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Savannah River Plutonium Processing Facility (SRPPF)

Potential Non-Pit Metal Feed Materials for SRPPF

SRNL-TR-2019-00206
September 2019
Revision 0

RECORD OF REVISIONS

Revision	Revision Date	Reasons for Revision
0	September 2019	Initial Issue

LIST OF ABBREVIATIONS AND ACRONYMS

AA	Atomic Absorption Spectrometry
AFS-2	Alternate Feedstock 2
CD	Critical Decision
CH	Chromatography
DMO	Direct Metal Oxidation
DNN	Defense Nuclear Nonproliferation
DOE	Department of Energy
EM	Office of Environmental Management
ES	Inductively Coupled Plasma Emission Spectroscopy
HEU	Highly Enriched Uranium
IC	Ion Chromatography
ICP-MS	Inductively Coupled Plasma/Mass Spectrometry
IDC	Item Description Code
KAC	K-Area Complex
LANL	Los Alamos National Laboratory
MDB	Master Database
MFFF	Mixed Oxide Fuel Fabrication Facility
M^3	Office of Material Management and Minimization
MOX	Mixed Oxide
MT	Metric Ton
nd	non-detectable
ND	(indeterminate; possibly Non Destructive Assay)
NNSA	National Nuclear Security Administration
NS	(indeterminate; possibly Neutron Scintillation)
PDC	Pit Disassembly and Conversion
PE	Direct Reader Emission Spectrometry
PF-4	LANL Plutonium Facility
ppm	parts per million
Pu	Plutonium
RA	Radiochemical Analysis
RF	Rocky Flats
RFETS	Rocky Flats Environmental Technology Site
ROD	Record of Decision
SNM	Special Nuclear Material
SRPPF	Savannah River Plutonium Processing Facility
SRS	Savannah River Site

APPROVALS

Prepared by:

JEFFREY ALLENDER (Affiliate) Digitally signed by JEFFREY ALLENDER (Affiliate) Date: 2019.09.30 14:05:05 -04'00'

J. S. Allender
Advisory Scientist
Savannah River National Laboratory

Date

9-30-2019

D. Stimac
Advisory Program Manager
Savannah River National Laboratory

Date

Approvals:

9/30/19

T. M. Adams
SRPPF Pit Production Technology Manager
Savannah River National Laboratory

Date

9-30-19

J. B. Schaade
SRPPF Deputy Project Engineering Manager
Savannah River Nuclear Solutions, LLC

Date

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EXECUTIVE SUMMARY

This study provides the Savannah River Plutonium Processing Facility (SRPPF) Project with summary level characterization information of Savannah River Site (SRS) non-pit plutonium (Pu) material currently in inventory that could be used for process development or that could be used for startup of both metal preparation and the foundry operations in support of pit manufacturing. The material characterization summarized in this report is based on extensive historical evaluation previously performed on these excess Pu materials as part of original process operations and the Surplus Plutonium Disposition Program. This study concentrated on the main feed material parameters of concern for the SRPPF Project, namely plutonium isotopic distribution and elemental and radiochemical impurities, and projects that up to 2 metric tons (MT) of elemental Pu as metal distributed in approximately 600 DOE-STD-3013 containers could be considered acceptable feed for the SRPPF process development or startup. The material has further been grouped into six subcategories based on the item's processing history to qualify the levels of gallium, americium, and other process chemicals that may be of interest for SRPPF processing. Known risks associated with the material characterization of this potential feed population and potential program and policy constraints that could limit the availability of this feed for SRPPF have been provided. With this excess material currently being owned by DOE-Environmental Management (EM), and being targeted for disposition as oxide by the National Nuclear Security Administration (NNSA), Office of Material Management and Minimization (M^3), the SRPPF Project should consider the following options if deciding to pursue use of this material for process development:

1. Allow interprogram and intersite negotiations to govern how the non-pit inventory will be redistributed around the complex – for storage, disposition, or non-weapons-program use. The Project would plan to receive and disassemble site-return pit units as feed for SRPPF process development.
2. Allow interprogram and intersite negotiations to govern how the non-pit inventory will be redistributed around the complex. The Project would plan to have LANL supply metal feed for SRPPF process development.
3. Develop a position paper that designates all or a specific portion of the non-pit metal inventory currently at SRS for SRPPF process development, startup, or production. Begin interprogram negotiations to request Redesignation of the SRS non-pit Pu metal for SRPPF process development, startup, or production feed, identifying SRPPF need-dates that can be considered as part of any material relocation planning.

1.0 INTRODUCTION

The Savannah River Plutonium Processing Facility (SRPPF) and Los Alamos National Laboratory (LANL) PF-4 are expected to fabricate new pits for the enduring stockpile. The processes will be fed with plutonium (Pu) metal that will be purified to meet weapons feed requirements. Because reactor production was shut down, this feed will come from recycling and purifying retired pits, from existing supplies of weapons-grade plutonium metal, and, if necessary, from conversion of existing supplies of plutonium oxides and compounds.

Each of these feed streams must be purified before reuse to remove americium that has grown in through plutonium decay, minor other decay daughters, and gallium from previous alloying. During this purification almost any other chemical impurity will be removed to achieve specification limits.

DOE and NNSA hold very little programmatic metal outside pits and such material is largely associated with ongoing Stockpile Stewardship and Weapons Sustainment programs at LANL. Savannah River Site (SRS) holds significant quantities of weapons-grade plutonium metal that has been managed for disposition under Defense Nuclear Nonproliferation (DNN) activities overseen by the Office of Materials Management and Minimization (M^3).[1] This "surplus" plutonium was declared excess to use in weapons fabrication by a 1995 Presidential declaration, but can be exchanged with programmatic material if certain conditions have been met that do not conflict with National nonproliferation policy. This report provides an unclassified overview of this surplus, non-pit, weapons-grade plutonium that may be suitable for Redesignation and reuse.

1.1 Study Goals

The goal of this study is to provide the SRPPF Project with surplus plutonium metal characterization information in order for the Project to determine additional equipment, floor space, and operational impacts of using sources of plutonium feed other than returned pits, electrorefining intermediates, or programmatic weapons-grade metal.

The SRPPF project can use the information of this study to examine how clean plutonium metal could be fed to the pit manufacturing foundry operations, allowing for concurrent startup of both metal prep and foundry operations prior to Critical Decision (CD-4) and hot startup, providing pre-stage production quality Pu metal feed to support the initial two years of pit manufacturing. Certain items that are unattractive for production without processing may be suitable for process development.

1.2 Study Scope

Historically, plutonium feed for pit manufacturing was provided from process operations at Hanford and SRS. This material was blended with recycle material to meet specifications for foundry feed metal. SRPPF feed material is assumed to consist of plutonium to be recovered from retired pits ("site returns") and acceptable Pu metal. Other sources of plutonium, including weapons-grade oxide or non-weapons-grade Pu (< 93.5% Pu-239), in either metal or oxide form, could be available for use but the impacts of processing these materials to meet foundry feed specifications would have to be addressed.

This study identifies existing SRS weapons-grade Pu metal inventories that could be used directly as feed material to allow for concurrent startup of the foundry and metal prep operations. This study does not identify other materials that could be processed in existing facilities or with modifications to existing facilities or SRPPF to provide additional feed capability to the SRPPF.

1.3 Problem to Be Analyzed

The available SRS inventory of non-pit metal is being identified in order for the SRPPF Project to perform calculations to determine if there is sufficient blend material available to meet pit isotopic specifications and for initial foundry operations. Characterization data is also being provided for the non-pit metal for SRPPF to determine if the impurity content is low enough for the SRPPF Feed Preparation process to produce plutonium of the desired purity. Use of available oxide feed would require the conversion of the feed to metal (via Direct Oxide Reduction, DOR) prior to removal of in-grown americium-241 from a large portion of the oxide, and therefore, has not been included for this phase of the report. Candidate oxide materials would require additional equipment installation (e.g., DOR furnaces). Use of these legacy non-pit feed materials could pose a significant increase in occupational exposure for the SRPPF from handling of high americium material.

2.0 STUDY ASSUMPTIONS

2.1 Available Inventories

Details on the nuclear materials inventories, primarily mass data for Special Nuclear Material (SNM), are classified. However, many other characteristics on chemical purity and isotopic content are unclassified at the item or summary level.

The primary category of surplus, non-pit, weapons-grade plutonium metal to be considered for SRPPF was designated as Alternate Feedstock (AFS-2) that was previously planned for conversion to oxide and feed to the Mixed Oxide (MOX) Fuel Fabrication Facility (MFFF). The amount of plutonium in this category had been identified as 3.55 metric tons (MT) of elemental plutonium. Table 2-1 below provides a historical and characterization summary of the subcategories of AFS-2 considered as part of this study.

Table 2-1. AFS-2 Metals Characterization Summary

[illegible]	[illegible]	[illegible]
1980s Hanford Ingots and SRS Buttons	• Produced at SRS and Hanford • Characterized against the Rocky Flats Button Specification • Destructive Analysis data available on most items (need confirmed) • Occasional single out-of-spec impurity that can be addressed in aqueous processing	• Generally available by mass spectrometry • A few items without Pu-238 data • Highly uniform with same average isotopics as weapons program returns
Post-1994 SRS Buttons	• Produced at SRS • No characterization data reported • Expected to mimic chemistry of Pre-1994 SRS buttons	• MC&A data by NDA for Pu-239, Pu-240 and Pu-241 only • No measurement uncertainty estimates • Pu-240 ranges from 4.2 to 7.5% (still suitable under MFFF spec but would require isotopic blending for production) • Many post-2000 items are off-specification for Pu-242 due to F-Canyon blending but may be re-blendable
Clean Metal Packaged at RFETS	• Items are cast metal from specific process history categories (do not have chloride potential) • Destructive analysis available for a substantial portion of items • May contain gallium • Items with > a few hundred ppm Ga are identified	• Fully characterized by NDA (cal-gamma) • Uncertainty levels somewhat high within a limited subset
Classified Metal From RFETS	• Items derived from weapons parts or classified shapes • Weapon system or alloy is generally known • Very limited destructive analysis available but expected to mimic pit metal • May contain gallium • Items with > a few hundred ppm Ga are identified • A single 3013 may contain material from multiple program types	• MC&A data by NDA for Pu-239, Pu-240 and Pu-241 on the fully assembled 3013 • No measurement uncertainty estimates • Some RFETS historical isotopic data available on single items prior to 3013 packaging
Impure Metal Packaged at RFETS	• Process history prevents categorization as "Clean Metal" • Almost all are less than 5% impurities • Chloride potential for some sub-categories (surface) • Destructive analyses available for substantial portion of parent items • May contain gallium • Items with > a few hundred ppm Ga are identified	• Fully characterized by NDA (cal-gamma) • Uncertainty levels somewhat high within a limited subset but all items derived from weapon program
Metals from Other Sites	• Produced at Livermore, Hanford, and SRS • Expect low impurity content but no data available • Limited process history information • Potential for chlorides undocumented	• Livermore and Hanford items have full Pu isotopic characterization and Prompt Gamma to limit Cl potential • SRS items have MC&A data only (Pu-239, Pu-240 and Pu-241) • Typical US weapons grade program range

For this study, the AFS-2 total must be reduced to remove certain inventories that are no longer available or that are less desirable due to purity or Pu isotopic distribution. Candidates were excluded as follows:

- 1.0 MT was removed through a previous Redesignation activity and transferred offsite, in exchange for future receipt of 1.0 MT of oxide for disposition at SRS.
- A limited quantity of AFS-2 was processed through H Canyon to be converted to oxide suitable as MFFF feed.
- Plutonium buttons produced by processing reactor targets after 1994 are assumed to be removed because of a Record of Decision (ROD) on the restart of F-Canyon processing that precluded use of the separated Pu for weapons production or taking actions that would improve the suitability of the stream for weapons use.
- Selected items that may contain specific undesirable impurities (e.g., high beryllium) that may be excluded as being difficult to accommodate.
- Items with significant alloying with highly enriched uranium (HEU) unless an SRPPF purification process will remove it. Items with HEU/Pu > 25% were already excluded under the MFFF AFS-2 specification.

2.2 Target Inventories

As a very round number, the total plutonium metal that could remain in this potential feedstock after further analysis is in the range of 2 MT. A small number of items from outside the AFS-2 category may be added. Tentative analysis puts the total of containers in the DOE-STD-3013 configuration at 601.

3.0 EVALUATION RESULTS

3.1 Isotopics

The Pu-240 content of the candidate items was limited to >5.0 wt.% and <6.5 wt.% for this study based on the specification for plutonium shipped to the Rocky Flats Plant (later renamed Rocky Flats Environmental Technology Site, RFETS, where packaging for disposition occurred) in Reference 2. This does not exclude a significant quantity of the available inventory. Almost all of the AFS-2 of weapons-grade assay resulted from weapons-production activities at Rocky Flats even if the metal was packaged at another site. Summary isotopic details can be developed, but the reader should recognize that the plutonium (in particular, Pu-241) continues to decay with time. Reference 3 includes isotopic breakdowns of AFS-2 by packaging site: at the time of measurement and projected to FY2035.

3.2 Process History Categorization

Because the material must be purified chemically to be acceptable to the foundry program, specific impurity levels are generally unimportant, and are dominated by gallium and americium for "clean" cast metal and by typical process chemicals like chlorine and calcium that will be used as part of the SRPPF purification process. Estimated halides were tracked for AFS-2 feeds to MOX because they could affect high-temperature equipment that would be used for direct metal oxidation (DMO) or dissolution in H Canyon, and past evaluations took them into account even if they are of only minor impact for SRPPF recycling.

The categories used for the past disposition evaluations are explained below, as taken from Reference 4. In some cases, the categories result from specific process history that could affect criteria that have not yet been defined. The fraction of the stored items that had laboratory analysis associated with them is stated, but a large fraction of the

Clean Metal (XM2-WG-PD) items with analyses were selected for the first Redesignation exchange of 1.0 MT.

Clean Metal (XM2-WG-PD): This category is formally defined as resulting from specific Item Description Code (IDC) process categories at Rocky Flats, or other relevant items such as SRS buttons made from plutonium production and/or blending. The item must have previously been cast to be considered part of this category; uncast metals were presumed to have the potential for chlorides or other components deleterious to the MFFF process. More than 50% of the Clean Metal packaged at RFETS is represented by analyses. Additional "classified metal" from RFETS was shipped to SRS for packaging. It does not have analyses in the Master Database (MDB) for the DOE-STD-3013 packaging program but can be assumed to have purity similar to pits and other Clean Metal ingots and parts. SRS buttons were also originally assumed to be "clean" in all respects that should be important to handling in SRPPF. Subsequent to the dissolution of the initial AFS-2 metal items in H Canyon, it was determined that a portion of the SRS buttons would not have met the weapons program plutonium specification; the SRS M&O Contractor was instructed to make no attempt to maintain the isotopic or chemical purity of the material produced at SRS post-1994 as part of the process for stabilization and disposition of excess ^{239}Pu materials held in the Separations facilities' inventory. This subset of Clean Metals prepared post-1994 would not be directly acceptable to the foundry program but could be considered for other SRPPF demonstration equipment use provided no policy restrictions apply.

Potential Chloride Clean Metal (XM2-WG-CL-LO): was tentatively identified as likely to meet the same specifications as clean metal but was uncast and from a process category that might have introduced minor chloride contamination. The MFFF goal was to screen materials that have any potential chloride content above 100 ppm. About 50% of the Pu packaged at RFETS is represented by analyses.

Potential Chloride Contamination (XM2-WG-CL): is low in impurities, but with less characterization information than the material above. For most purposes the two categories can be considered similar. About 1/3 of the Pu packaged at RFETS is represented by analyses.

Impure Metal with Potential Chlorides (XM2-WG-CLIM): can be higher in impurities and also have the potential for chlorides. About 1/3 of this category is also represented by analyses.

Because history and analytical information is limited, there may be considerable overlap among these categories. The intent of the subdivision is to assess the relative difficulty of disposition across the subgroup, assuming every item in the group qualifies for the disposition.

Impure Metal (XM2-WG-IM): results from Rocky Flats IDCs or 3013 analyses that indicate that the metal may not be pure enough for consideration as Clean Metal, but that is not expected to have chlorides. Note that "impure" is a relative term because all plutonium metals stored in 3013s have less than 4 wt.% non-actinide impurities, on average.

Re-Analysis Clean Metal (XM2-WG-XPD): This is metal that had previously been tagged as clean metal in XM2-WG-PD, but anomalous data have not been reconciled. A total of 17 analyses out of 173 showed one or more element that exceeds the "maximum exceptional" content for PDC Clean Metal or pits, but may be of lesser importance for SRPPF.

3.3 Container Count for Weapons-Grade Plutonium Metal Items

Container count for items in the above categories, remaining at SRS, is as follows:

XM2-WG-PD	304
XM2-WG-CL-LO	20
XM2-WG-CL	195.5
XM2-WG-CLIM	0
XM2-WG-IM	47
Other	34.5

Further details for each item denoted above (such as site-of-origin, originating IDC, current container identifier), Pu isotopic distribution and mass quantities have been documented in a classified addendum to this document.

3.4 Summary Impurity Data

Impurity information is shown below for each of the categories, to solicit questions about specific elements that may be of concern. Many of the items with analyses were shipped to other sites in the Complex as part of Redesignation Campaign 1, but the data should be representative of items that remain in storage at SRS.

Further information can be inferred from analyses of oxides that were produced from metals that were represented in these categories.[5] It should also be noted that the processes of handling, packaging, and pit disassembly may have introduced minor quantities of additional impurities, primarily transition metals, from contact with process equipment.[6,7]

The first table summarizes the analytical techniques that were used, the number of items that were reported with numerical values above detection limit for the technique, and the lowest value reported for that element and technique. In most cases the lowest reported value is the minimum detectable amount, in ppm mass.

The next table summarizes the combined analyses for each of the AFS-2 disposition categories, including the number of analyses used; the minimum and maximum; and the mean and median. An entry of "nd" means "not detectable".

The median value is shown to indicate that the mean may be heavily influenced by the few items at the top end of the range. Distributions can be developed for appropriate combinations of category and element. (For this table, the mean is calculated by using "0" as a replacement for "nd." This does not skew the averages significantly.)

Table 3-1. Rocky Flats Lab Analyses Summary Associated with AFS-2 Metal Items

Lab Analyses Associated with AFS-2 Metal Items
Predominantly Rocky Flats Measurement
Does Not Include RF Classified Metal Packaged at SRS or SRS Buttons
(Split input items may show more than once)
(each box shows # of reports > detection limits and lowest reported, ppm mass)

	Analytical Technique																			
	AA		ES		IC		ICP-MS		PE		??		CH		ND		NS		RA	
FREQUENTLY MEASURED ELEMENTS																				
Al	104	10.0	240	6.0	2	45.0	5	142.0	5	5.0	11	22.0								
B			343	0.5	2	1.2	2	7.4	5	0.5	11	2.0								
Be	1	3.0	343	0.1	2	0.4	3	8.9	5	0.1	11	0.1								
C											13	92.0	351	58.0						
Ca	1	199.0	342	2.5	2	7.0	1	69,571.0	5	2.5	11	2.5								
Cr	10	61.0	333	6.0	2	38.0	5	71.3	5	10.0	11	19.0								
Cu	1	10.0	342	1.0	2	20.0	5	43.5	5	2.5	11	8.0								
Fe	355	50.0					5	739.4			11	110.0								
Ga	22	50.0	56	2.5			3	11.8	1	500.0	12	1.0	266	2,180.0						
Mg			343	0.5	2	0.5	5	118.6	5	2.5	11	0.5								
Mn			343	0.5	2	12.0			5	2.5	11	3.0								
Mo	1	9.5	343	2.5			3	239.2	6	2.5	11	2.5								
Ni	353	10.0			2	74.0	3	906.9			11	2.5								
Pb	2	23.0	341	1.0	2	14.0	3	31.4	5	1.0	11	1.0								
Si			343	2.5	2	26.0	5	146.5	5	2.5	11	2.5								
Sn			343	2.0	2	5.0			5	2.5	11	2.5								
Ta			16	5.0			5	5.3												
Ti			340	5.0	2	2.0			5	5.0	11	5.0			3	2.5				
W			16	0-5			3	20.4			14	389.0								
Y			1	250.0																
Zr			16	5.0			3	56.5												
UNCOMMON MEASUREMENTS AND ACTINIDES																				
Am											11	85.0			35	82.0	225	58.0	28	63.0
As					3	2.2														
Ba					3	8.2														
Cd					2	2.2														
Ce					3	8.2														
Hf					3	0.4														
K					5	34.5														
La					3	1.5														
Li					2	709.7														
Na					5	42.2														
Nb					3	3.4														
P					1	8.3														
U											11	206.0	353	8.0						
V					3	4.7														
Zn					3	30.1														

Table 3-2. Statistical Impurity Analyses Summary Associated with AFS-2 Metals

Lab Analyses Associated with AFS-2 Metal Items
Predominantly Rocky Flats Measurement
Does Not Include RF Classified Metal Packaged at SRS or SRS Buttons
Statistics for Preliminary Baseline Material Groups (ppm mass)

	XM2-WG-CL					XM2-WG-CLIM					XM2-WG-CL-LO				
	#	min	max	mean	median	#	min	max	mean	median	#	min	max	mean	median
FREQUENTLY MEASURED ELEMENTS															
Al	41	14.0	133.0	57.6	50.0	74	5.0	6,319.0	144.3	53.5	23	9.0	40,338.6	1,823.8	50.0
B	41	0.5	36.0	6.5	6.0	74	0.5	250.0	9.0	6.0	23	0.5	19.0	7.0	7.4
Be	41	0.1	2.7	0.4	0.2	74	0.1	100.0	1.8	0.2	23	0.1	160.5	8.2	0.1
C	42	78.0	347.0	177.1	159.0	71	69.0	518.0	175.8	159.0	20	81.0	337.0	181.8	170.5
Ca	41	2.5	1,000.0	91.4	15.0	74	2.5	69,571.5	999.4	8.5	23	2.5	465.0	51.3	2.5
Cr	41	14.0	500.0	64.6	38.0	74	16.0	630.0	73.1	47.5	23	15.0	713.6	89.9	61.0
Cu	41	1.0	66.0	18.6	13.0	74	1.0	458.4	33.0	18.0	23	1.0	3,515.0	181.1	25.0
Fe	42	105.0	990.0	372.4	297.5	74	103.0	51,835.0	1,179.3	387.5	23	110.0	5,380.6	713.6	320.0
Ga	42	1.0	>10,000	8,297.5	>10,000	74	25.0	>10,000	7,621.6	>10,000	23	11.8	>10,000	6,417.2	>10,000
Mg	41	0.5	672.0	81.3	3.0	74	0.5	69,480.0	1,035.6	5.0	23	0.5	1,061.4	99.5	3.0
Mn	41	1.0	44.0	12.0	6.0	71	0.5	67.0	13.7	10.0	21	1.0	38.0	11.0	7.0
Mo	41	2.5	49.0	4.5	2.5	74	28.0	7,250.0	348.9	112.0	23	2.5	376.4	31.2	2.5
Ni	42	66.0	3,750.0	324.0	107.5	74	1.0	248.0	21.8	8.0	23	25.0	2,833.3	279.5	94.0
Pb	41	1.0	137.0	16.5	7.0	74	1.0	248.0	21.8	8.0	23	1.0	372.2	31.5	8.0
Si	41	2.5	616.0	69.9	34.0	74	2.5	399.0	54.5	40.5	23	2.5	599.3	"73.0	47.0
Sn	42	2.0	54.0	9.2	6.0	71	2.0	35.0	9.3	7.0	21	2.5	38.0	8.2	2.5
Ta	42	nd	nd	nd	nd	74	nd	1,000.0	17.5	nd	23	nd	166.8	8.2	nd
Ti	41	5.0	51.0	7.4	5.0	71	5.0	36.0	5.7	5.0	21	5.0	5.0	5.0	5.0
W	42	nd	nd	nd	nd	74	nd	389.0	6.2	nd	23	nd	68.2	3.9	nd
Y	40	nd	nd	nd	nd	71	nd	nd	nd	nd	21	nd	nd	nd	nd
Zr	40	nd	nd	nd	nd	74	nd	803.2	11.7	nd	23	nd	260.8	13.8	nd
UNCOMMON MEASUREMENTS AND ACTINIDES															
Am	35	86.0	551.0	160.1		60	82.0	2,500.0	205.5		20	63.0	880.0	199.6	
As	0					3	nd	2.2	0.7		2	3.5	4.8	4.2	
Ba	0					3	nd	8.2	2.7		2	28.1	57.9	43.0	
Cd	0					3	nd	nd	nd		2	2.2	11.9	7.1	
Ce	0					3	nd	10.7	3.6		2	8.2	120.0	64.1	
Hf	0					3	nd	38.3	12.8		2	0.4	114.5	57.5	
K	0					3	34.5	108.8	61.8		2	69.5	654.1	361.8	
La	0					3	nd	1.5	0.5		2	1.5	2.9	2.2	
Li	0					3	nd	709.7	236.6		2	nd	5,215.7	2,607.9	
Na	0					3	42.2	854.7	314.4		2	137.5	6,001.5	3,069.5	
Nb	0					3	nd	3.8	1.3		2	3.4	4.1	3.8	
P	0					3	nd	nd	nd		2	nd	8.3	4.2	
U	41	10.0	1,170.0	651.7		71	10.0	1,716.0	677.9		21	190.0	1,360.0	756.5	
V	0					3	nd	5.9	2.0		2	4.7	11.4	8.1	
Zn	0					3	nd	339.7	113.2		2	30.1	2,307.8	1,169.0	

	XM2-WG-IM					XM2-WG-PD					XM2-WG-XPD				
	#	min	max	mean	median	#	min	max	mean	median	#	min	max	mean	median
FREQUENTLY MEASURED ELEMENTS															
Al	57	20.0	126.0	60.4	55.0	154	10.0	250.0	41.8	33.0	17	15.0	16.3	46.0	33.0
B	57	0.5	200.0	6.8	2.0	154	0.5	15.0	5.0	5.0	16	3.0	500.0	40.1	7.0
Be	57	0.1	4.8	0.5	0.2	154	0.1	7.6	0.4	0.2	16	0.1	3.3	0.5	0.3
C	58	58.0	2,670.0	198.1	147.5	156	75.0	841.0	176.3	162.0	16	87.0	3,960.0	530.6	132.0
Ca	57	2.5	700.0	103.6	32.0	154	2.5	500.0	19.9	2.5	16	2.5	1,000.0	76.4	2.8
Cr	57	10.0	514.0	86.6	58.0	154	6.0	695.0	56.7	32.0	16	16.0	1,000.0	167.6	49.5
Cu	57	1.0	73.0	17.2	12.0	154	1.0	500.0	22.5	13.5	16	5.0	500.0	57.4	14.0
Fe	58	100.0	2,610.0	436.5	387.5	156	50.0	2,591.0	419.9	360.0	17	275.0	9,800.0	3,264.2	1,850.0
Ga	57	1.0	>10,000	2,206.8	11.0	156	2.5	>10,000	6,560.6	>5,000	16	26.0	>10,000	5,745.4	>5,000
Mg	57	0.5	500.0	188.0	115.0	154	0.5	500.0	31.4	4.0	16	1.0	500.0	35.8	4.0
Mn	57	1.0	58.0	13.1	10.0	154	0.5	88.0	10.3	7.0	16	5.0	186.0	50.1	21.0
Mo	57	2.5	11.0	3.2	2.5	154	2.5	13.0	3.0	2.5	16	2.5	23.0	7.5	3.8
Ni	58	30.0	12,000.0	667.6	158.5	156	10.0	10,000.0	352.9	54.0	17	32.0	21,000.0	1,444.8	59.0
Pb	57	1.0	44.0	6.4	1.0	154	1.0	75.0	6.4	3.5	16	1.0	97.0	24.8	14.5
Si	57	2.5	453.0	46.3	34.0	154	2.5	192.0	33.8	27.5	16	2.5	500.0	125.2	100.5
Sn	57	2.5	21.0	7.4	7.0	154	2.5	46.0	6.9	5.0	16	2.5	63.0	23.8	21.5
Ta	57	nd	5.0	0.0	nd	154	nd	5.0	0.7	nd	16	nd	350.0	21.9	nd
Ti	57	5.0	58.0	6.8	5.0	154	2.0	42.0	5.3	5.0	16	5.0	42.0	11.3	5.0
W	58	nd	389.0	0.0	nd	156	nd	1,389.0	24.2	nd	17	nd	112,889.0	3,737.9	nd
Y	57	nd	nd	nd	nd	148	nd	nd	nd	nd	17	nd	250.0	14.7	nd
Zr	57	nd	5.0	0.0	nd	146	nd	5.0	0.3	nd	17	nd	5.0	0.3	nd
UNCOMMON MEASUREMENTS AND ACTINIDES															
Am	21	58.0	3,032.0	172.0		146	94.0	2,871.0	327.7		16	104.0	424.0	221.8	
As	0					0					0				
Sa	0					0					0				
Cd	0					0					0				
Ce	0					0					0				
Hf	0					0					0				
K	0					0					0				
La	0					0					0				
Li	0					0					0				
Na	0					0					0				
Nb	0					0					0				
P	0					0					0				
U	58	80.0	1,645.0	400.1		156	10.0	5,230.0	435.3		17	20.0	938.0	297.7	
V	0					0					0				
Zn	0					0					0				

4.0 RISKS/OPPORTUNITIES

The quantity and quality of the Non-Pit Metal Feed has been recognized as presenting certain levels of risk to the SRPPF Project. The following is a summary of known risks associated with the AFS-2 material characterization and potential program and policy constraints that could limit the availability of this feed for SRPPF.

- Pu isotopic reported values from NDA may be suspect for certain calculated isotopes when material process history was not correctly considered (ex., ^{242}Pu incorrectly calculated for material "scrubbed" of ^{241}Am)
- Competing pit manufacturing activities at LANL could prioritize reuse of SRS non-pit metal feed materials for LANL thereby impacting availability of the material for use at SRPPF
- Potential legal impacts for continued Pu material storage at SRS could cause relocation of the non-pit feed materials for storage at another complex site
- "Unknown unknowns" based on limited process history data and physical testing results, while not safety issues, could slow down production and require flow-sheet modification or material rework for unexpected results
- Post-1994 SRS buttons may be made available for use by SRPPF with policy clarification associated with the ROD for F-Canyon Processing restart
- A small amount of AFS-2 metal falls slightly below the 5 wt.% ^{240}Pu criteria; these items could be homogenized with other items in the SRPPF batches
- Americium is removed from feed recycled into pit production primarily to reduce dose potential when weapons are deployed or stored. Weapons-grade plutonium has far less ^{241}Pu and ^{241}Am than typical fuel-grade plutonium (Reference 8): in the range of 0.4 wt.% Am/Pu versus 2-10 wt.% Am/Pu and may be suitable for development or blending for production.

5.0 SRPPF PROCESS DEVELOPMENT FEED OPTIONS

Based on the evaluation presented in this paper, SRS currently is storing non-pit Pu metal that could be used for SRPPF process development, SRPPF module startup, or possibly even for SRPPF production feed. With this surplus material currently being owned by DOE-Environmental Management (EM), and being targeted for disposition as oxide by NNSA M^3, the SRPPF Project should consider the following options if deciding to pursue use of this material for process development:

1. Allow interprogram and intersite negotiations to govern how the non-pit inventory will be redistributed around the complex –for storage, disposition, or non-weapons-program use. The Project would plan to receive and disassemble site-return pit units as feed for SRPPF process development.
2. Allow interprogram and intersite negotiations to govern how the non-pit inventory will be redistributed around the complex. The Project would plan to have LANL supply metal feed for SRPPF process development.

3. Develop a position paper that designates all or a specific portion of the non-pit metal inventory currently at SRS for SRPPF process development, startup, or production. Begin interprogram negotiations to request Redesignation of the SRS non-pit Pu metal for SRPPF process development, startup, or production feed, identifying SRPPF need-dates that can be considered as part of any material relocation planning.

(b) (5)