 200 West Area | 34 |
| Figure 3-10 | Uranium Flow and Inventory in Fuels Manufacturing Process (CY 1978) | 38 |
| Figure 3-11 | Waste Acid and Uranium-Bearing Acid Recovery System | 39 |
| Figure 3-12 | Hanford Uranium Mass Flow | 47 |
| | | |
| Section 4 | | |
| Figure 4-1 | Example Page of Specifications for UO ₃ Plant | 4 |
| | | |
| Section 5 | | |
| Figure 5-1 | Hanford Total PHMC Uranium Inventory | 1 |
| | | |
| Section 6 | | |
| Figure 6-1 | Estimate of Personnel Having Work Potentially Involving Exposure to Recycled Uranium at Specific Facilities | 8 |
| Figure 6-2 | Plutonium Contained in Recycled Uranium Shipped from Hanford | 12 |
| Figure 6-3 | Neptunium Contained in Recycled Uranium Shipped from Hanford | 13 |
| Figure 6-4 | Neptunium Contained in Recycled Uranium Shipped from Hanford | 14 |

Table of Contents

Appendices

| | | |
|-------------------|--|----|
| Appendix A | Acronyms and Glossary of Terms | |
| | Acronyms | 2 |
| | Glossary of Terms | 6 |
| Appendix B | Section 3 - Supplemental Information | |
| Table 3.2.1 | Out-of-Scope Hanford Receipts (as reference) | 3 |
| Table 3.2.2 | 1950-FY 65 Hanford (GE Company) Uranium Receipts from Offsite | 8 |
| Table 3.2.3 | Hanford FY 1966-70 Uranium Receipts | 21 |
| Table 3.2.4 | Hanford Chemical Processing Contractor (HVA) Uranium Receipts FY 1971-March 31, 1999 | 28 |
| Table 3.2.5 | Hanford Chemical Processing Contractor (HRA) Uranium Receipts FY 1971-March 31, 1999 | 30 |
| Table 3.2.6 | Hanford Chemical Processing Contractor (HUD & HTA) Uranium Receipts FY 1971-March 31, 1999 | 32 |
| Table 3.2.7 | Hanford Reactor/Fuel Fab Contractor (HXA) Uranium Receipts FY 1971-March 31, 1999 | 34 |
| Table 3.2.8 | Pacific Northwest National Laboratory (PNNL) Uranium Receipts FY 1965-March 31, 1999 | 36 |
| Table 3.3.1 | December 1947 Through June 51 Hanford (GE Company) Uranium Shipments Offsite | 38 |
| Table 3.3.2 | FY 1952-65 Hanford (GE Company) Uranium Shipments to Offsite Locations | 47 |
| Table 3.3.3 | FY 1966-70 Hanford Uranium Offsite Shipments | 60 |
| Table 3.3.4 | Hanford Chemical Processing Contractor (HVA) Uranium Shipments FY 1971-March 31, 1999 | 64 |
| Table 3.3.5 | Hanford Chemical Processing Contractor (HRA) Uranium Shipments FY 1971-March 31, 1999 | 66 |
| Table 3.3.6 | Hanford Chem. Processing Contrs (HUD & HTA) Uranium Shipments FY 1971-March 31, 1999 | 68 |
| Table 3.3.7 | Hanford Reactor Contractor (HXA) Uranium Shipments FY 1971-March 31, 1999 | 70 |
| Table 3.3.8 | Pacific Northwest National Laboratory (PNNL) Offsite Uranium Shipments | 72 |
| Appendix C | Section 4 - Supplemental Information | |
| Table 4-1 | Detailed Analyses of 1952 Produced UO ₃ | 2 |
| Table 4-2 | Detailed Analysis of LEU UO ₃ | 3 |
| Table 4-3 | Detailed Analysis of Drummed UO ₃ Product | 6 |

Table of Contents

| | | |
|-------------------|--|----|
| Appendix D | Section 5 - Supplemental Information | |
| Table 5.1.1 | Current Inventory of Hanford In-Scope Uranium | 2 |
| Table 5.1.2 | Pacific Northwest National Laboratory (PNNL) Recycled Uranium Inventory as of March 31, 1999 | 5 |
| Appendix E | Description of Research Strategies Used in Study | |
| E.0 | Uranium Mass Balance Project Document Retrieval and Review Process | 2 |
| Figure E-1 | Complexity and Range of Information to be Researched at Hanford | 2 |
| Figure E-2 | Uranium Mass Balance Project Document Identification/Review Process | 3 |
| E.1 | Databases Used | 4 |
| E.2 | Database Keyword Searches | 5 |
| Table E-1 | Keywords Used in Searching Databases | 7 |
| E.3 | Technical Review of Keyword Search Results | 7 |
| E.4 | Obtaining Documents and Boxes of Records | 8 |
| E.5 | Additional Document Searches | 9 |
| E.6 | Technical Review of Documents | 9 |
| E.7 | Project Records | 9 |
| E.8 | References | 10 |
| Appendix F | Supplemental Information on Hanford Fuel Fabrication | |
| F.1 | Single Pass Reactor Fuel Fabrication | 3 |
| F.1.1 | Fuel Canning | 3 |
| F.1.2 | Single Pass Fuel Fabrication Changes | 4 |
| F.2 | N-Reactor Fuel Fabrication Processing | 5 |
| F.2.1 | N-Reactor Fuel Fabrication | 5 |
| F.2.2 | Co-Extrusion Process | 6 |
| F.3 | Material Sources | 7 |
| F.4 | References | 8 |
| Appendix G | Supplemental Information on the UO₃ Plant | |
| G.1 | Operating History Uranium Trioxide (UO ₃) Plant | 3 |
| G.2 | Process Operations | 6 |
| G.3 | Waste Generation | 7 |
| G.4 | Radiation Exposure | 8 |
| G.5 | Contaminate Partitioning | 8 |
| G.6 | UO ₃ Related Incidents | 9 |
| G.7 | References | 10 |

Table of Contents

Appendix H Timeframe of Events at Hanford

Appendix I Estimates of Annual Recycled Uranium Constituents Shipped Offsite

| | | |
|------------|--|----|
| Table I-1 | Historical Hanford Recycled Uranium Receipts (MTU) | 4 |
| Table I-2 | Historical Hanford Recycled Uranium Shipments (MTU) | 5 |
| Table I-3 | Estimated Minimum Pu in Historical Hanford Recycled Uranium Shipments (Gm) | 6 |
| Table I-4 | Estimated Mean Pu in Historical Hanford Recycled Uranium Shipments (Gm) | 7 |
| Table I-5 | Estimated Maximum Pu in Historical Hanford Recycled Uranium Shipments (Gm) | 8 |
| Table I-6 | Estimated Minimum Np in Historical Hanford Recycled Uranium Shipments (Kg) | 9 |
| Table I-7 | Estimated Mean Np in Historical Hanford Recycled Uranium Shipments (Kg) | 10 |
| Table I-8 | Estimated Maximum Np in Historical Hanford Recycled Uranium Shipments (Kg) | 11 |
| Table I-9 | Estimated Minimum Tc in Historical Hanford Recycled Uranium Shipments (Kg) | 12 |
| Table I-10 | Estimated Mean Tc in Historical Hanford Recycled Uranium Shipments (Kg) | 13 |
| Table I-11 | Estimated Maximum Tc in Historical Hanford Recycled Uranium Shipments (Kg) | 14 |
| Table I-12 | Estimated Constituents Based On Low Value Of Constituent Boundary Range | 15 |
| Table I-13 | Estimated Constituents Based On Mean Value Of Constituent Boundary Range | 16 |
| Table I-14 | Estimated Constituents Based On High Value Of Constituent Boundary Range | 17 |