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# FLUOR

February 22, 2005

Fernald Closure Project  
Letter No. C:SP:2005-0005

Mr. John M. Sattler  
U. S. Department of Energy  
Ohio Field Office - Fernald Closure Project  
175 Tri-County Parkway  
Cincinnati, Ohio 45246

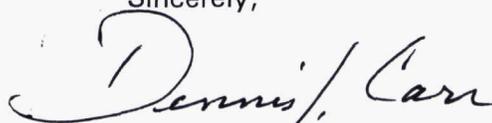
Dear Mr. Sattler:

**CONTRACT DE-AC24-01OH20115, SUBMITTAL OF NEVADA TEST SITE WASTE PROFILE  
ONLO-000000129, REVISION 5, MISCELLANEOUS URANIUM RESIDUE WASTES**

Enclosed is a signed copy of Nevada Test Site (NTS) Waste Profile ONLO-000000129, Revision 5, and Miscellaneous Uranium Residue Wastes. Revision 5 is the result of the annual profile review and is being submitted to update the profile to meet the requirements of the Nevada Test Site Waste Acceptance Criteria, Revision 5. To aid in the review, we have provided a detailed list of changes made to the profile and related documents.

A suggested cover letter for transmitting this Waste Profile to Nevada is enclosed for your convenience. Should you have any questions, or require additional information, please contact Steve Heffron at (513) 648-5650.

Sincerely,



Dennis J. Carr  
Senior Project Director  
Silos Project

DJC:DSA:kl  
Enclosure(s)

c: David S. Adkins, MS52-3  
Terri L. Binau, DOE Contracting Officer, DOE-OH (Springdale)  
Reinhard Friske, MS52-3  
Steve Heffron, MS 52-3  
Ralph E. Holland, DOE Contracting Officer, DOE-OH/FCP  
Dennis Sizemore, Fluor Fernald, Inc. Prime Contract, MS01  
Letter Log Copy, MS01  
File Record Subject-Submittal of Nevada Test Site Waste Profile ONLO-000000129,  
Revision 5, Miscellaneous Uranium Residue Wastes  
Project Number 40600/1.1  
Administrative Record, MS78

To: John B. Jones, NNSA/NSO

From: John Sattler

Subject: Submittal of Profile ONLO-000000129, Revision 5, Miscellaneous Uranium Residue Wastes

Enclosed is a signed copy of Nevada Test Site (NTS) Waste Profile ONLO-000000129, Revision 5, Miscellaneous Uranium Residue Wastes. Revision 5 is the result of the annual profile review and is being submitted to update the profile to meet the requirements of the Nevada Test Site Waste Acceptance Criteria, Revision 5. To aid in the review, we have provided a detailed list of changes made to the profile and related documents.

c: Without Enclosures  
Reinhard Friske, MS52-3  
Steve Heffron, MS52-3  
John W. Samples, MS52-3

**Fernald Closure Project Waste Profile**  
**Miscellaneous Uranium Residue Wastes**  
**ONLO-000000129, Rev. 5, 02/17/05**  
**Detailed List of Changes to ONLO-000000129**

1. General- Updated profile using revision 1 of the profile form.
2. Section B.2.b- Changed the profile revision number and date.
3. Section B.6- Changed to "One Time Only" waste stream with an estimated volume of 5 m<sup>3</sup>.
4. Section B.7- Changed estimated shipment frequency to approximately 2 shipments.
5. Section C.9- Removed inert filler material from list of waste components. This is a requirement in the profile instructions.
6. Section E.1- Changed "strong tight" to "excepted packaging" as currently defined by DOT regulations.



## C. Physical/Chemical Characterization

1. Physical/Chemical process knowledge. Describe the process knowledge information used for physical/chemical characterization of this waste stream:

Material Safety Data Sheets. Attach MSDSs used to designate this waste stream (Hanford Site users can list Hanford MSDS numbers below in lieu of providing MSDSs).

Mass balance from process inputs. Describe how process inputs are controlled and recorded:

Historical process and analytical data. Describe: **This waste consists of uranium process residue. Years of historical production data such as stringent process control specifications, sampling and MC&A data were used for characterization of this waste.**

Inert debris characterized by inventory control. Check this box when the waste stream consists largely of inert debris items that are characterized by inventory control procedures and recorded on inventory sheets. Briefly list or describe inventory procedures:

Other. Describe:

Physical/chemical characterization varies. Check this box when the characterization strategy varies from container to container. Describe below the strategy used to meet the acceptable knowledge requirements of the waste acceptance criteria.

2. Physical/chemical analysis. Describe the sampling and analysis performed to characterize this waste stream:

No analysis performed.

Field screening performed. Describe the frequency and type of field screening performed:

Laboratory analysis performed. Describe the sample source and sampling frequency and methods: **Sample source selected as required within sub-groups of waste, sampling frequency varies based on data needs, TCLP Test Method 1311. Table B-1 attached.**

List the analytical methods used, including upper confidence limits and explanations of anomalies for all analytes analyzed. Attach representative analytical sample result summary. For NTS, attach Table B-1 and data validation summary.

3. Regulatory status. Check all boxes below that describe the regulatory status of the waste stream:

Federally regulated (RCRA) hazardous waste (40 CFR 261). List all RCRA U, P, F, K or D waste codes that could apply to the waste stream; place waste codes that do not apply to all containers in parentheses:

For Hanford only, Washington State dangerous waste (WaAdminCode173-303), excluding W001. List all Washington waste codes that apply; place waste codes that do not apply to all containers in parentheses:

For Hanford only, Washington State dangerous PCB waste (Waste code W001 of WaAdminCode173-303): Describe PCB source and concentration:

TSCA regulated PCB (40 CFR 761). Describe category of PCB (i.e. PCB waste, PCB bulk product waste, PCB remediation waste, PCB analytical waste, etc). Describe PCB source and concentration:

Waste generated from cleanup activities conducted under CERCLA

Waste is not regulated under any of the above regulations.

Waste is hazardous per state-of-generation regulations? If yes, identify hazardous components and state regulations.

4. Federal land disposal restrictions. Check all boxes that apply:

Waste stream is not subject to federal land disposal restrictions

Waste stream requires treatment to meet land disposal restrictions of 40 CFR Part 268.

If checked, provide the following information:

Wastewater

Nonwastewater

Hazardous debris

Waste contains Underlying Hazardous Constituents (applicable UHCs must be included in Item C.9)

Was the waste treated after August 24, 1998? Yes  No

# Waste Profile Sheet

Waste stream meets some of the applicable land disposal restrictions of 40 CFR 268. Check this box if the waste has been treated to meet some federal land disposal restrictions or if it meets some federal land disposal restrictions as generated. If checked, describe the treatment performed and analytical data to support LDR determination:

Waste stream meets all applicable land disposal restrictions of 40 CFR 268. Check this box if the waste has been treated to meet all federal land disposal restrictions or if it meets the land disposal restrictions as generated. If checked, describe the treatment performed and analytical data to support LDR determination:

5. For Hanford only, Waste characteristics. Check any of the boxes for regulated characteristics (WaAdminCode173-303-090) that apply to the waste stream:

- |   |   |  |
|---|---|--|
| <input type="checkbox"/> Flash point < 38°C   | <input type="checkbox"/> Flash point 38°C - <60°C               | <input type="checkbox"/> Flash point 60°C – 93.3°C |
| <input type="checkbox"/> Ignitable solid  | <input type="checkbox"/> Oxidizer                               |  |
| <input type="checkbox"/> pH 2 or less   | <input checked="" type="checkbox"/> pH 12.5 or greater          |  |
| <input type="checkbox"/> Liquid that corrodes steel at a rate greater than or equal to 0.25 inches/year |   |  |
| <input type="checkbox"/> Reactive cyanide   | <input type="checkbox"/> Reactive sulfide                       | <input type="checkbox"/> Water Reactive            |
| <input type="checkbox"/> Explosive, unstable or pyrophoric  | <input type="checkbox"/> Generates toxic gases, vapors or fumes |  |

6. Physical state:

- |   |  |                                       |   |
|---|--|---------------------------------------|---|
| <input type="checkbox"/> Liquid                 | <input type="checkbox"/> Sludge        | <input type="checkbox"/> Debris       | <input checked="" type="checkbox"/> Solid |
| <input checked="" type="checkbox"/> Powder/Dust | <input type="checkbox"/> Sealed Source | <input type="checkbox"/> Encapsulated | <input type="checkbox"/> Solidified       |
| <input type="checkbox"/> Other; describe:       |  |                                       |   |

7. Liquid form. If the waste stream contains liquid, check all that apply:

- |   |   |  |
|---|---|--|
| <input type="checkbox"/> Containerized liquid | <input checked="" type="checkbox"/> Absorbed Liquid | <input type="checkbox"/> Stabilized liquid |
|---|---|--|

8. Other contents: Check any of the following that are components of the waste stream, and provide a description of how the waste acceptance criteria for each are met:

- |   |   |  |  |
|---|---|--|--|
| <input type="checkbox"/> Animal carcasses | <input type="checkbox"/> Infectious waste   | <input type="checkbox"/> Vegetation            | <input type="checkbox"/> Free liquids                              |
| <input type="checkbox"/> Chelating agents | <input type="checkbox"/> Organic liquids  | <input type="checkbox"/> Asbestos waste        | <input checked="" type="checkbox"/> Particulates<br><b>EW-1016</b> |
| <input type="checkbox"/> Gases            | <input type="checkbox"/> PCBs   | <input checked="" type="checkbox"/> Explosives | <input type="checkbox"/> Pyrophorics                               |
| <input type="checkbox"/> Beryllium Dust   | <input checked="" type="checkbox"/> Other<br><b>Hydrogen Gas Generation, WM:PKGG-T-0026 and EW-1016</b> |  |  |

9. Waste composition. Describe the gross composition/component of the waste stream and all hazardous constituents that contribute to any waste codes or LDR treatment standards.

If the chemical composition varies greatly from container to container, check this box and provide bounding values or ranges here. Further evaluation will occur on the specific package paperwork as it is provided for highly variable streams

CAS Number	Chemical constituent	Waste Component	Estimated weight percent <input checked="" type="checkbox"/> Estimated volume percent <input type="checkbox"/>
		<b>Solid Uranyl Nitrate</b> <b>MEF # 3701</b>	<b>1</b>
		<b>Roasted Uranium Residues</b> <b>MEF # 3807</b>	<b>25</b>
		<b>Scrap Uranium Fluorides</b> <b>MEF # 3808</b>	<b>25</b>
		<b>Magnesium Fluoride Slag Residues</b> <b>MEF # 3809</b>	<b>4</b>
		<b>Scrap Uranium Oxides</b> <b>MEF # 3810</b>	<b>30</b>
		<b>Dust Collector Residues</b> <b>MEF # 3820</b>	<b>9</b>
		<b>Dust Collector Bags</b> <b>MEF # 3821</b>	<b>1</b>
		<b>Contaminated Graphite</b> <b>MEF # 3845</b>	<b>1</b>
		<b>Scrap Salts</b> <b>MEF # 3846</b>	<b>1</b>

# Waste Profile Sheet

CAS Number	Chemical constituent	Waste Component	Estimated weight percent <input checked="" type="checkbox"/> Estimated volume percent <input type="checkbox"/>
		<b>Incinerator Ash/Cinders</b> <b>MEF # 3847</b>	<b>0.5</b>
		<b>Rockwell Cleanings</b> <b>MEF # 3848</b>	<b>1</b>
		<b>Project Related Trash and Debris</b>	<b>1</b>
		<b>Boron Carbide</b>	<b>0.5</b>

## D. Radiological Characterization

1. Radiological process knowledge. Describe the source(s) of the radioactive material in this waste stream (i.e., the radiological processes that introduced the radioactive material into the waste stream).

**This waste is uranium process residue. Refer to Process Knowledge Narrative (PKN).**

2. Radiological characterization methods. Describe the analysis and characterization methods used to determine the radionuclide inventory of the waste stream. Check all that apply.

- Radionuclide material accountability. Describe the accounting methods used to help establish the radionuclide inventory: **Site MC&A material accounting methods**
- Radiochemical analysis. Describe type and frequency of sampling and analysis: *For NTS, attach Table B-1 and data validation summary* **Historical process sampling and analysis data. Product grade uranium residue was sampled on a regular lot basis throughout the production years. Other components of this waste were sampled as required to obtain representative data. Alpha and Gamma Spectroscopy.**
- Nondestructive assay. Describe type and frequency of assay performed:
- Field measurement instruments. Describe the type of instruments and how they are used to help establish the radionuclide inventory:
- Scaling factors. Explain how the scaling factors were derived and how they are used:
- Computer models. Describe the computer model used and how it is used to establish the radionuclide inventory:
- Other. Describe method: **Ratios such as calculating U-234 and U-236 based on the uranium content and U-235 enrichment levels were used as part of the radiological characterization.**

If several methods are checked above, describe how the methods are used together to establish the radiological inventory of the waste stream. For complex or highly variable waste streams, explain the strategy used to meet the acceptable knowledge requirements of the waste acceptance criteria. **MC&A records, based on historical process sampling, are used for % uranium and % U-235 enrichment. Historical process and specific waste directed sampling and analysis, along with the limited use of ratios, is used for all other radionuclides.**

3. Estimated Radiation Dose of disposal package (mSv/hr):

Surface **0.005 to 0.2**                      30 cm **0.005 to 0.15**                      One Meter **0.005 to 0.02**

4. (Section D 4 need not be filled out for Hanford only profiles)

Yes     No    Does the waste contain enriched uranium ( $^{235}\text{U}$  wt%  $\geq 0.90$ ),  $^{233}\text{U}$ ,  $^{239}\text{Pu}$ ,  $^{241}\text{Pu}$ ,  $^{242\text{m}}\text{Am}$ ,  $^{243}\text{Cm}$ ,  $^{245}\text{Cm}$ ,  $^{247}\text{Cm}$ ,  $^{249}\text{Cf}$ ,  $^{251}\text{Cf}$ ? If yes, answer the following and check those that apply for compliance with the criticality safety criteria of the NTSWAC. If no, skip to Section D.5.

4.1  Attach completed NTSWAC, Appendix E, Table E.3,  $^{235}\text{U}$  FGE and  $^{235}\text{U}$  Effective Enrichment, for each enrichment level or range.

4.2  Waste package contains 15 g of  $^{235}\text{U}$  FGE or less.  
Specify controlling document:

# Waste Profile Sheet

- 4.3  Fissile material does not exceed 350 g of <sup>235</sup>U FGE per package nor does it exceed 2 g of <sup>235</sup>U FGE per kilogram of waste (mass of the package is not included in the mass of the waste) (graphite and beryllium must not exceed 1% of the mass of the waste).  
Specify controlling document:
- 4.4  Waste complies with the limits and conditions as specified in NTSWAC, Appendix E, Table E.4.  
Specify controlling document: **EW-1016**
- 4.5  Graphite and beryllium exceeds 1% of the mass of the waste.
- 4.6  Waste complies with the limits and conditions as specified in NTSWAC, Appendix E, Tables E.5 and E.6. Specify controlling document: **EW-1016**
- 4.7  A waste specific nuclear criticality safety evaluation (NCSE) was performed to show compliance with the NTSWAC, Section 3.2.1. Attach NCSE for review and specify controlling document:

5. Reportable radionuclides. List the radionuclides that could be reportable in the waste stream:  
 If the nuclides vary greatly from container to container, check this box and provide bounding values or ranges here. Further evaluation will occur on the specific package paperwork as it is provided for highly variable streams. *Note: For the NTS, concentrations must be entered in Becquerel/cubic meter.*

Isotope	Concentration Ci/m3 ( <b>Bq/m3</b> ); Range and Activity Representative of Final Waste Form	Isotope	Concentration Ci/m3 (Bq/m3); Range and Activity Representative of Final Waste Form
U-234	7.9E+06 to 1.3E+11 3.4E+10		
U-235	4.7E+05 to 5.9E+10 1.6E+09		
U-236	(9.2E+03) to 1.5E+10 3.0E+09		
U-238	5.2E+07 to 7.0E+10 2.6E+10		
Pu-239	(1.8E+04) to 3.5E+09 3.9E+08		
Pu-241	(9.2E+03) to 2.5E+10 2.8E+09		
Np-237	(1.8E+04) to 3.0E+09 6.3E+08		
Am-241	(1.8E+04) to 1.0E+09 5.7E+07		
Tc-99	(9.2E+04) to 9.4E+10 1.3E+10		
Sr-90	(4.6E+04) to 4.7E+09 6.6E+08		

6. Does the waste contain any alpha-emitting transuranic radionuclides with a half-life greater than 5 years, <sup>241</sup>Pu, or <sup>242</sup>Cm? **YES** If yes, list below.

Transuranic Nuclide	Concentration (nCi/g); Range and Activity Representative of Final Waste Form
Pu-238	(4.0E-04) to 2.4E+00 4.0E-01
Pu-239	(4.0E-04) to 2.6E+01 3.0E+00
Pu-241	(2.0E-04) to 1.8E+02 2.2E+01
Am-241	(4.0E-04) to 8.0E+00 4.4E-01
Np-237	(4.0E-04) to 2.3E+01 4.8E+00

7. Are there any packages in this waste stream that exceed the Plutonium Gram Equivalent limits specified in NTSWAC, Section 3.2.2? Yes  No   
Provide container type(s), quantity, and supporting PGE calculations. **PGE calculations attached.**
8. For Hanford only, Total FGE as defined in Hanford Site Solid Waste Acceptance Criteria, HNF-EP-0063.

## E. Packaging

1. Packaging used. Check the applicable boxes.  
 Drum; describe size(s), type, and weight range: **30 gal, metal drum, 45 kg to 228 kg; 55 gal, metal drum, 45 kg to 440 kg; 85 gal, metal drum, 45 kg to 441 kg; all drums are either excepted packaging, IP2 or 7A packages**

# Waste Profile Sheet

- Metal box; describe size(s), type, and weight range **Nominal 4'x4'x8', 273 kg to 4082 kg, boxes are either excepted packaging, IP2 or 7A packages**
- Wood box; describe size(s), type, and weight range:  
Do the Metal or Wood boxes meet the 3,375 lb/ft<sup>2</sup> strength test? Yes  No  N/A
- High integrity container; describe size(s), type, and weight range:
- Intermodal transport container; describe size(s), type, and weight range: **8'x8'x20', ISO cargo container, 10000 kg to 19048 kg, excepted packaging**
- Other container; describe size(s), type, and weight range:
- Bulk waste – bulk package and shipment dimensions and weight ranges – describe (supersack, burrito wraps, equipment, etc.):
- Vented; describe type of venting: **As required, 3/4" to 2" NucFil**
- Shielded; describe type of shielding:
- Sorbents; describe type and amount used: **As required for condensate control specified in procedure WM:PKGG-A-0002 (Absorbent Determinations). Three types of absorbents acceptable: lime (8-104 lbs.), QuikSolid granular (1-12 lbs.) or Stergo pads (16-2594 sq ft) depending on shipping configuration.**
- Radiologically stabilized in concrete or other stabilization agent; describe type and amount of material used and provide data to demonstrate waste meets stabilization criteria:

- 2. Maximum container size: **2.44m x 2.44m x 6.1m**
- 3. Maximum container gross weight: **19048 kg**
- 4. Describe any liners/protective coatings used to ensure that the container is compatible with the waste: **NA**
- 5. Does each container meet each of the package criteria as defined in the waste acceptance criteria?  
 Yes  No  
List documentation that demonstrates compliance with waste acceptance criteria.

**The Fernald controlling document is PT-0014, Procurement of Storage and Shipping Containers. Container specific test data is available upon request.**

- 6. Reference any special handling procedures and ALARA documentation, if applicable. **NA**

## F. Additional Information

- 1. Comments: **NA**
- 2. Exception or Deviation Request to waste acceptance criteria: Complete if needed
  - a) Identify specific requirement for which an exception or deviation is desired:
  - b) Provide reason an exception or deviation is needed:
  - c) Describe any proposed alternative methods to meet the general intent of the requirement:
- 3. Attachments. List any attachments provided with this profile: **Document Reference List, Chemical Form List, Table E.3, PE-g Calculations, Table 1 Analytical Results, Process Knowledge Narrative**

## G. Generator Signatures

To the best of my knowledge, the information provided on this form and the attached documentation is a full, true and accurate description of the waste stream. Willful and deliberate omissions have not been made. All known and suspected hazardous materials have been disclosed.

Technical Contact Name: **David S. Adkins**

Signature: \_\_\_\_\_

Date:

**2/22/05**

Waste Certification Official Name: **Reinhard Friske**

Signature: \_\_\_\_\_

Date:

**2-22-05**

**PROFILE ONLO000000129, Revision 5, E-5**  
**Chemical Form of Radionuclide List**

1.  $\text{UO}_3$  Uranium Trioxide
2.  $\text{CaU}_x\text{O}_y$  Calcium Uranate
3.  $\text{UF}_4$  Uranium Tetrafluoride
4.  $\text{UO}_2$  Uranium Dioxide
5.  $\text{U}_3\text{O}_8$  Triuranium Octoxide

**Procedures Reference List  
for Profile ONLO00000129, Revision 5**

<b>EW-0001</b>	MEF Characterization Process Procedure
<b>EW-1016</b>	Waste Management Work Authorization Program
<b>PL-3048</b>	Prototype Sampling and Analysis Plan for Waste at the FCP
<b>PT-0014</b>	Procurement of Storage and Shipping Containers
<b>PT-0018</b>	Preparation of Documentation of Off-Site Shipments of Hazardous Materials
<b>RM-0005</b>	FCP Lot Marking and Color Coding System
<b>RM-0053</b>	Waste Characterization Information Manual
<b>WM:CHAR-T-0001</b>	Radiological Characterization for Waste Disposal
<b>WM:PKGG-A-0001</b>	Certification of Low Level Radioactive Waste and Supporting Paperwork
<b>WM:PKGG-A-0002</b>	Absorbent Determination
<b>WM:PKGG-T-0026</b>	Safeguards for Handling Hydrogen and Methane Gas-Generating Materials, Pyrophoric Materials, and Bulging/Pressurized Containers
<b>WM:SHIP-T-0003</b>	Inspection of Waste Packages and Loaded Transport Vehicles

# Profile ONLO-000000129, Revision 5

Table 1  
Analytical Results

The analytical data in this table are supported by historical analytical data. The values were selected from the highest 90% upper confidence limit for each constituent from all related sample plans. The mean values are from the same sample plan as is the related 90% upper confidence limit value.

TCLP Metals	Mean Concentration (mg/l) TCLP	90% Upper Confidence Limit for the Mean Concentration (mg/l) TCLP
Arsenic	3.20	4.10
Barium	1.40	10.3
Cadmium	0.70	0.80
Chromium	1.91	2.20
Lead	1.05	2.45
Mercury	0.0004	0.0006
Selenium	0.47	0.71
Silver	0.45	0.57
<b>TCLP Volatiles:</b> Analysis not performed based on process knowledge of the material.		
<b>TCLP Semi-volatiles:</b> Analysis not performed based on process knowledge of the material.		
<b>TCLP Pesticides and Herbicides:</b> Analysis not performed based on process knowledge of the material.		

Table E.3: Calculation of U<sup>235</sup> Fissile Gram Equivalence and Effective U<sup>235</sup> Enrichment for LLW Packages

Nuclide (A)	High Activity Conc. (Bq/m <sup>3</sup> ) (B)	Volume of Package (m <sup>3</sup> ) (C)	Activity (Bq) (D)	Specific Activity (Bq/g) (E)	Mass of Isotope (g) (D/E=F)	U <sup>235</sup> FGE Factors (G)	U <sup>235</sup> FGE (F×G=H)	If FGE is >1% of U <sup>235</sup> Mass, then include (I)	
U <sup>233</sup>			0.0E+00	3.6E+08	0.0E+00	1.4E+00	0.0E+00		
U <sup>235</sup>	5.90E+10	1.46E-02	8.6E+08	8.1E+04	1.1E+04	1.0E+00	1.1E+04	1.1E+04	
Pu <sup>239</sup>	3.50E+09	1.46E-02	5.1E+07	2.3E+09	2.2E-02	1.6E+00	3.6E-02	3.6E-02	
Pu <sup>241</sup>	2.50E+10	1.46E-02	3.7E+08	3.8E+12	9.6E-05	3.5E+00	3.4E-04	3.4E-04	
Am <sup>242m</sup>			0.0E+00	3.6E+11	0.0E+00	5.4E+01	0.0E+00		
Cm <sup>243</sup>			0.0E+00	1.9E+12	0.0E+00	7.8E+00	0.0E+00		
Cm <sup>245</sup>			0.0E+00	6.4E+09	0.0E+00	2.3E+01	0.0E+00		
Cm <sup>247</sup>			0.0E+00	3.5E+06	0.0E+00	7.8E-01	0.0E+00		
Cf <sup>249</sup>			0.0E+00	1.5E+11	0.0E+00	7.0E+01	0.0E+00		
Cf <sup>251</sup>			0.0E+00	5.9E+10	0.0E+00	1.4E+02	0.0E+00		
<b>Effective U<sup>235</sup> Enrichment =</b>			<b>Total U<sup>235</sup> FGE ( 11000)/Total grams uranium (91)</b>				<b>TOTAL U<sup>235</sup></b>		
			<b>Effective U235 Enrichment =</b>				<b>FGE</b>	<b>1.1E+04</b>	
							<b>19.96</b>		

Plutonium Gram Equivalent Calculations for  
Reportable Isotopes included in NTS Profile ONLO-000000129, Rev.5

Isotope	Package Activity, Bq/m3	PE-g Conversion Factors	PE-g/m3
U-234	1.30E+11	1.13E-10	1.47E+01
U-235	5.90E+10	1.05E-10	6.20E+00
U-236	1.50E+10	1.07E-10	1.61E+00
U-238	7.00E+10	1.02E-10	7.14E+00
Np-237	3.00E+09	4.60E-10	1.38E+00
Am-241	1.00E+09	4.44E-10	4.44E-01
Tc-99	9.40E+10	7.08E-15	6.66E-04
Sr-90	4.70E+09	1.11E-12	5.22E-03
Pu-241	2.50E+10	8.50E-12	2.13E-01
Pu-239	3.50E+09	4.35E-10	1.52E+00
		<b>PE-g/m<sup>3</sup> =</b>	<b>3.32E+01</b>
Drum Waste Volume (m <sup>3</sup> ) =	1.17E-01	<b>Drum Total PE-g =</b>	<b>3.88E+00</b>
Box Waste Volume (m <sup>3</sup> ) =	7.02E-01	<b>Box Total PE-g =</b>	<b>2.33E+01</b>
Intermodel Waste Volume (m <sup>3</sup> ) =	5.62E+00	<b>Intermodel Total PE- g =</b>	<b>1.87E+02</b>

# FCP PROCESS KNOWLEDGE OVERVIEW

## MISCELLANEOUS URANIUM RESIDUE WASTES

### OV.1 FORWARD

This narrative represents the uranium residue waste inventory stored at the Fernald Closure Project (FCP) that is included in NTS Profile ONLO-000000129. Addressed in this narrative are Calcium Uranate,  $UO_3$  Reactor Recycle Tails, Dust Collector Residues, Dust Collector Bags, Magnesium Fluoride Slag Residues, Copper-Contaminated Sump Cake, Scrap Uranium Fluorides, Scrap Uranium Oxides, Roasted Uranium Residues, Contaminated Graphite, Scrap Salts, Incinerator Ash/Cinders, Rockwell Cleanings, Solid Uranyl Nitrate and Project Related Trash and Debris. These materials were generated from uranium processing/waste handling operations at the FCP and other facilities within the DOE complex. These residues have all been identified for disposal as wastes.

### OV.1 HISTORICAL PERSPECTIVE OF FCP SITE OPERATIONS

The historical production processes at the FCP consisted of ten production plants, each having a specific mission that supplied the succeeding plant with an intermediate product for further processing until the eventual uranium form was produced. Operations began in October 1951, with the completion of the Pilot Plant as an operating prototype of the entire production process to develop performance data for designing large-scale equipment while producing limited quantities of uranium metal. In December 1953, the Sampling Plant (1) became operational for receiving, weighing, sampling, and storing feed materials from both onsite and offsite sources. The three Metal Production and Fabrication Plants (5, 6, and 9) became operational by 1953. All five Chemical Plants (2/3, 4, 7, and 8) became operational within the following year. During its 37 years of operation, the FCP delivered nearly 170,000 metric tons uranium (MTU) of high purity metal in a variety of configurations and enrichment assays to DOE user sites at Hanford, Savannah River, and Oak Ridge. Approximately 35,000 MTU of uranium oxides and compounds were delivered to the Gaseous Diffusion Plants located at Paducah and Portsmouth.

### OV.2 FORMER PRODUCTION OPERATIONS

#### OV.2.1 Chemical Process Operations in Plants 2/3, 4, 7, 8 and the Pilot Plant

The FCP production process began with the conversion of impure uranium feed materials and recycled residues to pure uranium trioxide ( $UO_3$ ) in the Ore Refinery Plant (2/3), beginning in December 1953. This was accomplished in a three-step operation that began with acid-leaching uranium from dry solid feed materials followed by solvent extraction processing to produce a highly pure solution of uranyl nitrate (UNH). Pure UNH solution underwent thermal decomposition to  $UO_3$  in the final step.

Plant 4 began operating in October 1953 for converting  $\text{UO}_3$  that was either produced in Plant 2/3 or received from offsite to uranium tetrafluoride ( $\text{UF}_4$ ), commonly called green salt, by a two-step operation. In the first step,  $\text{UO}_3$  was reduced by hydrogen to form uranium dioxide ( $\text{UO}_2$ ), which was then converted to green salt using anhydrous hydrofluoric acid in the second step. Green salt product was the source material for making uranium metal derbies in the Metals Production Plant (5) beginning in May 1953.

Green salt was also produced in the Hexafluoride Reduction Plant (7) and the Pilot Plant by a direct process that reduced uranium hexafluoride ( $\text{UF}_6$ ) by hydrogen to form  $\text{UF}_4$ . Plant 7 operated for only three years, beginning in June 1954, primarily for supplementing the supply of normal uranium green salt produced by Plant 4 to meet the peak metal demands of the mid-1950s. Depleted  $\text{UF}_6$  was processed to  $\text{UF}_4$  in the Pilot Plant during this period to support the classified D38 Program at the Oak Ridge Y-12 Plant. Pilot Plant equipment was similar to Plant 7, but on a much smaller scale for producing slightly enriched  $\text{UF}_4$ .

The Scrap Recovery Plant (8) began operations in November 1953 for upgrading process residues to a form suitable for uranium recovery in Plant 2/3. Process residues were numerous forms of low-assay uranium materials that were generated by all production operations and offsite operations at Reactive Metals, Inc. (RMI) and at Weldon Spring. Examples include  $\text{MgF}_2$  slag, sump filter cakes, dust collector materials, incinerator ash, and off-specification  $\text{UO}_3$  and  $\text{UF}_4$ . Low-grade metal scrap that was unacceptable for recycling via remelting was furnaced to black oxide ( $\text{U}_3\text{O}_8$ ). After screening, the fine material fraction became acceptable feed for Plant 2/3 operations and the coarse material fraction was further oxidized in a furnace.

#### 0V.2.2 Metal Production and Fabrication Operations in Plants 5, 6, and 9

Plant 5 converted  $\text{UF}_4$  into uranium derbies, weighing as much as 370 pounds each, by a thermite reduction process using magnesium metal granules. By-product magnesium fluoride ( $\text{MgF}_2$ ) slag was generated in substantial quantities by the reduction process. Most derbies were cast into ingots along with high purity recycle metal scraps, either in Plant 5 or in Plant 9, depending upon the isotopic enrichment. Dimensions of cylindrical ingots were sized to the specific end-use configurations required by the reactor sites. As-cast ingots were cropped by sawing approximately 2 inches from the top section to remove shrinkage cavities and impurities that rose to the top of the melt during solidification. Cropped ingots were sent to the Plant 6 Rolling Mill and the Special Products Plant (9) for center-drilling and surface machining. Uranium alloy produced for DOD applications were in a slab casting configuration. High-purity derbies were also shipped to other DOE sites after surface cleaning was performed.

In Mid-1952, the Rolling Mill and Machining Areas of the Metals Fabrication Plant (6) became operational for fabricating cropped ingots into finished uranium cores. Cylindrical cropped ingots having

a diameter of 6-8 inches and 60 inches length were heat treated prior to the rolling mill operation. Equipment in this operation consisted of an ingot furnace, blooming mill with reversing rolls, shearing devices, molten salt heat treating furnace, and conveyors. The blooming mill operation produced an oval billet having nominal dimensions of 1¾ inch x 2 ¼ inch. After shearing and heat treating, the oval billets advanced to a six-stand finishing mill for producing rod stock having standard diameters in the range of 1 to 2 inches. In 1971, the rolling mill operation was shut down and all machined ingots were heat treated in Plant 6 before they were shipped to RMI for extrusion into tubes.

## CHARACTERIZATION OF WASTE STREAM COMPONENTS

### CONTROL OF NUCLEAR MATERIALS AT FCP

A wide variety of uranium process residues were generated by the former FCP production operations. These materials cover the full range of quality and constituents from very low-assay contaminated materials to progressively higher quality process residues. Additionally, the FCP received many similar materials from offsite locations, since the site served as the DOE repository for surplus uranium materials. Control of these various forms of materials was maintained by the "FCP Lot Marking and Color Coding System (RM-0005)", and continues to be used along with inventory data in the Sitewide Waste Information, Forecasting, and Tracking System (SWIFTS) system at the site.

Uranium residues from the production operations all were packaged into material lots and assigned a 15-digit code according to the five basic elements of the Lot Identification system. The elements consisted of a 4-digit Production Order Number (PO), 3-digit Source Code (SRC), 1-digit Enrichment Class Code, 3-digit Material Description Code (MDC), and 4-digit Lot Sequence Number. This system can provide substantial process knowledge information on the entire inventory of uranium wastes and is utilized to characterize them for offsite disposal. Descriptions of waste types in the remainder of this document are in bold type and are followed by the MDC in parentheses for internal purposes.

### URANIUM RESIDUE WASTES

Based on a review of historical sample data, process knowledge and MC&A data, the residues under this profile contain between 0.01% and 89% Uranium with a weighted average of 51% Uranium. U-235 enrichment is between 0.14% and 19.9% with a weighted average of 0.88%. Of the entire profile inventory approximately 0.14% by weight is greater than 2.0% enrichment and approximately 0.008% by weight is greater than 5.0% enrichment.

Other radionuclides present may include thorium, members of the uranium and thorium decay chains, and some quantities of fission products and transuranic nuclides. The fission products and transuranic nuclides are a consequence of low concentrations of these nuclides that were present in reactor-recycle material that was initially processed at the reactor site prior to shipment to FCP and some feed plant ash received from the Paducah Gaseous Diffusion Plant. None of the waste samples had transuranic concentrations greater than 100 nCi/g; the total of all alpha-emitting transuranics with half-lives greater than 20 years is less than 60 nCi/g.

Based on the review of the available sample data (refer to Table 1 for results) and process knowledge documentation, residues associated with profile ONLO-000000129 are considered low-level radioactive

waste (LLRW). The waste is not considered hazardous waste under Federal, Nevada or Ohio RCRA regulations and does not require treatment to meet appropriate LDR requirements.

Some of the uranium wastes in the narrative has the potential for generating hydrogen (H<sub>2</sub>) gas if confined in moist air for an extended period of time. These wastes will be packaged and processed per FCP procedures required for packaging of hydrogen generating materials. WM:PKGG-T-0026 specifies the safeguards for handling hydrogen gas generating materials. The project specific work authorization package specifies the packaging requirements for drums, metal boxes and ISO containers and includes steps, which address materials identified as possible hydrogen gas generating materials. EW-1016 is the controlling document for the FCP Waste Management Project Work Authorization Program, which requires that project specific details be addressed. EW-1016 will require concerns regarding hydrogen gas generation or other special packaging requirements be addressed in the project specific work authorization package, which will be in place prior to packaging these containers for shipment.

As stated above, special packaging requirements will be addressed in the project specific work authorization package, which will be in place for packaging these containers for shipment. As part of the packaging process, if void space is present in the containers during the packaging operation, the void space will be filled with inert filler material such as vermiculite, lime or dicalite.

Section 3.2.1 of the NTSWAC outlines the requirements for completing a criticality safety evaluation (CSE) for certain enriched materials. As stated above, special packaging requirements will be addressed in the project specific work authorization package, which will be in place for packaging these containers for shipment. All waste under this profile will be packaged in a manner to ensure each container does not exceed the limits and the waste package meets the conditions specified in Table E.4 or Tables E.5 and E.6 as listed in the NTSWAC. The packaging of this material will be performed under the oversight of the FCP WMP Quality Control Operations who will document the packaging meets the requirements as stated above.

#### **MEF 3821, Dust Collector Bags (026 and 029)**

During the production era, dust collectors were used sitewide at all process facilities to ventilate work areas and to prevent the loss/emission of material. Larger stationary dust collector systems were used to ventilate processes or work areas. Residues collected by stationary dust collector systems flowed through bags to a hopper, which discharged to a drumming station. Smaller portable dust collectors were used for housekeeping and cleaning of stationary dust collectors. The portable dust collectors contained dust collector bags. The majority of the dust collector bags were constructed of Canton flannel (cotton), polyester felt, dacron, or wool.

The dust collector bags consist of the bag itself and dust collector residue adhering to the bag. These dust collector residues are those residues that when the bag was emptied of its contents stayed in the bag and was containerized as part of the dust collector bag. Therefore, the bags contain the same waste material as the dust collector residues.

This waste stream also consists of used carbon filter elements contaminated with  $\text{UO}_2\text{F}_2$ . The waste was generated from filtering of off-gases at the Pilot Plant  $\text{UF}_6$  to  $\text{UF}_4$  reactor number 1. The Pilot Plant was the  $\text{UF}_6$  to  $\text{UF}_4$  reduction Plant. Solidified uranium hexafluoride ( $\text{UF}_6$ ) was received from off-site in steel cylinders of varying capacities depending on enrichment. Cylinders were placed in a heating chamber and the solid  $\text{UF}_6$  was vaporized. The  $\text{UF}_6$  vapor passed through a feed control station and entered the 6 to 4 reactor where, in contact with hydrogen (from dissociated ammonia) it was reduced to  $\text{UF}_4$ . The off-gasses produced in the reaction consisted of nitrogen, hydrogen, and anhydrous HF. Any off gas from the reaction vessel passed through a bed of activated carbon elements. Any  $\text{UF}_6$  present was adsorbed on the surface of the carbon elements. The adsorbed  $\text{UF}_6$  spontaneously converted to  $\text{UO}_2\text{F}_2$  when exposed to ambient humidity.

#### **MEF 3820, Dust Collector Residues (062, 132 & 135)**

##### **Dust Collector Residues, High Fluoride (062), Plant 1**

Plant 1 was the official Atomic Energy Commission sampling station for determining uranium and isotopic assays of uranium ores and concentrates. The plant's primary functions were to receive; weigh, sample, and store feed materials from both onsite and offsite sources.

Certain process residues generated from onsite production operations underwent processing steps within Plant 1 to prepare them for uranium recovery operations in Plant 2/3. Processes consisted of repackaging, milling, and sampling for quality control/nuclear accountability analysis. The Titan and Fitz mills were used to pulverize residues into a desired particle size. After sampling, the pulverized material was placed in containers and held until it was scheduled for delivery. Portable vacuums that provided housekeeping for the Titan mill operations generated dust collector residues.

##### **Dust Collector Residues, High Fluoride (062) and Low Fluoride (132), Plant 2/3**

Plant 2/3 was the refinery. Scrap uranium residues were converted to pure uranium trioxide ( $\text{UO}_3$ ) in Plant 2/3. This was accomplished in a three-step operation designated Digestion, Extraction, and Denitration.

In the Digestion step, uranium contained in dry feed materials was leached in hot nitric acid ( $\text{HNO}_3$ ) to produce a slurry of impure uranyl nitrate (UNH). Enriched and normal uranium metal that was not

suitable for remelt casting to ingots was also dissolved in nitric acid to produce UNH solution via a similar reaction.

After adjusting the acid concentration by ammoniation, the impure UNH feed slurry was fed to the Extraction step. In this step, tri-butyl phosphate (TBP) in kerosene selectively removed soluble uranyl ion ( $\text{UO}_2^{++}$ ) from aqueous acidic UNH solutions into the organic TBP extract phase. The uranium-barren slurry containing almost all of the metallic nitrates and anionic impurities that were present in the feed materials was called raffinate. A high-purity UNH solution was produced that was subsequently converted to  $\text{UO}_3$ , called orange oxide, by thermal decomposition in the Denitration step.

After milling and screening,  $\text{UO}_3$  was loaded into portable metal hoppers or drums, either for transport to Plant 4, or shipment offsite. Dust collector residues were generated as the result of housekeeping activities related to dumping and metal dissolving operations, ventilation of the area where dumping of feed materials occurred at the west end of Plant 2/3 and ventilation of the vacuum transfer, milling, and packaging of  $\text{UO}_3$ .

#### **Dust Collector Residues, High Fluoride (062), Pilot Plant**

The Pilot Plant had the same capabilities for production of metal products as the Metal Production Plants (5, 6, & 9), but was utilized on a smaller scale. Test quantities of derbies, ingots, and uranium shot were produced in order to develop manufacturing methods and techniques for use in large-scale operations in the Metal Production Plants. Dust collector residues were generated as the result of general housekeeping activities, which included vacuuming floor sweepings and stationary dust collector clean out, housekeeping for  $\text{UF}_6 \rightarrow \text{UF}_4$  reactors and green salt packaging stations, ventilation for  $\text{UF}_4$  packaging stations, housekeeping for the  $\text{UF}_4$  production area, housekeeping for the Pilot Plant Annex and housekeeping for the remelt and casting area.

#### **Dust Collector Residues, High Fluoride (062), Low Fluoride (132) & High Fluoride, Greater than 20% Assay (135), Plant 5**

In Plant 5, green salt ( $\text{UF}_4$ ) was reduced with magnesium metal granules (Mg) to produce uranium metal. A steel furnace reduction pot was lined with compacted finely milled magnesium fluoride ( $\text{MgF}_2$ ), to protect the furnace pot from the intense heat of the thermite reaction. Green salt ( $\text{UF}_4$ , 500 lbs) and magnesium metal granules (Mg, 80 lbs.) were then blended in the "F" machines and added to the pot. The pot was then capped with  $\text{MgF}_2$  slag, lidded and heated in an electric-resistance furnace to a temperature range of 1150°F to 1250°F. These actions were performed in a ventilated enclosure. This reaction yields a derby of uranium metal and  $\text{MgF}_2$  slag, which was generated in substantial quantities by the reduction process. High-quality derbies were cleaned, weighed, identified, and transferred to the Ingot Casting Areas of Plants 5 and 9. Most derbies were cast into ingots together with

remelt metal scrap, and briquettes made from machining chips. Depleted uranium ingots were cast in Plant 5 to meet Savannah River requirements. Larger ingots for Hanford requirements were cast in Plant 9. High-purity derbies were also shipped to other DOE sites after surface cleaning was performed.

Dust collectors serviced the "F" machine blending, filling, capping and lidding areas in Plant 5 during the production era. The Dust collector residues from these dust collectors consist of  $MgF_2$ ,  $UF_4$ , and Mg. These residues were collected in an effort to recover raw materials.  $UF_4$  reduction to produce derbies was a standard process using only high-grade quality materials. Dust collector residues were generated from the dust collectors which serviced the East Remelt Furnaces, East Crucible Burnout Area, East Separation Booth of the Casting Area, East Charge Station, East Ingot Separation Booth, Crucible Burnout Operation, West Separation Booth, Mold Coating, East and West Saw and Ingot Pickling. The dust collector residue waste stream from these processes will inherently be consistent with the ingredients used in the process and its products.

#### **Dust Collector Residues, High Fluoride (062), Plant 8**

The Scrap Recovery Plant (8) was used for upgrading process residues to a form suitable for uranium recovery in Plant 2/3. Process residues were numerous forms of low-assay uranium materials that were generated by all production operations and offsite operations at Reactive Metals, Inc. (RMI) and at Weldon Spring. Examples include  $MgF_2$  slag, sump filter cakes, dust collector materials, incinerator ash, and off-specification  $UO_3$ ,  $UF_4$  and  $U_3O_8$ . After screening, the fine material fraction became acceptable feed for Plant 2/3 operations and the coarse material fraction was further oxidized in a furnace. Dust collector residues were generated and collected at the Plant 8 Rotex Screening operation.

#### **Dust Collector Residues, High Fluoride (062) and Low Fluoride (132), Plant 9**

The Special Products Plant (Plant 9) was used to process special orders of uranium products for vendors throughout the DOE complex. The principle operation included the casting of uranium metal to produce various forms (e.g., billets, flats, and ingots). Ancillary operations included cleaning of uranium derbies in salt baths, machining operations, decladding of uranium metal forms, pickling of uranium derbies prior to remelting, and waste water treatment. The Plant 9 derby salt cleaning operations were serviced by a Hoffman dust collector (G-42-615). The purpose of the salt bath was to remove any remaining  $MgF_2$  slag from the derbies produced in Plant 5. Dust collector residues were generated as a result of the derby salt cleaning operations, dust collector G-42-615 and general housekeeping in Plant 9 using the Spencer Portable vacuum.

#### **MEF 3809, Magnesium Fluoride ( $MgF_2$ ) Slag Residue (031, 034, 035, 037, 077, 088 & 125)**

The FCP, as a result of producing uranium derbies, produced several types of byproduct magnesium fluoride slag, **Roasted  $MgF_2$  (031),  $MgF_2$  for Milling (034),  $MgF_2$ , Good Liner Material (035),  $MgF_2$ ,**

**Ground (037), Dry Crushed Slag from Furnace Pot Blowouts (077), Unroasted but Milled MgF<sub>2</sub> (088) and Unrecycled Slag +20 Mesh (125).** Plant 5 and the Pilot Plant (in lesser quantities) converted UF<sub>4</sub> green salt into uranium derby metal by a thermite reduction process using magnesium metal granules, as follows:



This reaction took place in a closed steel furnace pot, which was lined with compacted finely milled Magnesium Fluoride (MgF<sub>2</sub>) Slag that served as a refractory layer for protecting the furnace pots from the intense heat of the thermite reaction. Green salt and magnesium granules were blended and charged to the cavity of the lined pot and sealed. The pot was placed into an electric-resistance furnace and heated to a temperature range of 1150°F to 1250°F. When that temperature range was reached after 3 to 4 hours, the charge spontaneously reacted to produce the derby. After cooling in air and water, the furnace pots were inverted in an enclosed derby breakout station. The contents were removed by jolting the inverted pot to separate the derby from byproduct MgF<sub>2</sub> slag.

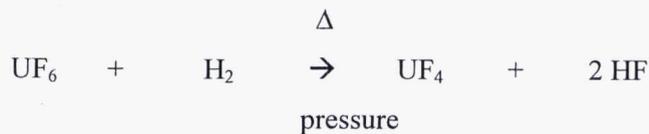
Magnesium Fluoride Slag (MgF<sub>2</sub>) was conveyed from the breakout station to the slag milling facility located near the Reduction Area of Plant 5. The MgF<sub>2</sub> was milled, screened and classified to meet the specifications for material to be used in preparation of subsequent liners for reduction pots. Once this system had sufficient material to meet the schedule, surplus MgF<sub>2</sub> was placed in a category for eventual recovery of the Uranium content in Plant 2/3 operations.

The Magnesium Fluoride Slag destined for Uranium recovery was pulverized at the Plant 1 Titan Roller Mill. The MgF<sub>2</sub> was often blended with enriched UO<sub>2</sub>, or other high-grade residues, during the milling process. The blending of the MgF<sub>2</sub> with enriched UO<sub>2</sub> accounts for the relatively high concentration of Uranium in this waste.

**MEF 3808, Scrap Uranium Fluoride Residue(065, 079, 082, 210, 211, 212 & 216)**

During the production era, uranium tetrafluoride (UF<sub>4</sub>), commonly called green salt, was used as feed material for producing uranium derbies. UF<sub>4</sub> was produced at the Pilot Plant and Plant 4 for metal production in Plants 5 and 9.

**UF<sub>4</sub> From Pilot Plant UF<sub>6</sub> (211)** was produced in the Pilot Plant by a direct process that reduced uranium hexafluoride (UF<sub>6</sub>) by hydrogen to form UF<sub>4</sub>. The hexafluoride reduction, or UF<sub>6</sub> to UF<sub>4</sub> conversion process, proceeded rapidly at operating temperatures of about 1000°F, according to the following reaction:



Cylinders containing UF<sub>6</sub> in solid form were connected to vaporizers to generate gaseous UF<sub>6</sub> for the reduction reaction. Hydrogen was generated by ammonia dissociation, and was mixed with the UF<sub>6</sub> gas in a specially designed nozzle contained within a vertical reaction tube or tower.

Most of the solid UF<sub>4</sub> settled downward within the reactor tower/tube as a fine powder and was collected in the hopper. From there, the UF<sub>4</sub> powder was weighed and packaged into 10-gallon cans for transfer to either Plant 4 or 5. **Scrap Salts, High Fluoride, Including Floor Sweepings (065)** were collected during general maintenance of the UF<sub>6</sub> to UF<sub>4</sub> reactor area, as well as UF<sub>4</sub> dust that was removed by two sintered metal filters at each reactor.

Plant 1 was considered an operations support facility and not a mainline production plant. UF<sub>4</sub> product was received at this facility for weighing and sampling. **Off-Spec UF<sub>4</sub> (082)** was containerized for waste at this facility. Green salt was classified as off-spec for several reasons including tap density and contamination with iron, nickel or UO<sub>2</sub>F<sub>2</sub>.

In Plant 4, UF<sub>4</sub> was produced from UO<sub>3</sub>, and then blended and packaged for the Metals Production Plant (Plant 5). UO<sub>3</sub> was first converted to uranium dioxide (UO<sub>2</sub>) by reducing it with hydrogen. The UO<sub>2</sub> then reacted with anhydrous hydrogen fluoride (AHF) to produce UF<sub>4</sub>.

Plant 4 converted UO<sub>3</sub> that was either produced in Plant 2/3 or recycled from offsite sources to UF<sub>4</sub> by a two-step Reduction/Hydrofluorination operation. Byproduct UO<sub>3</sub> recycled from Hanford operations that recovered transuranic elements from spent reactor fuel was a major source of enriched uranium feed for Plant 4.

In the first step, orange oxide was reduced by hydrogen (H<sub>2</sub>) to form uranium dioxide (UO<sub>2</sub>), as follows:



Mobile hoppers were used to deliver orange oxide to a two-stage, stainless steel fluid bed reduction reactor that operated at about 1000°F. Dissociated ammonia (hydrogen and nitrogen) entered the bottom of the reactor through a gas diffuser plate. Nitrogen served as a carrier gas to fluidize UO<sub>3</sub> for hydrogen reduction to form talcum-fine UO<sub>2</sub> powder.

In the hydrofluorination step,  $\text{UO}_2$  powder was conveyed to three horizontal, ribbon-screw furnaces, arranged in series, anhydrous hydrogen fluoride (HF) was introduced to this furnace system and flowed counter-currently to the  $\text{UO}_2$  powder for the conversion to product **UF<sub>4</sub> (210)**, as follows:



Recycle  $\text{UO}_3$  from Hanford was not as chemically reactive as  $\text{UO}_3$  produced in Plant 2/3. The Reduction-Oxidation-Reduction (ROR) process was developed in 1961, as a method for increasing its reactivity and conversion of  $\text{UO}_3$ . In the ROR process,  $\text{UO}_3$  underwent the standard reduction process step to form  $\text{UO}_2$ , but not the subsequent hydrofluorination step to produce  $\text{UF}_4$ . Instead, the intermediate  $\text{UO}_2$  powder was oxidized in heated air to form black oxide ( $\text{U}_3\text{O}_8$ ) to increase the particulate surface area and chemical reactivity. The  $\text{U}_3\text{O}_8$  was packaged for a second-pass feeding to the system for hydrogen reduction step and subsequent hydrofluorination step to produce **UF<sub>4</sub> From Hanford  $\text{UO}_3$  (212)**.

In the production of green salt, orange oxide ( $\text{UO}_3$ ) powder was continuously fed into a two-stage fluid bed reactor (FBR). The orange oxide was allowed to flow into the first stage of the FBR at a controlled rate and temperature. Hydrogen gas generated from dissociated ammonia was also fed into the FBR, where it fluidized and initiated the conversion of the orange oxide to brown oxide ( $\text{UO}_2$ ). Exiting the FBR, the brown oxide powder passed through the cocoa reactor while in a hydrogen atmosphere. This reactor transferred the brown oxide at a controlled temperature from the FBR to Talcum screw reactors A, B, and C.

For Bank 8, brown oxide powder was conveyed through only one Talcum reactor where it was in contact with a countercurrent stream of air and was converted to black oxide ( $\text{U}_3\text{O}_8$ ). When it was determined that complete oxidation occurred in the Talcum A reactor, reactors B and C were bypassed. The black oxide was processed back through Bank 7 or 9, where it was converted into **UF<sub>4</sub> (210)** green salt. Green salt from Plant 4 Banks 7, 8, and 9 was delivered by conveyor to the packaging system from the talcum weigh bins under Banks 7, 8, and 9, or from mobile hoppers, drums, or cans to any one of the three packaging systems. In the packaging systems, green salt was weighed, blended according to specification, sampled, and packaged in 10-gallon cans. The cans were filled to a uniform weight range, and then the amount of green salt in each can was adjusted to a final net weight range by manually adding or removing material. The operation was serviced by a dust collector system. **Off-Spec UF<sub>4</sub> (082)** was containerized as waste.

Plant 5 converted  $\text{UF}_4$  green salt into uranium derby metal by a thermite reduction process using magnesium metal granules, as follows:



In the metal reduction area of Plant 5, approximately 500 pounds of green salt were mixed with 80 pounds of magnesium granules to produce uranium metal derbies. To begin the reduction process that produces uranium metal, the  $UF_4$  and magnesium granules were blended and charged into a steel pot lined with  $MgF_2$  slag. The pot was heated in a Rockwell furnace at 1150°F to 1250°F for three to four hours until the contents reacted. At this point, the internal temperature of the pot would reach approximately 3000°F. This reaction produced a derby of uranium metal and  $MgF_2$  slag. After cooling in air and water, the furnace pots were inverted in an enclosed derby breakout station. The contents were removed by jolting the inverted pot to separate the derby from byproduct  $MgF_2$  slag.

**Unfired Reduction Charges (079)** were generated when the  $MgF_2$  pot liner collapsed as the  $UF_4$  and magnesium metal mix were being added to the "F" machine. The unfired reduction charges could not be used.

**Charged  $UF_4$  Pots (216)** were also generated as a result of these activities, and contained the same materials as the reduction charges.

The Analytical Laboratory also generated material included in this profile during routine miscellaneous lab activities performed in the Analytical Laboratory. The material from the laboratory in this profile consists of unused portions of enriched, normal and depleted samples of off-spec and product grade  $UF_4$  (082 & 210) and  $UF_4$  From Hanford  $UO_3$  (212).

**MEF 3807, Roasted Uranium Residues (123, 143, 144, 159 & 163)**

Off-specification green salt ( $UF_4$ ) was reacted with hydrated lime ( $Ca(OH)_2$ ) in Oxidation Furnace #2 in Plant 8 to produce **Calcium Uranate (123)**. Calcium Uranate was produced to increase solubility and convert the fluoride to calcium fluoride which is slightly soluble in nitric acid. The generation of Calcium Uranate was carried out in batches and composite samples from the batches were analyzed for production quality control. Most of the analytical data on Calcium Uranate, including analysis of transuranics, comes from the on-site analysis of these composite production samples. Calcium Uranate is a dry powder and will not fail the PFLT. It is not considered a high moisture content material as defined by the NTSWAC.

Sump/filter cakes generated at various on-site locations were sent for roasting at Plant 8, the Scrap Recovery Plant, and milling at Plant 8 or Plant 1. These materials include calcium uranate, uranium salts and insoluble oxides, precipitation aids such as lime, diatomaceous earth, and Filter Aid (Expanded Perlite Amorphous Silicate), which was used to enhance collection of solids on the filter media.

Wastewater was received at Plant 8 from the General Sump, which received water from the general production area and various stormwater collection points in the production area. This water was treated in accordance with the FCP NPDES discharge permit. If material was either precipitated or identified as being suspended in the water, either the Eimco or Oliver rotary filters were used to remove the material from the effluent water and the water was discharged. The filters used were standard industrial rotary vacuum filters. Approximately 2000 gallons of water were pumped into the Precoat Makeup Tank. Twenty-four to thirty bags of filter aid were added, depending on which filter was used. The mixture was agitated until a uniform slurry was produced, and the slurry was pumped into the filter basin. As the filter drum rotated the vacuum pump was started and the filter aid collected on the filter until the precoat was 2" to 3" thick. After the precoat was ready the material to be filtered was pumped into the reservoir. As the material was filtered and solids built up on the precoat they were continuously cut off by a "knife." The accumulated solid material, or sump cake, was then dried, or "roasted," in the Primary Calciner, which operated at approximately 800°F. This material is referred to as **Roasted Calcium Precipitated Sump and Filter Cake (143)**. The drying operation was considered part of the wastewater treatment process and resulted in dry, free flowing, powder product. This material is not considered a high moisture content material as defined by the NTSWAC.

**Offsite Sump and Filter Cakes After Roasting at FEMP (144)** was produced via processing sump cake obtained from Hanford and RMI. Although the specific processes are not known, it is assumed these sump cakes were generated via filtration processes similar to those at the FEMP. As with other waste types discussed, this material has undergone a roasting process and is not considered a high moisture content material as defined by the NTSWAC.

Sump liquors were generated in various plants on site and filtered at the generating plant. Some of the resulting sump/filter cake was sent through Plant 8 for roasting and milling prior to the recovery of uranium. Materials generated in Plant 6, the Metal Fabrication and Machining Plant, and Plant 9, the Special Products Uranium Operations Plant, were included in this population. In both plants, sump liquors were treated with lime or ammonium to enhance precipitation of the uranium products, then filtered on a plate-and-frame press. The resulting filter cake was then drummed and set aside for sampling. The filter cake from Plants 6 and 9 was then sent to Plant 8 for roasting (drying) in the furnace, kiln, or Primary Calciner, and milling in Plant 8 or Plant 1. This material is referred to as **Roasted, Milled, and/or Screened Calcium-Precipitated Sump and Filter Cakes (159) or Roasted, Milled, and/or Screened Ammonium-Precipitated Sump and Filter Cakes (163)**. The drying operation was considered part of the treatment process and resulted in dry, free flowing, powder product. This material is not considered a high moisture content material as defined by the NTSWAC.

MEF 3810, Scrap Uranium Oxides (032, 084, 085, 100, 101, 102, 122, 133, 134, 140, 142, 154, 155, 157, 165, 166, 167, 170, 192, 200, 201, 202 & 214)

Scrap uranium oxide residues were generated by onsite operations and received from offsite sources. Residue materials remained until they could be processed for uranium recovery in special campaigns. Waste materials included under MEF 3810 and being included in this profile are as follows:

**032 - Incinerator Ashes Passing Through Grate, 084- Bad Reduction (no derby), 085 – Rotexed  $U_3O_8$ , Not From Plant 8 , 100 – Scrap  $U_3O_8$ , Low Fluoride, 101 – Scrap  $U_3O_8$ , High Fluoride, 102 – Scrap  $UO_2$ , 122-  $U_3O_8$  +8 Mesh, Low Fluoride, 133- Oxides Clad or Mixed With Aluminum, 134-  $U_3O_8$  for Reoxidation, 140- Oxides Clad or Mixed With Zirconium, 142- Oxides Clad or Mixed With Stainless Steel, 154-  $U_3O_8$  Rotexed Plant 8 Furnace Product, 155-  $U_3O_8$  8 Mesh From Rotexing, 157 – Reject  $UO_3$ , 165 –  $U_3O_8$  Not Requiring Re-Oxidation, 166 –  $UO_2$  Pellets, 167 –  $UO_2$  Powder, 170 – Ore Concentrate - Miscellaneous, 192- Oxide for Screening and Milling, 200 –  $UO_3$  Product, 201 –  $UO_3$  Reactor Recycle Tails , 202 –  $UO_2$  Product and 214 –  $U_3O_8$  From Recycle  $UO_3$ .**

**Plant 1** was the official receiving station for uranium compounds assaying less than 20.0 % U-235 furnished by licensees. The plant's primary function was to receive, weigh, sample and store feed materials from both onsite and offsite sources. Plant 1 was considered an operations support facility and not a mainline production plant. At one time, the principal function of Plant 1 was to obtain representative samples of the large quantities of incoming ore concentrates. Later, the plant was primarily used to sample and recycled production materials until needed by the production plants.

Waste materials from Plant 1 storage include brown oxide ( $UO_2$ ), orange oxide ( $UO_3$ ), black oxide ( $U_3O_8$ ), and oxides for cascade feed.

**The Plant 2/3 refinery** conducted processes for the digestion of uranium-bearing materials (principally  $U_3O_8$  and residues), the purification of uranyl nitrate hexahydrate [UNH], and the thermal decomposition [denitration] of these solutions. The Plant 2/3 facility included three primary process areas: Digestion, Extraction, and Denitration. In the Digestion area, uranium ore concentrates and recycle materials were dissolved in nitric acid to produce UNH. This solution was purified in the Extraction area. The purified UNH was thermally decomposed to uranium trioxide [ $UO_3$ ] in Denitration area.

From the 1950's until the early 1960's, the FCP processed ore concentrates such as virgin pitchblende ore and ion exchange concentrates from the Belgian Congo, ore concentrates from Canada, Australia, Portugal, and South Africa. Black oxide and soda salt feeds were received from the Colorado Plateau.

Since the early 1960's, the FCP has processed recycled uranium residues from onsite recovery operations and from offsite facilities.

The ore concentrate was received in 55 or 30-gallon drums from the sampling plant where it was sampled for assay and weighed. Batches of ore concentrate were grouped on the receiving pad. The drums were placed by batches on a roller conveyor leading to the appropriate dumping station. There were two dumping stations for cold feed and one for hot feed. A bucket elevator carried the ore to the top of the digestion building from which it was conveyed by screw conveyor to a surge hopper. A screw conveyor moved the material to one of three digester tanks.

Nitric acid from the nitric acid recovery system was stored in two tanks from which it was pumped to either of two overhead acid tanks. A predetermined quantity was discharged from one of these tanks to a digester to comprise a digestion batch. The rate of addition and the temperature of the digest batch controlled the rate of the digestion reaction. Each digester was equipped with heavy-duty agitators and internal coils that were used to heat or cool the reaction vessel.

After all of the feed was added to the digester, a sample was taken for analysis for uranium, acid, fluoride and chloride concentrations. Based on these analytical results, the batch would be adjusted to the proper acid normality (2.9N to 3.3N), uranium concentration (approximately 150 g/l), and fluorides and chlorides not to exceed 250 ppm. When digestion was complete, the UNH solution was processed through either a plate-and-frame filter or a cartridge filter. Then it was pumped through one of two polishing cartridge filters and into a storage feed tank for extraction.

In the Extraction area, the uranyl nitrate slurry was purified by liquid-liquid extraction. The UNH slurry and a two-component solvent mixture (tributyl phosphate [TBP] and kerosene) were fed into extraction columns in a counter-flow arrangement. Since the uranyl nitrate is preferentially attracted to the solvent, nitric acid and impurities are left behind in the aqueous raffinate. The purified uranyl nitrate was then separated from the solvent in a second extraction with deionized water, since the uranyl nitrate is preferentially attracted to the water rather than the solvent. The solution was treated with a sodium carbonate solution to remove degradation products from the finished uranyl nitrate solution.

In the Denitration area, purified uranyl nitrate hexahydrate was thermally decomposed at a range of 1200°F to 1500°F to produce the orange oxide ( $\text{UO}_3$ ).  $\text{UO}_3$  product was transferred from the denitration pots using a gulping system. A Roots-Connersville blower provided suction to pull the material into a surge hopper (north and south) through two tandem cyclone separators. A hammer mill at the hopper discharge pulverized the  $\text{UO}_3$  before it was drummed. Orange oxide ( $\text{UO}_3$ ) was stored as feed stock for green salt ( $\text{UF}_4$ ) production in Plant 4.  $\text{UO}_3$  was transferred to Plant 4 in T-hoppers.

Waste materials from Plant 2/3 include  $\text{UO}_3$ , oxides for screening and milling, and  $\text{U}_3\text{O}_8$  from several sources and generation areas including off-site sources.

**Plant 4** converted  $\text{UO}_3$  that was either produced in Plant 2/3 or recycled from offsite sources to  $\text{UF}_4$  by a two-step Reduction/Hydrofluorination operation. Plant 4 was also used as a location to blend, sample and package  $\text{UF}_4$  from the Pilot Plant and offsite locations.

In Plant 4,  $\text{UF}_4$  was produced from  $\text{UO}_3$ , and then blended and packaged for Plant 5.  $\text{UO}_3$  was first converted to uranium dioxide ( $\text{UO}_2$ ) by reducing it with hydrogen. Mobile hoppers were used to deliver orange oxide to a two-stage, stainless steel fluid bed reduction reactor that operated at about 1000°F. Dissociated ammonia (hydrogen and nitrogen) entered the bottom of the reactor through a gas diffuser plate. Nitrogen served as a carrier gas to fluidize  $\text{UO}_3$  for hydrogen reduction to form talcum-fine  $\text{UO}_2$  powder.

In the hydrofluorination step,  $\text{UO}_2$  powder was conveyed to three horizontal, ribbon-screw furnaces, arranged in series. Anhydrous Hydrogen Fluoride (AHF) was introduced to this furnace system and flowed counter-currently to the  $\text{UO}_2$  powder for the conversion to product  $\text{UF}_4$ . Byproduct  $\text{UO}_3$  recycled from Hanford operations was a major source of enriched uranium feed for Plant 4. Recycle  $\text{UO}_3$  from Hanford was not as chemically reactive as  $\text{UO}_3$  produced in Plant 2/3. The Reduction-Oxidation-Reduction (ROR) process was developed in 1961, as a method for increasing its reactivity and conversion of  $\text{UO}_3$ . In the ROR process,  $\text{UO}_3$  underwent the standard reduction process step to form  $\text{UO}_2$ , but not the subsequent hydrofluorination step to produce  $\text{UF}_4$ . Instead, the intermediate  $\text{UO}_2$  powder was oxidized in heated air to form black oxide ( $\text{U}_3\text{O}_8$ ) to increase the particulate surface area and chemical reactivity. The  $\text{U}_3\text{O}_8$  was packaged for a second-pass feeding to the system for hydrogen reduction step and subsequent hydrofluorination step to produce  $\text{UF}_4$ .

Green salt from Plant 4, Banks 7 and 9 was delivered by conveyor to the packaging system from the weigh bins under Banks 7 and 9, or from mobile hoppers, drums, or cans to any one of the three packaging systems. In the packaging systems, green salt was weighed, blended according to specification, sampled, and packaged in 10-gallon cans. The cans were filled to a uniform weight range, and then the amount of green salt in each can was adjusted to a final net weight range by manually adding or removing material. The packaging operations were serviced by a dust collector system.

Waste materials from Plant 4 operations include black oxide ( $\text{U}_3\text{O}_8$ ), brown oxide ( $\text{UO}_2$ ), and orange oxide ( $\text{UO}_3$ ).

**Uranium derbies were made in Plant 5** by the reduction of  $UF_4$  in an excess of Magnesium metal. The  $UF_4$  and Magnesium were blended and charged into a steel pot lined with Magnesium Fluoride and heated in a Rockwell Furnace to a temperature between 1150°F and 1250°F. An exothermic reaction generally occurred between the  $UF_4$  and Magnesium according to the equation  $UF_4 + 2Mg = U + 2MgF_2$ . The “Bad reduction – No Derby” waste stream was created when the reaction failed to occur or go to completion, leaving some mixture of precursors, products, and Uranium oxides. When the reduction was successful, molten metal was formed resulting in a Uranium derby. Black oxide ( $U_3O_8$ ) formed when Uranium metal, at elevated temperatures, came in contact with Oxygen in the air. Black oxide formed on the exposed surface of the molten metal and was collected during derby breakout and crucible burnout operations.

**The Metals Fabrication Plant, Plant 6**, was concerned with machining, heat treating, chips and turnings, briquetting and pickling of uranium metal. Depleted uranium extruded tubes were machined into finished fuel cores (Mark 31) in the Machining area. Extruded tubes were cut to core blanks and passed through a series of machining operations which included reaming, turning the outside diameter and end finishing. A heat treating operation was performed. Fully machined cores were cleaned with caustic and acid, then, inspected for compliance with specifications. Acceptable cores were packaged for off-site shipment.

Turnings, generated in the machining operations, were briquetted and sent to remelt along with tubes and other remeltable metal. Pickling was required on some of the remeltable metal to make it suitable as casting feed.

**The Recovery Plant, Plant 8**, was designed to recover residues by upgrading them to a form suitable for Refinery feed. Scrap uranium oxide residues were generated during various processing operations. These residues were analyzed and subjected to feed preparation operations, as required, prior to being re-analyzed and certified as meeting feed specifications established for uranium recovery process operations in Plant 2/3. Low-grade metal scrap and uranium oxides were oxidized to  $U_3O_8$  in Plant 8 to prepare a suitable feed material for Plant 2/3 operations. Examples of high-grade residues are uranium chips and turnings that could not be briquetted for remelting; saw chip from metal fabrication operations, and scrap  $U_3O_8$ .

The feed preparation furnace system consisted of several furnaces, each specific for the type of material to be roasted. Miscellaneous metallic and alloyed scraps were sent to the Oxidation Furnace; massive metal pieces to the Muffle Furnace; and other miscellaneous metal forms to the Box Furnace. After screening, the fine fraction became prepared feed and the coarse fraction was returned to the furnace for further oxidization. The oxidized materials required certification analysis to verify meeting Plant 2/3 feed

specifications.

**The Special Products Plant, Plant 9**, contained facilities for the casting and machining of ingots and billets similar to those in Plants 5 and 6. The N-Reactor Casting Area cast remeltable metal into ingots, and ingots were drilled and machined in the Ingot Preparation Area prior to extrusion. A metal decladding facility was also located in Plant 9 for the purpose of producing remeltable metal for the casting process by selective acid dissolution techniques. Depleted derbies were heat shocked to remove adhering magnesium fluoride slag prior to being shipped off-site.

Waste materials from Plant 9 include  $U_3O_8$  from several sources and generation areas.

**Other scrap uranium oxide waste streams** included in this MEF were generated from miscellaneous areas and off-site generators. Miscellaneous areas include Building 65, the Chemical Pits, the General Laboratory, Operations & Engineering Services, and the Analytical Laboratories.

#### **MEF 3845, Contaminated Graphite (017 and 024)**

In the metal casting operation areas such as; the Analytical Laboratory (bench scale), Plant 5 and Plant 9, derbies, briquettes, and other remeltable uranium metal were charged into graphite coated crucibles in a predetermined ratio to assure that ingots of the required chemical and physical specifications were produced. The graphite crucibles were then heated under a vacuum in an induction-type furnace until the uranium became molten. The molten uranium metal was then poured through a controlled opening into graphite ingot molds. Graphite was used in the crucibles and molds due to its resistance to heat. The resulting ingots were air-cooled, end cropped, sampled and weighed.

Spent contaminated graphite from metal castings, molds and crucibles was crushed or broken in pieces (**Contaminated Graphite, Uncrushed but Broken into Large Pieces, 017**) or (**Contaminated Graphite, Crushed, 024**). Graphite contaminated with slightly enriched uranium was processed to recover the uranium and graphite used in the production of depleted uranium was discarded to the waste pits.

#### **MEF 3846, Scrap Salts (060, 061, 066)**

Scrap furnace salts were generated from Heat Treating operations conducted in Plants 6, 9, and the Pilot Plant. Chloride salts, 50% potassium and 50% sodium chloride, (**Furnace Salt, Chloride, 060**) were used for heat treating uranium ingots and cores immersed in a salt bath. Potassium carbonate and lithium carbonate (**Furnace Salt, Non-Chloride, 061**) was used in the Rolling Mill for cleaning uranium metal derbies. Periodically, the heat treat furnaces were shut down for accountability of uranium inventories and the salts were drummed as a process residue for recovery. Material from cleaning floors near these

operations was collected and is referred to as **Scrap Salts, Low Fluoride, Including Floor Sweepings (066)**.

**MEF 3847, Incinerator Ash/Cinders (033)**

The Department of Energy Gaseous Diffusion Plant in Paducah, Ky produced  $UF_6$  by heating uranium oxides and uranium salts with fluorine. Residues of partially reacted material formed on reactor vessel walls. These residues contained  $UF_4$  and unreacted uranium oxides. The waste is commonly referred to as bottom ash or incinerator ash. The residue was periodically cleaned from the reactor vessels at the Paducah facility and sent to the FCP for uranium recovery. In preparation for digestion, larger pieces not falling through the screen were milled at the Plant 1 Titan Mill. This waste is referred to as **Incinerator Cinders (033)**.

**MEF 3848, Rockwell Cleanings (071)**

Plant 5 was the Metal Production Plant where  $UF_4$  was reduced to uranium metal. To begin the reduction process that produced uranium metal,  $UF_4$  and magnesium granules were blended and charged into a steel pot lined with magnesium fluoride slag. The pot was heated in a Rockwell Furnace at a controlled temperature ranging from  $1100^{\circ}F$  to  $1250^{\circ}F$  for three to four hours until the contents reacted. This reaction produced a derby of uranium metal and magnesium fluoride slag. The slag was removed from the derby and recycled to reclaim any uranium metal suspended in the slag. The slag could then be used as liner material in the reduction pots.

However, when the reaction was faulty, such as a reduction charge pot blowout, and a derby was not produced, a cleanout of the Rockwell Furnace was needed. Blowouts occurred when a pinhole or crack developed in the reduction pot allowing a release of the reduction charge. The result of a bottom blowout was a waste stream consisting of magnesium fluoride, uranium metal and magnesium oxide with associated project related trash such as; damaged furnace elements and insulators. This waste stream was containerized and categorized as **Rockwell Cleanings, (071)**.

**MEF 3701, Solid Uranyl Nitrate (160)**

This waste consists of enriched Uranium as solid nitrates, sulfates and oxides and is referred to as **Impure Uranyl Nitrate, Solid (160)**.

The United States Department of Energy [USDOE] operates the New Brunswick laboratory at the Argonne National Laboratory facility at Argonne, IL. The USDOE conducts research and development work at the lab. The documents under which the material was shipped to and received by the FCP identifies this material as enriched Uranium, solid nitrate, sulfate and oxide. Process knowledge indicates that the material originated as acidic solutions of uranium used as laboratory standards and stock

solutions. Laboratory personnel dried or calcined the aqueous solutions in order to produce a stable, solid form that could be shipped to the FCP and recycled.

The FCP used the Safe Geometry Evaporator/Calciner located in Plant 3 to denitrate enriched uranyl nitrate solutions. This system produced cascade-quality  $U_3O_8$  containing between 2% and 5% U-235. The Material Description Code (MDC) indicates that the material is solid uranyl nitrate but operating manuals and procedures for the calciner state that the product was oxides of Uranium.

#### **Project Related Contaminated Trash and Debris**

Small volumes of Personal Protection Equipment (PPE), assorted forms of project related trash (such as plastic, paper, wood, bolts, glass, bags, etc.) and debris associated with the removal of residue from process equipment (pipe, valves, scrap metal, etc.) are generated during the preparation of containers for shipping uranium wastes. These materials are packaged in some of the uranium waste containers, depending upon the availability of freeboard space. This material does not exceed 1% of the total estimated waste stream weight. Negligible activity is added to the shipment by the presence of these materials and does not increase the total activity within the number of significant figures reported. The added volume is not included in the estimate of the waste volume used in calculating volume activity concentrations. This yields a conservative value for the volume activity concentrations.