

ATTACHMENT 3-18

to the

***Generator Knowledge Report for the Plutonium Isentropic Compression Experiments
Containment Systems, Revision 0 (PA-RPT-01023, R0)***
Effective Date: April 30, 2016

for

Shot 18 (Aug 2015)

Date: December 9, 2016

INTRODUCTION

The *Generator Knowledge Report for the Plutonium Isentropic Compression Experiment Containment Systems* (GK Report) provides information for the Plutonium Isentropic Compression Experiment (Pu-ICE) program to support waste management and characterization efforts. Attachment 3-18 presents generator knowledge (GK) information specific to the eighteenth Pu-ICE conducted in August 2015, also known as ‘Shot 18 (Aug 2015) and Pu-ICE Z-2841 (1).’ Shot 18 (Aug 2015) was generated on August 28, 2015 (1). Calculations based on the isotopic content of Shot 18 (Aug 2015) and the measured mass of the containment system demonstrate the post-shot containment system is low-level waste (LLW). Therefore, this containment system will be managed at Sandia National Laboratory/New Mexico (SNL/NM) as LLW. Attachment 3-18 provides documentation of the TRU concentration and documents the concentration of any hazardous constituents.

RADIONUCLIDE CONTENT INFORMATION

Los Alamos National Laboratory (LANL) provided the isotopic composition for Shot 18 (Aug 2015) (2) which is listed in Table 1.

Table 1. Isotopic Composition for Targets (Aug 2015 Z-Accelerator Experiment)

Lot ID	Net Weight (g)	Pu-238 (%)	Pu-239 (%)	Pu-240 (%)	Pu-241 (%) not TRU	Pu-242 (%)
S. Mid	1.430E-01	1.050E-02	9.398E+01	5.893E+00	7.310E-02	4.780E-02
N. Mid	1.440E-01	1.050E-02	9.398E+01	5.893E+00	7.310E-02	4.780E-02
TOTALS (g)	2.870E-01					

Isotopic and Pu Content decayed to Aug 2015 - Based on Mass Spectroscopy Measurement in April 2005; Measurement Code C46 or C47; Uncertainty = +/- 0.1%

Additional radiological constituents include: Am-241 (884 $\mu\text{g/g}$)

g = gram

wt% = weight percent

Using the isotopic information provided by LANL (2), decayed by SNL (1), and specific activities for the Pu isotopes taken from the CH TRAMPAC, the masses and activities of the isotopes were determined as follows (using Pu-239 as an example):

Where: Total nuclear material mass = 2.847E-01 gram (g)
Pu-239 percent of total mass = 93.98 %
Pu-239 specific activity = 6.29E-02 curies per gram (Ci/g)

Therefore: Pu-239 mass = $(2.847 \times 10^{-1} \text{ g}) \times (0.9398)$
 $= 2.676 \times 10^{-1} \text{ g}$ (Eq. 1)

And:
$$\text{Pu-239 activity} = (2.676\text{E-01 g}) \times (6.29\text{E-02 Ci/g}) \\ \equiv 1.683\text{E-02 curies (Ci)}$$
 (Eq. 2)

Table 2 lists the mass and activity, by isotope, for Shot 18 (Aug 2015).

Table 2. TRU Isotope Masses and Activities for Shot 18 (Aug 2015)

TRU Isotope	Percent of Nuclear Material Weight (%)	Isotope Mass (g)	Specific Activity* (Ci/g)	Activity (Ci)	Activity (nCi)
Pu-238	1.050E-02	2.989E-05	1.73E+01	5.14E-04	5.14E+05
Pu-239	9.398E+01	2.675E-01	6.29E-02	1.67E-02	1.67E+07
Pu-240	5.893E+00	1.678E-02	2.30E-01	3.83E-03	3.83E+06
Pu-242	4.780E-02	1.361E-04	3.97E-03	5.40E-07	5.40E+02
Am-241		2.52E-04	3.47E+00	8.69E-04	8.69E+05
TOTALS (Ci)				2.19E-02	2.19E+07

* From CH-TRAMPAC

g = gram

Ci = curie

TRU CONCENTRATION

Based on the isotopic content and activity of the targets (2), and the measured mass of the Shot 18 (Aug 2015) containment system (1), the TRU concentration is calculated, as follows:

Where: Total TRU activity (i.e., activity of Pu-238 + Pu-239 + Pu-240 + Pu-242 + Am-241) = 2.19E-02 Ci or 2.19E+07 nanocuries (nCi)
 Shot 18 (Aug 2014) containment system mass = 1035 lbs or 469,890 g

Therefore: TRU concentration = $(2.19E+07 \text{ nCi}) / (469,890 \text{ g})$ (Eq. 3)
 = 46.6 nanocuries per gram (nCi/g) or 47 nCi/g

PACKAGING AND FINAL SNL/NM ID NUMBER

Shot 18 (Aug 2015) is packaged in a 544 metal box. The SNL ID number is SNL/NM007540.

HAZARDOUS CONSTITUENTS AND BERYLLIUM

Lead and silver are used in the manufacturing of the containment vessels. Calculations (1) have shown that both constituents are below the regulatory level and therefore this waste is non-mixed. The beryllium contamination was determined to be $< 0.025 \text{ ug}/100\text{cm}^2$ or 1.19E-09% by weight (1).

DISPOSAL PATH

At the time of this report, the disposal facility has not been determined.

REFERENCES

1. Disposal Request DR2016063, Radioactive and Mixed Waste Management Facility, Sandia National Laboratory, January 7, 2016.
2. "Memorandum to Joel Lash from Franz Freibert," [Plutonium Samples for August 2015 Z-Accelerator Experiment], Los Alamos National Laboratory, Los Alamos, New Mexico, August 18, 2015.

Required Information	Shot 18 (August 2015)	Reference
General Information		
Z Machine Experiment #	Z-2841	DR2016063
Experiment Date	08/27/2015	DR2016063
Container Load Date	08/31/2015	DR2016063
Containment Vessel Weight	1035 lbs	DR2016063
LANL Legacy WPF#/LANL WS ID	TBD	
CCP WIPP Waste Stream ID	N/A	
LANL WIPP Waste Stream ID	TBD	
Waste Matrix Code	S5400	
WCATS Work Path	TBD	Determined by LANL
WCATS Account Information	Obtain from LANL	Determined by LANL
LANL Exception Memo	None unless specified by SAFE-4	Determined by LANL
Radiological Information		
Target Lot IDs (list up to four target IDs)	S. Mid N. Mid	DR2016063
Special Nuclear Material Mass	N/A	
Uncertainty (Meas Code C46 or C47)	N/A	
Isotope Activity (report Ci for WCATS)		
Pu-238 Ci	5.14E-04	DR2016063
Pu-239 Ci	1.67E-02	DR2016063
Pu-240 Ci	3.83E-03	DR2016063
Pu-241 Ci	2.12E-02	DR2016063
Pu-242 Ci	5.40E-07	DR2016063
Am-241 Ci	8.69E-04	DR2016063
Container Information (544 Box)		
Container Type	Metal drums, barrels, kegs, boxes	544 metal box
Tare Weight (544 Box) (calculated)	725 lbs	DR2016063
Gross Weight (measured)	1760 lbs	DR2016063
Net Weight (measured)	1035 lbs	DR2016063
Container Volume	80 ft ³	
ID # - LANL	TBD	
ID # - SNL/NM	SNL/NM007540	DR2016063
Purchase Order #	TBD	
Lot #	TBD	
Manufacture Month/Year	TBD	
Serial #	TBD	
Layers of Confinement	0	
Prohibited Items	None	

ATTACHMENT 3-21

to the

***Generator Knowledge Report for the Plutonium Isentropic Compression Experiments
Containment Systems, Revision 0 (PA-RPT-01023, R0)***
Effective Date: April 30, 2016

for

Shot 21 (Sept 2016)

Date: December 9, 2016

INTRODUCTION

The *Generator Knowledge Report for the Plutonium Isentropic Compression Experiment Containment Systems* (GK Report) provides information for the Plutonium Isentropic Compression Experiment (Pu-ICE) program to support waste management and characterization efforts. Attachment 3-21 presents generator knowledge (GK) information specific to the twenty-first Pu-ICE conducted in September 2016, also known as ‘Shot 21 (Sept 2016) and Pu-ICE Z-3008 (1).’ Shot 21 (Sept 2016) was generated on September 29, 2016 (1). Calculations based on the isotopic content of Shot 21 (Sept 2016) and the measured mass of the containment system demonstrate the post-shot containment system is low-level waste (LLW). Therefore, this containment system will be managed at Sandia National Laboratory/New Mexico (SNL/NM) as LLW. Attachment 3-21 provides documentation of the TRU concentration and documents the concentration of the hazardous constituents.

RADIONUCLIDE CONTENT INFORMATION

Los Alamos National Laboratory (LANL) provided the isotopic composition for Shot 21 (Sept 2016) (2) which is listed in Table 1.

Table 1. Isotopic Composition for Targets (Sept 2016 Z-Accelerator Experiment)

Lot ID	Net Weight (g)	Pu-238 (%)	Pu-239 (%)	Pu-240 (%)	Pu-241 (%) Not TRU	Pu-242 (%)
South	1.97E-01	1.04E-02	9.39E+01	5.89E+00	6.91E-02	4.78E-02
North	1.97E-01	1.04E-02	9.39E+01	5.89E+00	6.91E-02	4.78E-02
TOTALS (g)	3.94E-01					

Isotopic and Pu Content decayed to Aug 2014 - Based on Mass Spectroscopy Measurement in April 2005; Measurement Code

C46 or C47; Uncertainty = +/- 0.1%

Additional radiological constituents include: Am-241 (922 ug/g)

g = gram

wt% = weight percent

Using the isotopic information provided by LANL (2) and decayed by SNL (1) and specific activities for the Pu and Am isotopes taken from the CH TRAMPAC, the masses and activities of the isotopes were determined as follows (using Pu-239 as an example):

Where: Total nuclear material mass = 3.94E-01 gram (g)
Pu-239 percent of total mass = 93.98 %
Pu-239 specific activity = 6.29 E-02 curies per gram (Ci/g)

Therefore: Pu-239 mass = $(3.94E-01 \text{ g}) \times (0.939) = 0.370\text{g}$ (Eq. 1)

And: Pu-239 activity = $(0.370\text{g}) \times (6.29E-02 \text{ Ci/g}) = 2.33E-02 \text{ curies (Ci)}$ (Eq. 2)

Table 2 lists the mass and activity, by isotope, for Shot 21 (Sept 2016).

Table 2. TRU Isotope Masses and Activities for Shot 21 (Sept 2016)

TRU Isotope	Percent of Nuclear Material Weight (%)	Isotope Mass (g)	Specific Activity* (Ci/g)	Activity (Ci)	Activity (nCi)
Pu-238	1.04E-02	4.098E-05	1.73E+01	7.09E-04	7.09E+05
Pu-239	9.398E+01	3.703E-01	6.29E-02	2.33E-02	2.33E+07
Pu-240	5.89E+00	2.32E-02	2.30E-01	5.34E-03	5.34E+06
Pu-242	4.78E-02	1.88E-04	3.97E-03	7.46E-07	7.46E+02
Am-241	922 ug/g	3.63E-04	3.47E+00	1.26E-03	1.26E+06
TOTALS TRU (Ci)				3.06E-02	3.06E+07

* From CH-TRAMPAC

g = gram

Ci = curie

TRU CONCENTRATION

Based on the isotopic content and activity of the targets (2), and the measured mass of the Shot 21 (Sept 2016) containment system (1), the TRU concentration is calculated, as follows:

Where: Total TRU activity (i.e., activity of Pu-238 + Pu-239 + Pu-240 + Pu-242 + Am-241) = 3.06E-02 Ci or 3.06E+07 nanocuries (nCi)
 Shot 21 (Sept 2016) containment system mass = 1048 lbs or 475,792 g

Therefore: TRU concentration = $(3.06E+07 \text{ nCi}) / (474,792 \text{ g})$ (Eq. 3)
 = 64.3 nanocuries per gram (nCi/g) or 64 nCi/g

PACKAGING AND FINAL SNL/NM ID NUMBER

Shot 21 (Sept 2016) is packaged in a 544 metal box. The SNL ID number is SNL/NM007543.

HAZARDOUS CONSTITUENTS AND BERYLLIUM

Lead and silver are used in the manufacturing of the containment vessels. Calculations (1) have shown that both constituents are below the regulatory level and therefore this waste is non-mixed. The beryllium contamination was determined to be $< 0.025 \text{ ug}/100\text{cm}^2$, or 1.0E-09%. (1).

DISPOSAL PATH

At the time of this report, the disposal facility has not been determined.

REFERENCES

1. Disposal Request DR2016322, Radioactive and Mixed Waste Management Facility, Sandia National Laboratory, November 02, 2016.
2. "Memorandum to Joel Lash from Franz Freibert," [Plutonium Samples for September 2016 Z-Accelerator Experiment], Los Alamos National Laboratory, Los Alamos, New Mexico, September 19, 2016.

Required Information	Shot 21 (Sept 2016)	Reference
General Information		
Z Machine Experiment #	Z-3008	DR2016322
Experiment Date	09/29/2016	DR2016322
Container Load Date	09/30/2016	DR2016322
Containment Vessel Weight	1048 lbs	DR2016322
LANL Legacy WPF#/LANL WS ID	TBD	
CCP WIPP Waste Stream ID	N/A	
LANL WIPP Waste Stream ID	TBD	
Waste Matrix Code	S5400	
WCATS Work Path	TBD	Determined by LANL
WCATS Account Information	Obtain from LANL	Determined by LANL
LANL Exception Memo	None unless specified by SAFE-4	Determined by LANL
Radiological Information		
Target Lot IDs (list up to four target IDs)	South North	DR2016322
Special Nuclear Material Mass	N/A	
Uncertainty (Meas Code C46 or C47)	N/A	
Isotope Activity (report Ci for WCATS)		
Pu-238 Ci	7.09E-04	DR2016322
Pu-239 Ci	2.33E-02	DR2016322
Pu-240 Ci	5.34E-03	DR2016322
Pu-241 Ci	2.72E-02	DR2016322
Pu-242 Ci	7.46E-07	DR2016322
Am-241 Ci	1.26E-03	DR2016322
Container Information (544 Box)		
Container Type	Metal drums, barrels, kegs, boxes	544 metal box
Tare Weight (544 Box) (calculated)	726 lbs	DR2016063
Gross Weight (measured)	1774 lbs	DR2016063
Net Weight (measured)	1048 lbs	DR2016063
Container Volume	80 f ³	
ID # - LANL	TBD	
ID # - SNL/NM	SNL/NM007543	DR2016063
Purchase Order #	TBD	
Lot #	TBD	
Manufacture Month/Year	TBD	
Serial #	TBD	
Layers of Confinement	0	
Prohibited Items	None	