Concrete Dispositioning Plan

(Project Cyprus_20282)

1191-I-002, Revision 1

Prepared for:

Curium US LLC
2703 Wagner Place
Maryland Heights, MO 63043

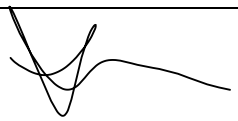
July 20, 2021

Prepared by:

AMERIPHYSICS

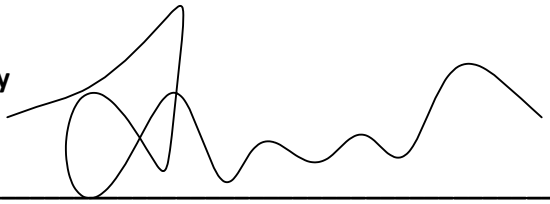
9111 Cross Park Drive, Suite D200
Knoxville, TN 37923
800.563.7497

RECORD OF REVISIONS

Change Number	Date	Description of Change	Approval
1	07/20/2021	Revised Section 3 to improve the physical description, and revised Section 5.1 to reflect that samples will be sent to an off-site laboratory for analysis.	

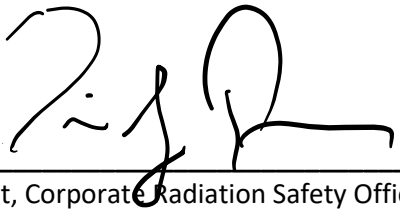
APPROVALS

Prepared By



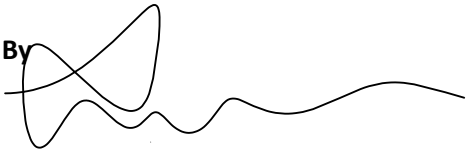
Thomas W. Hansen, Jr., Project Health Physicist — 07/20/2021 Date

Reviewed By



Timothy J. Pratt, Corporate Radiation Safety Officer — 07/20/2021 Date

Approved By



Thomas W. Hansen, Jr., President, Ameriphysics, LLC — 07/20/2021 Date

Contents

Attachments

Abbreviations and Acronyms

Ameriphysics	Ameriphysics, LLC
cpm	counts per minute
cm	centimeter(s)
Curium	Curium US LLC
ft	foot/feet
GEL	GEL Laboratories
keV	kiloelectron volt
MDC	Minimum Detectable Concentration
MDCR	Minimum Detectable Count Rate
µrem/hr	microrem per hour
NaI	Sodium Iodide
pCi/g	picocuries per gram

1 INTRODUCTION

Curium US LLC (Curium) is renovating a former cyclotron suite at its site in Maryland Heights, Missouri, to ready the space for a new cyclotron. The former cyclotron and support equipment have been removed, and Curium has contracted Ameriphysics, LLC (Ameriphysics) to remove and dispose of certain elements of the suite's concrete structure. The work is well documented in a project scope document (Curium 2021) and Ameriphysics Radiological Work Plan (Ameriphysics 2021).

The work involves the removal and dispositioning of approximately 400 tons of concrete. Approximately 230 tons is expected to demonstrate low levels of residual radioactivity as a result of activation from cyclotron activation and is designated for disposal at the Waste Control Specialists facility in Webster, Texas. The remaining material, approximately 170 tons, is not expected to be residually radioactive because it was either was not exposed to a neutron/proton flux or it was substantially shielded by other concrete. Nonetheless, the work area involved is designated as a radiologically controlled area, so a process is needed to demonstrate that concrete may be released from radiological controls so that it may be disposed or recycled as regular construction debris. The purpose of this plan is to describe the unrestricted-release procedure and its basis and to secure U.S. Nuclear Regulatory Commission approval of the process contained herein.

2 CONCISE CONTAMINANTS OF CONCERN

Although cyclotron operation produces a variety of activation products in concrete, the cyclotron had been shut down for a long time (i.e., years) prior to its removal, and many of the short-lived radionuclides have had an opportunity to decay. Ameriphysics obtained two concrete core samples in areas known to demonstrate elevated radioactivity to determine the principal radionuclides and isotopic abundances involved. The samples were analyzed via gamma

spectroscopy by GEL Laboratories (GEL). GEL's report is enclosed in its entirety as Attachment 1, and the results in units of picocuries per gram (pCi/g) are summarized in Table 2-1.

Table 2-1. Summary of Cyclotron Room Sample Results

Nuclide	Sample Results (pCi/g)	
	Cyclotron Room Sample 1 1191-1	Cyclotron Room Sample 2 1191-2
Antimony-124	ND	ND
Cadmium-109	ND	ND
Cesium-134	ND	ND
Chromium-51	ND	ND
Cobalt-56	ND	ND
Cobalt-57	ND	ND
Cobalt-58	ND	ND
Cobalt-60	24.5	36.1
Europium-152	207	344
Europium-154	15.3	22.7
Europium-155	ND	ND
Iron-59	ND	ND
Manganese-54	ND	ND
Niobium-95	ND	ND
Scandium-46	ND	ND
Silver-108m	ND	ND
Silver-110m	ND	ND
Sodium-22	ND	ND
Zinc-65	ND	ND
Total Activity:	246.8	402.8

ND = Not Detected

As Table 2-1 shows, Co-60, Eu-152, and Eu-154 are detected in appreciable concentrations whereas other potential site radionuclides are not. Thus, these three radionuclides serve as the concise list of radionuclide contaminants for purposes of determining procedures for unrestricted free release.

3 PHYSICAL DESCRIPTION

Although the procedure reflected by Section 5 may be used to release any of the concrete that is removed by Ameriphysics' work from radiological controls, there are four surfaces to which it is specifically applicable – three target room walls and a floor area adjacent to the cyclotron vault. The surfaces are described as follows and shown in Figure 3-1.

- Area A is an exterior target room wall. It is nominally 16 feet (ft) wide x 11.5 ft tall x 7 ft thick and is constructed of stacked block. The blocks making the outside surfaces of the wall are mortared for structural stability, and the blocks filling the space between the mortared walls are dry stacked. The dimensions of the blocks are approximately 8 inches x 8 inches x 16 inches. The interior one-third of the wall will be removed and disposed as radioactive waste. The outer two thirds (approximately 4.5 ft) of the wall is not expected to be activated.
- Area B is an interior target room wall. It is nominally 16 ft wide x 11.5 ft tall x 4 ft thick and is constructed of stacked block. Half of the wall thickness (i.e., the side facing the target room interior) will be removed and disposed as radioactive waste. The outer half (2 ft) is not expected to be activated.
- Area C is an interior wall that makes the "maze" entrance to the target room. The section of the wall that will be removed is nominally 9 ft wide x 10.5 feet tall x 7 ft thick and is constructed mostly of stacked block. The wall is not expected to be activated.
- Area D is section of concrete slab floor measuring approximately 21 ft long x 8 ft wide. A portion of floor approximately 8 ft x 7 ft is located in an opening in one of the cyclotron room walls. The remainder of the floor is outside the vault. A 14-inch thickness of floor will be removed, and none of the material is expected to be activated.

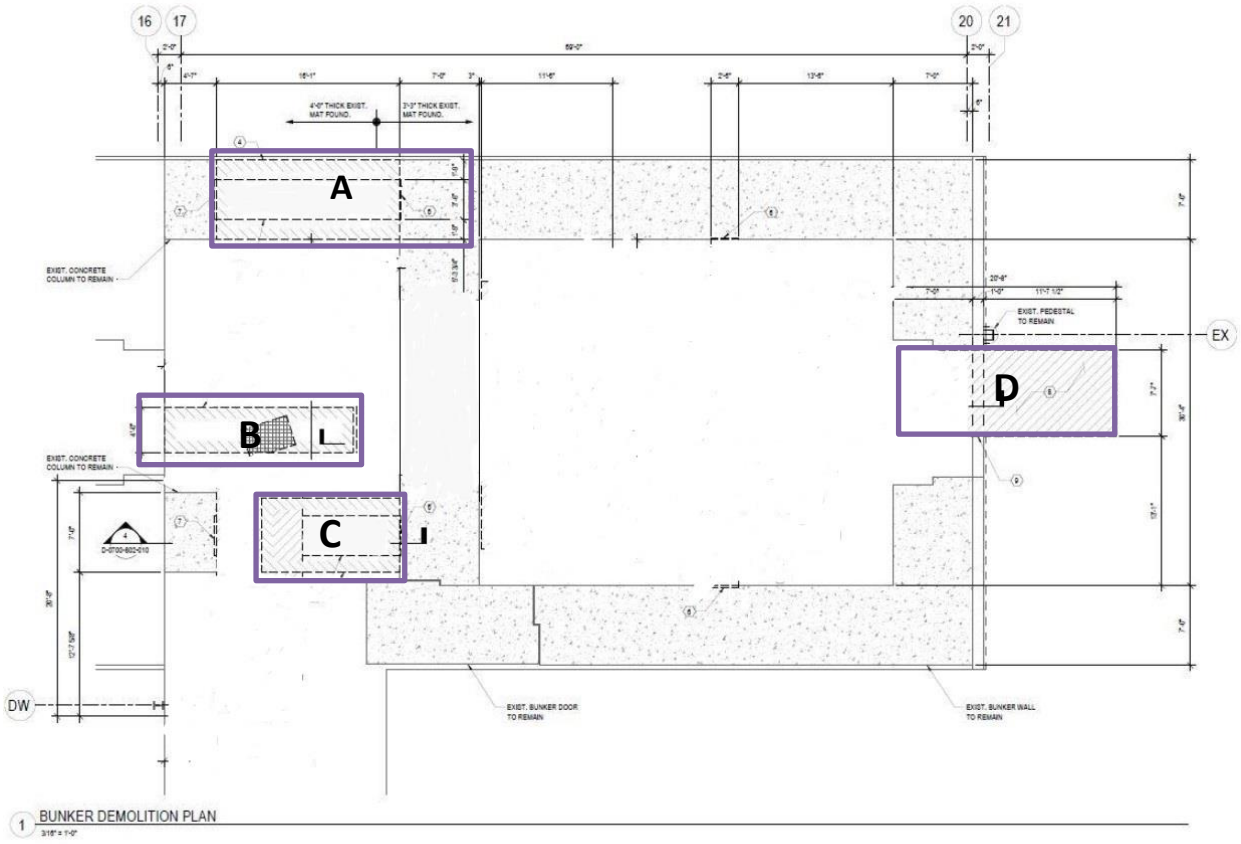


Figure 3-1. Specific Surfaces Considered

4 SUITABILITY OF SURFACE SCANS

The isotopic abundances of Co-60, Eu-152, and Eu-154 were used to evaluate the detection sensitivity of gamma scans conducted with a 2-inch x 2-inch Sodium Iodide (NaI) detector. The approach presented in Section 6 of NUREG-1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions*, was used (NRC 1998). The method requires modeling (using MicroShield) of a small cylindrical volume of elevated activity to determine the net exposure rate. The following input parameters were used:

- Areal dimension of the cylindrical hot spot: 0.25 square meters (radius of 28 centimeters [cm])
- Depth of hot spot: 15 cm
- Dose point: 10 cm above surface

- Density of hot spot: 2.35 grams per cubic cm

Note that this model reflects the exact conditions of the methodology presented in NUREG-1507, with the exception of density. In this instance, the MicroShield default density for concrete was used rather than soil.

Nuclide activities were calculated by multiplying the activity concentrations of the highest sample result by the mass of the modeled volume (86,821 grams).

The modeling code performed the appropriate calculations and determined the total exposure rate, 254 microrem per hour (µrem/hr), which accounts for buildup. The dose modeling report from MicroShield is included as Attachment 2. Additionally, MicroShield provided the exposure rate for a number of gamma energies associated with the input source term. These data were used along with data for a 2 x 2 NaI detector from NUREG-1507, Table 6.3, to weight the counts per minute (cpm) per µrem/hr value at each energy by the fractional exposure rate to estimate an overall cpm/µrem/hr value specific to the source term as shown by Table 4-1.

Table 4-1. Weighted cpm/µrem/hr for the 2 x 2 NaI Detector

Energy (keV)	Exposure Rate (µrem/hr)	Exposure Rate Fraction		cpm/µrem/hr[1]	cpm/µrem/hr (weighted)
15[2]	1.01E-01	3.99E-04		2.20E+03	8.77E-01
40	1.09E+00	4.30E-03		8.88E+03	3.82E+01
50	3.75E-01	1.48E-03		1.18E+04	1.75E+01
100	3.06E+00	1.21E-02		9.84E+03	1.19E+02
200	2.46E+00	9.71E-03		4.23E+03	4.11E+01
300	1.41E+01	5.57E-02		2.52E+03	1.40E+02
400	4.60E+00	1.81E-02		1.70E+03	3.08E+01
500	5.35E-01	2.11E-03		1.27E+03	2.68E+00
600	5.29E+00	2.09E-02		1.01E+03	2.11E+01
800	2.98E+01	1.18E-01		7.10E+02	8.34E+01
1000	9.96E+01	3.93E-01		5.40E+02	2.12E+02
1500	9.25E+01	3.65E-01		3.50E+02	1.28E+02
Total:	2.54E+02		Total Weighted cpm/µrem/hr:		8.35E+02

[1] Values from NUREG-1507 Table 6.3.

[2]No value listed on table for 15 kiloelectron volt (keV). The value for 20 keV used.

The scan Minimum Detectable Concentration (MDC) for a 2 x 2 NaI detector was calculated using the following inputs:

- Scan rate of 0.5 meters per second provides an observation interval of approximately 1 second based on a hot spot diameter of 56 cm
- Locally determined background is expected to be less than or equal to 3,548 cpm
- The desired level of surveyor performance, 95% correct detections and 60% false positive rate, results in a *d'* of 1.38
- The surveyor efficiency (*p*) is assumed to be 0.5

Based on these inputs, the Minimum Detectable Count Rate (MDCR) for an ideal observer and a surveyor MDCR ($MDCR_{surveyor}$) for the given level of surveyor efficiency were calculated as follows:

1) B_i = (3,548 cpm) * (1 sec) * (1min/60 sec) = 59.13 counts
2) MDCR = (1.38) * sqrt(59.13) * (60 sec/1 min) = 636.7 cpm
3) $MDCR_{surveyor}$ = 636.7 cpm/sqrt(0.5) = 900 cpm

The corresponding Minimum Detectable Exposure Rate is determined by dividing the $MDCR_{surveyor}$ by the weighted conversion factor determined in Table 9-1 (equation 6-18 of NUREG-1507):

Minimum Detectable Exposure Rate = 900 cpm / 835 cpm/µrem/hr = 1.08 µrem/hr

Finally, the radionuclide concentrations necessary to yield the minimum detectable exposure rate was calculated using equation 6-22 of NUREG-1507 as follows:

Scan MDC = (402.8 pCi/g) * 1.08 µrem/hr / 254 µrem/hr = 1.71 pCi/g

The scan MDC was compared against the screening values listed in NUREG-1757, Volume Appendix B, Table B.2, for the site's principal contaminants. The screening values are shown in Table 4-2.

Table 4-2. Screening Values for Principal Radionuclides of Concern

Nuclide	NUREG-1757 Table B.2 Screening Values (pCi/g) of Common Radionuclides for Soil Surface Contamination Levels
Co-60	3.80E+00
Eu-152	8.70E+00
Eu-154	8.00E+00

Since the scan MDC is well below the most limiting soil screening value, Co-60 at 3.8 pCi/g, it is reasonable to conclude that NaI scans are effective for detecting elevated residual radioactivity at concentrations of concern.

5 PROCEDURE FOR FREE RELEASE OF NON-ACTIVATED CONCRETE

5.1 Sampling

Each concrete feature that is considered for unrestricted free release will be sampled along its leading edge (i.e., the surface facing the neutron flux). This will be accomplished on walls by dividing the walls into four approximately equal sized quadrants and taking a 15 cm deep sample from each of the quadrants. The floor will be sampled 15 cm deep at two equally spaced locations along the edge parallel to the vault wall.

The samples will be transferred to GEL, and the concentration of Co-60, Eu-152, and Eu-154 in pCi/g will be determined via gamma spectroscopy. An MDC of 0.1 pCi/g is required. Results less than MDC will indicate that the concrete is not activated, and the scanning procedure reflected

by Section 5.2 may be used to disposition any concrete behind the surface the sample represents (i.e., concrete further away from the neutron flux).

Any sample result over MDC will indicate that the surface the material represents cannot be released and must be disposed as radioactive material instead. This does not preclude resampling the surface after remediation and reassessing its suitability for unrestricted release.

5.2 Gamma Scan

Concrete blocks and debris that are candidate for unrestricted free release, based initially on generator knowledge and supported by the sampling from Section 5.1, will be removed and transported via a skid steer to an area of low background radiation that is adjacent to a "clean waste" container. The blocks will be surveyed with a NaI gamma scintillation detector which, as previously demonstrated, provides a good detection sensitivity for the principal contaminants involved: Co-60, Eu-152, and Eu-154. If any discernible above background residual radioactivity is detected by the scan, the concrete will be disposed as radioactive waste. If no above background activity is detected, then the survey results will be documented on a container-specific survey, and the concrete will be placed in the container and disposed or recycled as clean construction debris.

6 REFERENCES

Ameriphysics 2021. *Radiological Work Plan, Removal and Remediation of Activated Concrete (Project Cyprus_20282),* 1191-1-001. Ameriphysics, LLC, Knoxville, TN. June 28.

Curium 2021. *Project Scope, Project Cyprus_20282*. Curium US LLC, St. Louis, MO. March 22

NRC 1998. *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions*, NUREG 1507. U.S. Nuclear Regulatory Commission, Washington, D.C. August.

Attachment 1

Laboratory Results

GEL Laboratories LLC
a member of The GEL Group INC

PO Box 30712 Charleston, SC 29417
2040 Savage Road Charleston, SC 29407
P 843.556.8171
F 843.766.1178

gel.com

July 13, 2021

Mr. Tom Hansen
Ameriphysics, LLC
911 Cross Park Dr. Suite D200
Knoxville, Tennessee 37923

Re: Ameriphysics, LLC
Work Order: 549388

Dear Mr. Hansen:

GEL Laboratories, LLC (GEL) appreciates the opportunity to provide the enclosed analytical results for the sample(s) we received on July 12, 2021. This original data report has been prepared and reviewed in accordance with GEL's standard operating procedures.

Test results for NELAP or ISO 17025 accredited tests are verified to meet the requirements of those standards, with any exceptions noted. The results reported relate only to the items tested and to the sample as received by the laboratory. These results may not be reproduced except as full reports without approval by the laboratory. Copies of GEL's accreditations and certifications can be found on our website at www.gel.com.

Our policy is to provide high quality, personalized analytical services to enable you to meet your analytical needs on time every time. We trust that you will find everything in order and to your satisfaction. If you have any questions, please do not hesitate to call me at (843) 556-8171, ext. 4708.

Sincerely,

Taylor Cannon
Project Manager

Purchase Order: GELP20-0938
Enclosures

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 − (843) 556−8171 − www.gel.com

Certificate of Analysis Report
for

AMPH002 Ameriphysics, LLC

Client SDG: 549388 GEL Work Order: 549388

The Qualifiers in this report are defined as follows:

* A quality control analyte recovery is outside of specified acceptance criteria

** Analyte is a Tracer compound

** Analyte is a surrogate compound

U Analyte was analyzed for, but not detected above the MDL, MDA, MDC or LOD.

UI Gamma Spectroscopy−−Uncertain identification

Where the analytical method has been performed under NELAP certification, the analysis has met all of the requirements of the NELAC standard unless qualified on the Certificate of Analysis.

The designation ND, if present, appears in the result column when the analyte concentration is not detected above the limit as defined in the 'U' qualifier above.

This data report has been prepared and reviewed in accordance with GEL Laboratories LLC standard operating procedures. Please direct any questions to your Project Manager, Taylor Cannon.

Reviewed by 

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: July 13, 2021

Company : Ameriphysics, LLC
Address : 911 Cross Park Dr. Suite D200

Knoxville, Tennessee 37923
Contact: Mr. Tom Hansen
Project: Ameriphysics, LLC

Client Sample ID: 1191-1
Sample ID: 549388001
Matrix: Misc Solid
Collect Date: 09-JUL-21 13:30
Receive Date: 12-JUL-21
Collector: Client

Project: AMPH00225
Client ID: AMPH002

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis													
Gammaspec, Gamma, Solid - Client List "As Received"													
Antimony-124	U	-0.102	+/-0.0944	0.149		pCi/g			MXR1	07/12/21	1127	2149187	1
Cadmium-109	U	1.36	+/-3.72	6.78		pCi/g							
Cesium-134	U	0.301	+/-0.369	0.404		pCi/g							
Cesium-137	U	0.0870	+/-0.226	0.357	0.100	pCi/g							
Chromium-51	U	1.40	+/-1.38	2.35		pCi/g							
Cobalt-56	U	0.130	+/-0.296	0.380		pCi/g							
Cobalt-57	UI	0.000	+/-0.858	1.08		pCi/g							
Cobalt-58	U	0.108	+/-0.362	0.366		pCi/g							
Cobalt-60		24.5	+/-0.632	0.197		pCi/g							
Europium-152		207	+/-2.23	0.837		pCi/g							
Europium-154		15.3	+/-1.28	1.88		pCi/g							
Europium-155	U	-0.383	+/-0.593	1.06		pCi/g							
Iron-59	U	-0.143	+/-0.387	0.643		pCi/g							
Manganese-54	U	-0.233	+/-0.209	0.350		pCi/g							
Niobium-95	U	0.289	+/-0.301	0.361		pCi/g							
Scandium-46	U	0.0907	+/-0.221	0.380		pCi/g							
Silver-108m	U	0.00379	+/-0.137	0.248		pCi/g							
Silver-110m	U	-0.00456	+/-0.304	0.519		pCi/g							
Sodium-22	UI	0.000	+/-0.645	0.237		pCi/g							
Zinc-65	UI	0.000	+/-0.544	1.08		pCi/g							

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
GEL Prep Method	Wet Soil Prep GL-RAD-A-026	AA1	07/12/21	1045	2149125

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	DOE HASL 300, 4.5.2.3/Ga-01-R	

Notes:
Counting Uncertainty is calculated at the 95% confidence level (1.96-sigma).

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: July 13, 2021

Company :	Ameriphysics, LLC
Address :	911 Cross Park Dr. Suite D200
	Knoxville, Tennessee 37923
Contact:	Mr. Tom Hansen
Project:	Ameriphysics, LLC

Client Sample ID:	1191-1	Project:	AMPH00225
Sample ID:	549388001	Client ID:	AMPH002

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method

Column headers are defined as follows:

DF: Dilution Factor
DL: Detection Limit
MDA: Minimum Detectable Activity
MDC: Minimum Detectable Concentration
Lc/LC: Critical Level
PF: Prep Factor
RL: Reporting Limit
SQL: Sample Quantitation Limit

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: July 13, 2021

Company : Ameriphysics, LLC
Address : 911 Cross Park Dr. Suite D200

Knoxville, Tennessee 37923
Contact: Mr. Tom Hansen
Project: Ameriphysics, LLC

Client Sample ID: 1191-2
Sample ID: 549388002
Matrix: Misc Solid
Collect Date: 09-JUL-21 13:35
Receive Date: 12-JUL-21
Collector: Client

Project: AMPH00225
Client ID: AMPH002

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis													
Gammaspec, Gamma, Solid - Client List "As Received"													
Antimony-124	U	0.0394	+/-0.120	0.236		pCi/g			MXR1	07/12/21	1127	2149187	1
Cadmium-109	U	0.688	+/-8.96	8.06		pCi/g							
Cesium-134	U	0.236	+/-0.296	0.516		pCi/g							
Cesium-137	U	-0.0301	+/-0.254	0.444	0.100	pCi/g							
Chromium-51	U	-0.986	+/-1.54	2.84		pCi/g							
Cobalt-56	U	-0.0157	+/-0.337	0.466		pCi/g							
Cobalt-57	UI	0.000	+/-1.03	1.34		pCi/g							
Cobalt-58	U	0.231	+/-0.488	0.449		pCi/g							
Cobalt-60		36.1	+/-0.757	0.236		pCi/g							
Europium-152		344	+/-2.87	1.02		pCi/g							
Europium-154		22.7	+/-1.46	2.30		pCi/g							
Europium-155	U	0.675	+/-0.723	1.31		pCi/g							
Iron-59	U	-0.109	+/-0.476	0.791		pCi/g							
Manganese-54	U	-0.271	+/-0.265	0.445		pCi/g							
Niobium-95	U	0.447	+/-0.409	0.457		pCi/g							
Scandium-46	U	0.0313	+/-0.279	0.476		pCi/g							
Silver-108m	U	-0.0494	+/-0.169	0.304		pCi/g							
Silver-110m	U	0.272	+/-0.380	0.655		pCi/g							
Sodium-22	UI	0.000	+/-0.740	0.293		pCi/g							
Zinc-65	U	0.601	+/-0.613	0.934		pCi/g							

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
GEL Prep Method	Wet Soil Prep GL-RAD-A-026	AA1	07/12/21	1045	2149125

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	DOE HASL 300, 4.5.2.3/Ga-01-R	

Notes:
Counting Uncertainty is calculated at the 95% confidence level (1.96-sigma).

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: July 13, 2021

Company : Ameriphysics, LLC
Address : 911 Cross Park Dr. Suite D200

Knoxville, Tennessee 37923
Contact: Mr. Tom Hansen
Project: Ameriphysics, LLC

Client Sample ID: 1191-2
Sample ID: 549388002
Project: AMPH00225
Client ID: AMPH002

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method

Column headers are defined as follows:
DF: Dilution Factor
DL: Detection Limit
MDA: Minimum Detectable Activity
MDC: Minimum Detectable Concentration
Lc/LC: Critical Level
PF: Prep Factor
RL: Reporting Limit
SQL: Sample Quantitation Limit

QC Summary

Report Date: July 13, 2021

Ameriphysics, LLC
911 Cross Park Dr. Suite D200
Knoxville, Tennessee

Contact: **Mr. Tom Hansen**

Workorder: **549388**

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
Rad Gamma Spec											
Batch 2149187											
QC1204861622 549388001 DUP											
Cesium-137	U	0.0870	U	0.102	pCi/g	N/A		N/A	MXR1	07/12/21	12:32
	Uncertainty	+/-0.226		+/-0.216							
Antimony-124	U	-0.102	U	-0.00575	pCi/g	N/A		N/A			
	Uncertainty	+/-0.0944		+/-0.0985							
Cadmium-109	U	1.36	U	5.47	pCi/g	N/A		N/A			
	Uncertainty	+/-3.72		+/-3.81							
Cesium-134	U	0.301	U	0.248	pCi/g	N/A		N/A			
	Uncertainty	+/-0.369		+/-0.241							
Chromium-51	U	1.40	U	-0.416	pCi/g	N/A		N/A			
	Uncertainty	+/-1.38		+/-1.27							
Cobalt-56	U	0.130	U	0.192	pCi/g	N/A		N/A			
	Uncertainty	+/-0.296		+/-0.235							
Cobalt-57	UI	0.000	UI	0.000	pCi/g	N/A		N/A			
	Uncertainty	+/-0.858		+/-0.831							
Cobalt-58	U	0.108	U	0.196	pCi/g	N/A		N/A			
	Uncertainty	+/-0.362		+/-0.425							
Cobalt-60		24.5		24.5	pCi/g	0.163		(0%-20%)			
	Uncertainty	+/-0.632		+/-0.637							
Europium-152		207		210	pCi/g	1.1		(0%-20%)			
	Uncertainty	+/-2.23		+/-2.37							
Europium-154		15.3		14.3	pCi/g	6.85		(0%-20%)			
	Uncertainty	+/-1.28		+/-1.13							
Europium-155	U	-0.383	U	-0.156	pCi/g	N/A		N/A			
	Uncertainty	+/-0.593		+/-0.627							
Iron-59	U	-0.143	U	-0.371	pCi/g	N/A		N/A			
	Uncertainty	+/-0.387		+/-0.397							
Manganese-54	U	-0.233	U	-0.00639	pCi/g	N/A		N/A			
	Uncertainty	+/-0.209		+/-0.216							

QC Summary

Workorder: **549388**

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
Rad Gamma Spec											
Batch 2149187											
Niobium-95	U	0.289	U	0.337	pCi/g	N/A		N/A	MXR1	07/12/21	12:32
	Uncertainty	+/-0.301		+/-0.324							
Scandium-46	U	0.0907	U	-0.141	pCi/g	N/A		N/A			
	Uncertainty	+/-0.221		+/-0.235							
Silver-108m	U	0.00379	U	-0.00657	pCi/g	N/A		N/A			
	Uncertainty	+/-0.137		+/-0.146							
Silver-110m	U	-0.00456	U	-0.0580	pCi/g	N/A		N/A			
	Uncertainty	+/-0.304		+/-0.313							
Sodium-22	UI	0.000	UI	0.000	pCi/g	N/A		N/A			
	Uncertainty	+/-0.645		+/-0.606							
Zinc-65	UI	0.000	U	0.450	pCi/g	N/A		N/A			
	Uncertainty	+/-0.544		+/-0.483							
QC1204861623 LCS											
Americium-241	485			485	pCi/g		99.9	(75%-125%)		07/12/21	11:24
	Uncertainty			+/-9.76							
Cesium-137	161			161	pCi/g		100	(75%-125%)			
	Uncertainty			+/-3.33							
Antimony-124			U	-0.0525	pCi/g						
	Uncertainty			+/-0.400							
Cadmium-109				41.3	pCi/g						
	Uncertainty			+/-17.0							
Cesium-134			U	0.318	pCi/g						
	Uncertainty			+/-0.599							
Chromium-51			U	-0.571	pCi/g						
	Uncertainty			+/-3.48							
Cobalt-56			U	0.397	pCi/g						
	Uncertainty			+/-0.527							
Cobalt-57			U	0.0939	pCi/g						
	Uncertainty			+/-0.284							
Cobalt-58			U	-0.0203	pCi/g						
	Uncertainty			+/-0.535							

QC Summary

Workorder: **549388**

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
Rad Gamma Spec											
Batch 2149187											
Cobalt-60	85.6			83.7	pCi/g		97.7	(75%-125%)	MXR1	07/12/21	11:24
	Uncertainty			+/-2.79							
Europium-152			U	0.868	pCi/g						
	Uncertainty			+/-1.38							
Europium-154			U	-0.890	pCi/g						
	Uncertainty			+/-0.709							
Europium-155			U	0.193	pCi/g						
	Uncertainty			+/-1.19							
Iron-59			U	0.215	pCi/g						
	Uncertainty			+/-1.06							
Manganese-54			U	-0.277	pCi/g						
	Uncertainty			+/-0.606							
Niobium-95			U	0.0786	pCi/g						
	Uncertainty			+/-0.458							
Scandium-46			U	-0.120	pCi/g						
	Uncertainty			+/-0.594							
Silver-108m			U	-0.0380	pCi/g						
	Uncertainty			+/-0.531							
Silver-110m			U	0.334	pCi/g						
	Uncertainty			+/-0.782							
Sodium-22			U	-0.298	pCi/g						
	Uncertainty			+/-0.251							
Zinc-65			U	1.11	pCi/g						
	Uncertainty			+/-1.14							
QC1204861621 MB											
Cesium-137			U	0.00345	pCi/g					07/12/21	11:28
	Uncertainty			+/-0.0164							
Antimony-124			U	-0.0339	pCi/g						
	Uncertainty			+/-0.0565							
Cadmium-109			U	-0.128	pCi/g						
	Uncertainty			+/-0.413							

QC Summary

Workorder: **549388**

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date Time
Rad Gamma Spec										
Batch 2149187										
Cesium-134			U	0.0213	pCi/g				MXR1	07/12/21 11:28
	Uncertainty			+/-0.0184						
Chromium-51			U	-0.0218	pCi/g					
	Uncertainty			+/-0.133						
Cobalt-56			U	-0.00630	pCi/g					
	Uncertainty			+/-0.0211						
Cobalt-57			U	0.000680	pCi/g					
	Uncertainty			+/-0.0120						
Cobalt-58			U	0.00207	pCi/g					
	Uncertainty			+/-0.0125						
Cobalt-60			U	-0.00361	pCi/g					
	Uncertainty			+/-0.0270						
Europium-152			U	0.00431	pCi/g					
	Uncertainty			+/-0.0454						
Europium-154			U	0.0266	pCi/g					
	Uncertainty			+/-0.0640						
Europium-155			U	0.0293	pCi/g					
	Uncertainty			+/-0.0510						
Iron-59			U	0.0119	pCi/g					
	Uncertainty			+/-0.0289						
Manganese-54			U	-0.00425	pCi/g					
	Uncertainty			+/-0.0256						
Niobium-95			U	0.0131	pCi/g					
	Uncertainty			+/-0.0249						
Scandium-46			U	-0.0152	pCi/g					
	Uncertainty			+/-0.0219						
Silver-108m			U	0.00702	pCi/g					
	Uncertainty			+/-0.0153						
Silver-110m			U	0.0273	pCi/g					
	Uncertainty			+/-0.0296						

QC Summary

Workorder: **549388**

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
Rad Gamma Spec											
Batch 2149187											
Sodium-22			U	0.00460	pCi/g				MXR1	07/12/21	11:28
	Uncertainty			+/-0.0234							
Zinc-65			U	-0.00396	pCi/g						
	Uncertainty			+/-0.0304							

Notes:

Counting Uncertainty is calculated at the 95% confidence level (1.96-sigma).

The Qualifiers in this report are defined as follows:

**	Analyte is a Tracer compound
<	Result is less than value reported
>	Result is greater than value reported
BD	Results are either below the MDC or tracer recovery is low
FA	Failed analysis.
H	Analytical holding time was exceeded
J	See case narrative for an explanation
J	Value is estimated
K	Analyte present. Reported value may be biased high. Actual value is expected to be lower.
L	Analyte present. Reported value may be biased low. Actual value is expected to be higher.
M	M if above MDC and less than LLD
M	REMP Result > MDC/CL and < RDL
N/A	RPD or %Recovery limits do not apply.
N1	See case narrative
ND	Analyte concentration is not detected above the detection limit
NJ	Consult Case Narrative, Data Summary package, or Project Manager concerning this qualifier
Q	One or more quality control criteria have not been met. Refer to the applicable narrative or DER.
R	Sample results are rejected
U	Analyte was analyzed for, but not detected above the MDL, MDA, MDC or LOD.
UI	Gamma Spectroscopy--Uncertain identification
UJ	Gamma Spectroscopy--Uncertain identification
UL	Not considered detected. The associated number is the reported concentration, which may be inaccurate due to a low bias.
X	Consult Case Narrative, Data Summary package, or Project Manager concerning this qualifier
Y	Other specific qualifiers were required to properly define the results. Consult case narrative.
^	RPD of sample and duplicate evaluated using +/-RL. Concentrations are <5X the RL. Qualifier Not Applicable for Radiochemistry.
h	Preparation or preservation holding time was exceeded

QC Summary

Workorder: **549388**

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time

N/A indicates that spike recovery limits do not apply when sample concentration exceeds spike conc. by a factor of 4 or more or %RPD not applicable.
^ The Relative Percent Difference (RPD) obtained from the sample duplicate (DUP) is evaluated against the acceptance criteria when the sample is greater than five times (5X) the contract required detection limit (RL). In cases where either the sample or duplicate value is less than 5X the RL, a control limit of +/- the RL is used to evaluate the DUP result.
* Indicates that a Quality Control parameter was not within specifications.
For PS, PSD, and SDILT results, the values listed are the measured amounts, not final concentrations.

Where the analytical method has been performed under NELAP certification, the analysis has met all of the requirements of the NELAC standard unless qualified on the QC Summary.

Ameriphysics, LLC	Chain of Custody (COC)			
QA Program Form	Doc	QAF 14-1	Rev #	1
	Date	2/10/2015	Form #	1

549388

Section 1

Project Number: 1191 Project Name: Maryland Heights, MO

Send Report To: Ameriphysics, LLC

Address: 9111 Cross Park Drive, Suite D200, Knoxville, TN 37923

Phone: (865)705-2796 Fax:

Sampler (Print Name): Tom Hansen

Shipment Method: FedEx Airbill Number:

Laboratory Receiving: GEL Laboratories

Section 4

Page 1 of 1

Purchase Order #: N/A

Batch #: 1191-001

Section 2

Sample ID	Sample Description	Sample Date	Sample Time	Sample Matrix	Sample Volume	Cont. Type	Cont. Quantity	Section 3 Analysis Requested: Gamma Spec (Na-22, Sc-46, Cr-51, Mn-54, Fe-59, Co-56, Co-57, Co-58, Co-60, Zn-65, Nb-95, Ag-108m, Ag-110M, Cd-109, Sb-124, Cs-134, CS-137, Eu-152, Eu-154, and Eu-155)	All True Positives	N/A	N/A	N/A	Comments, Special Instructions, etc.	Lab Sample ID (to be completed by lab
1191-1	Concrete Sample	7/9/21	13:30	S	0.5 L	P	1	X	X					
1191-2	Concrete Sample	7/9/21	13:35	S	0.5 L	P	1	X	X					

Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:
[signature]	[signature]	7/12/21	9:00
Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:
Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:

Sample Custodian Remarks (Completed By laboratory):

QA/QC level	Turnaround	Sample Receipt	
Level I	Routine	Total # Containers Received?	
Level II	24 Hour (circled)	COC Seals Present?	
Level III	1 Week	COC Seals Intact?	
Other	Other:	Received Containers Intact?	
		Temperature?	

TC

GEL Laboratories LLC

SAMPLE RECEIPT & REVIEW FORM

Client: Amer	**SDG/AR/COC/Work Order:** 549388
Received By: BE	**Date Received:** 7/12/21
Carrier and Tracking Number	Circle Applicable: (FedEx Express) FedEx Ground UPS Field Services Courier Other 2812 9137 1342

Suspected Hazard Information	Yes	No	*If Net Counts > 100cpm on samples not marked "radioactive", contact the Radiation Safety Group for further investigation.
A)Shipped as a DOT Hazardous?		\	Hazard Class Shipped: UN#: If UN2910, Is the Radioactive Shipment Survey Compliant? Yes___ No___
B) Did the client designate the samples are to be received as radioactive?		\	COC notation or radioactive stickers on containers equal client designation.
C) Did the RSO classify the samples as radioactive?	\		Maximum Net Counts Observed* (Observed Counts - Area Background Counts): 300 (CPM) mR/Hr Classified as: (Rad 1) Rad 2 Rad 3
D) Did the client designate samples are hazardous?		\	COC notation or hazard labels on containers equal client designation.
E) Did the RSO identify possible hazards?		\	If D or E is yes, select Hazards below. PCB's Flammable Foreign Soil RCRA Asbestos Beryllium Other:

	Sample Receipt Criteria	Yes	NA	No	Comments/Qualifiers (Required for Non-Conforming Items)
1	Shipping containers received intact and sealed?	\			Circle Applicable: Seals broken Damaged container Leaking container Other (describe)
2	Chain of custody documents included with shipment?	\			Circle Applicable: Client contacted and provided COC COC created upon receipt
3	Samples requiring cold preservation within (0 ≤ 6 deg. C)?*		\		Preservation Method: Wet Ice Ice Packs Dry ice (None) Other: *all temperatures are recorded in Celsius TEMP: 22
4	Daily check performed and passed on IR temperature gun?	✓			Temperature Device Serial #: IR2-21 Secondary Temperature Device Serial # (If Applicable):
5	Sample containers intact and sealed?	\			Circle Applicable: Seals broken Damaged container Leaking container Other (describe)
6	Samples requiring chemical preservation at proper pH?		\		Sample ID's and Containers Affected: If Preservation added, Lot#:
7	Do any samples require Volatile Analysis?			\	If Yes, are Encores or Soil Kits present for solids? Yes___ No___ NA___(If yes, take to VOA Freezer) Do liquid VOA vials contain acid preservation? Yes___ No___ NA___(If unknown, select No) Are liquid VOA vials free of headspace? Yes___ No___ NA___ Sample ID's and containers affected:
8	Samples received within holding time?	\			ID's and tests affected:
9	Sample ID's on COC match ID's on bottles?	\			ID's and containers affected:
10	Date & time on COC match date & time on bottles?	\			Circle Applicable: No dates on containers No times on containers COC missing info Other (describe)
11	Number of containers received match number indicated on COC?	\			Circle Applicable: No container count on COC Other (describe)
12	Are sample containers identifiable as GEL provided by use of GEL labels?	\			
13	COC form is properly signed in relinquished/received sections?	\			Circle Applicable: Not relinquished Other (describe)

Comments (Use Continuation Form if needed):

PM (or PMA) review: Initials AM Date 7/12/21 Page 1 of 1

GL-CHL-SR-001 Rev 7

List of current GEL Certifications as of 13 July 2021

State	Certification
Alabama	42200
Alaska	17−018
Alaska Drinking Water	SC00012
Arkansas	88−0651
CLIA	42D0904046
California	2940
Colorado	SC00012
Connecticut	PH−0169
DoD ELAP/ ISO17025 A2LA	2567.01
Florida NELAP	E87156
Foreign Soils Permit	P330−15−00283, P330−15−00253
Georgia	SC00012
Georgia SDWA	967
Hawaii	SC00012
Idaho	SC00012
Illinois NELAP	200029
Indiana	C−SC−01
Kansas NELAP	E−10332
Kentucky SDWA	90129
Kentucky Wastewater	90129
Louisiana Drinking Water	LA024
Louisiana NELAP	03046 (AI33904)
Maine	2019020
Maryland	270
Massachusetts	M−SC012
Massachusetts PFAS Approv	Letter
Michigan	9976
Mississippi	SC00012
Nebraska	NE−OS−26−13
Nevada	SC000122021−1
New Hampshire NELAP	2054
New Jersey NELAP	SC002
New Mexico	SC00012
New York NELAP	11501
North Carolina	233
North Carolina SDWA	45709
North Dakota	R−158
Oklahoma	2019−165
Pennsylvania NELAP	68−00485
Puerto Rico	SC00012
S. Carolina Radiochem	10120002
Sanitation Districts of L	9255651
South Carolina Chemistry	10120001
Tennessee	TN 02934
Texas NELAP	T104704235−21−19
Utah NELAP	SC000122021−35
Vermont	VT87156
Virginia NELAP	460202
Washington	C780

Radiochemistry
Technical Case Narrative
Ameriphysics, LLC
SDG #: 549388

Product: **Gammaspec, Gamma, Solid - Client List**
Analytical Method: DOE HASL 300, 4.5.2.3/Ga-01-R
Analytical Procedure: GL-RAD-A-013 REV# 27
Analytical Batch: 2149187

Preparation Method: GEL Prep Method
Preparation Procedure: GL-RAD-A-026 REV# 18
Preparation Batch: 2149125

The following samples were analyzed using the above methods and analytical procedure(s).

GEL Sample ID#	Client Sample Identification
549388001	1191-1
549388002	1191-2
1204861621	Method Blank (MB)
1204861622	549388001(1191-1) Sample Duplicate (DUP)
1204861623	Laboratory Control Sample (LCS)

The samples in this SDG were analyzed on an "as received" basis.

Data Summary:

There are no exceptions, anomalies or deviations from the specified methods. All sample data provided in this report met the acceptance criteria specified in the analytical methods and procedures for initial calibration, continuing calibration, instrument controls and process controls where applicable.

Qualifier Information

Qualifier	Reason	Analyte	Sample	Client Sample
UI	Results are considered a false positive due to high counting uncertainty.	Sodium-22	549388001	1191-1
			549388002	1191-2
			1204861622	1191-1(549388001DUP)
UI	Results are considered a false positive due to low abundance.	Cobalt-57	549388001	1191-1
			549388002	1191-2
			1204861622	1191-1(549388001DUP)

Certification Statement

Where the analytical method has been performed under NELAP certification, the analysis has met all of the requirements of the NELAC standard unless otherwise noted in the analytical case narrative.

Attachment 2

MicroShield Summary Report

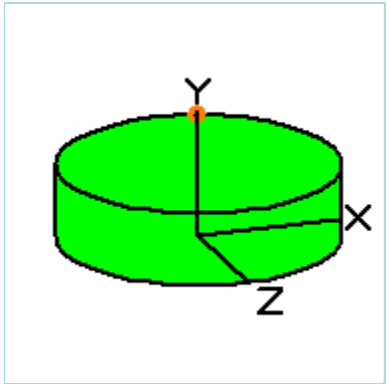
MicroShield 8.03
Ameriphysics LLC (8.03-0000)

Date	By	Checked
7/13/2021	TJP	TWH

Filename	Run Date	Run Time	Duration
Curium Concrete Scan MDC 7.14.2021.msd	July 13, 2021	10:57:20 AM	00:00:00

Project Info	
Case Title	Scan MDC
Description	For Free Release of Non-activated Concrete
Geometry	8 - Cylinder Volume - End Shields

Source Dimensions	
Height	15.0 cm (5.9 in)
Radius	28.0 cm (11.0 in)



Dose Points			
A	X	Y	Z
#1	0.0 cm (0 in)	25.0 cm (9.8 in)	0.0 cm (0 in)

Shields			
Shield N	Dimension	Material	Density
Source	3.69e+04 cm³	Concrete	2.35
Air Gap		Air	0.00122

Source Input: Grouping Method - Standard Indices
Number of Groups: 25
Lower Energy Cutoff: 0.015
Photons < 0.015: Included
Library: Grove

Nuclide	Ci	Bq	µCi/cm³	Bq/cm³
Co-60	3.1300e-006	1.1581e+005	8.4720e-005	3.1346e+000
Eu-152	2.9900e-005	1.1063e+006	8.0931e-004	2.9944e+001
Eu-154	1.9700e-006	7.2890e+004	5.3322e-005	1.9729e+000

Buildup: The material reference is Source
Integration Parameters

Radial	20
Circumferential	10
Y Direction (axial)	10

Results

Energy (MeV)	Activity (Photons/sec)	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.015	1.737e+05	1.143e-03	1.178e-03	9.800e-05	1.011e-04
0.04	6.694e+05	1.778e-01	2.466e-01	7.861e-04	1.091e-03
0.05	1.674e+05	8.585e-02	1.409e-01	2.287e-04	3.753e-04
0.1	3.440e+05	7.372e-01	2.002e+00	1.128e-03	3.062e-03

0.2	8.788e+04	5.027e-01	1.395e+00	8.873e-04	2.461e-03
0.3	2.991e+05	2.946e+00	7.442e+00	5.589e-03	1.412e-02
0.4	7.004e+04	1.016e+00	2.358e+00	1.979e-03	4.595e-03
0.5	6.398e+03	1.255e-01	2.723e-01	2.463e-04	5.345e-04
0.6	5.281e+04	1.326e+00	2.712e+00	2.589e-03	5.294e-03
0.8	2.254e+05	8.377e+00	1.567e+01	1.593e-02	2.980e-02
1.0	6.116e+05	3.082e+01	5.405e+01	5.681e-02	9.962e-02
1.5	4.009e+05	3.504e+01	5.498e+01	5.896e-02	9.250e-02
Totals	**3.109e+06**	**8.116e+01**	**1.413e+02**	**1.452e-01**	**2.536e-01**

Radiological Work Plan

Removal and Remediation of Activated Concrete
(Project Cyprus_20282)

1191-I-001, Revision 1

Prepared for:

Curium US LLC
2703 Wagner Place
Maryland Heights, MO 63043

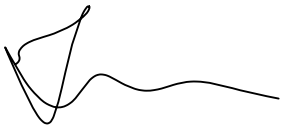
July 20, 2021

Prepared by:

AMERIPHYSICS

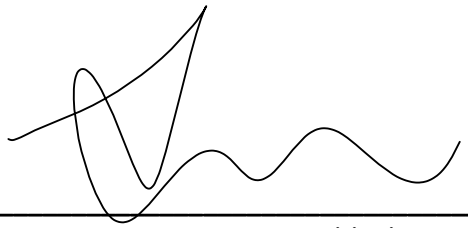
9111 Cross Park Drive, Suite D200
Knoxville, TN 37923
800.563.7497

RECORD OF REVISIONS

Change Number	Date	Description of Change	Approval
1	07/20/2021	Revised Section 5.3 to include an effluent air limit and to make the required MDC for air sampling 3E-11 µCi/ml. Revised Section 6 to indicate that liquid waste would be transferred to Curium.	

APPROVALS

Prepared By



Thomas W. Hansen, Jr., Project Health Physicist — 07/20/2021 Date

Reviewed By

Timothy Pratt, RSO, Ameriphysics, LLC — 07/20/2021 Date

Approved By

Thomas W. Hansen, Jr., President, Ameriphysics, LLC — 07/20/2021 Date

Contents

Abbreviations and Acronyms

ALARA	As Low As Reasonably Achievable
ALI	Annual Limit on Intake
Ameriphysics	Ameriphysics, LLC
CFR	Code of Federal Regulations
CHP	Certified Health Physicist
Curium	Curium US LLC
DAC	Derived Air Concentration
dpm/100cm^2	disintegrations per minute per 100 square centimeters
DOT	U.S. Department of Transportation
ft	foot/feet
ICRP	International Commission on Radiological Protection
µCi	microcurie
µCi/ml	microcurie per ml
mrem/hr	millirem per hour
NRC	U.S. Nuclear Regulatory Commission
PM	Project Manager
PPE	Personal Protective Equipment
RCA	Radiologically Controlled Area
RCM	Ameriphysics' Radiological Control Manual
RCP	Radiological Control Procedure
RCS	Radiological Control Supervisor
RSO	Radiation Safety Officer
RWP	Radiation Work Permit
TEDE	Total Effective Dose Equivalent
WCS	Waste Control Specialists

1 PURPOSE

Curium US LLC (Curium) is renovating a former cyclotron suite at its site in Maryland Heights, Missouri, to ready the space for a new cyclotron. The former cyclotron and support equipment have been removed, and Curium has contracted Ameriphysics, LLC (Ameriphysics) to remove and dispose of activated concrete.

The work area involved is designated as a radiologically controlled area (RCA). Consequently, any access to, egress from, and work within the area will be controlled according to a radiation protection program conforming to Title 10, Code of Federal Regulations (CFR), § 20.1101.

Ameriphysics is a U.S. Nuclear Regulatory Commission (NRC) licensee, and it maintains an NRC approved § 20.1101-based radiation protection program that will be used to control its work at the Curium site. Ameriphysics' program is described in its Radiological Control Manual (RCM) and implementing Radiological Control Procedures (RCPs). Ameriphysics' license, RCM, and RCPs have been submitted to Curium in their entirety under separate cover. Thus, the purpose of this Plan is to describe the site-specific controls that are necessary to implement Ameriphysics' existing radiation protection program at the Curium site rather than to entirely repeat program requirements.

2 SCOPE OF WORK

The work is well documented in a Curium document dated March 22, 2021, and entitled *Project Scope, Project Cyprus_20282*. In general, the work consists of cutting, breaking, unstacking, drilling, and scabbling activated concrete. A variety of demolition tools will be used including concrete saws, wire saws, demolition hammers, and core drills. The resulting wastes will be collected, packaged, and disposed according to the residual radioactivity they contain. Some of the forementioned tools rely on water for cooling and lubrication, and this water and any potentially contaminated cuttings it contains must also be collected and dispositioned.

The work area is not very large. The nominal exterior footprint of the space measures 44 feet (ft) x 59 ft (2,596 ft^2), but because the facility is outfitted with 7 ft thick walls, the occupiable space is closer to 1,350 ft^2. Consequently, the work is expected to be accomplished with a small crew of 6 to 8 people.

3 PROJECT MANAGEMENT, ORGANIZATION, RESPONSIBILITES, AND CONTROLS

All employees and visitors are responsible for working safely and acting in a manner that does not jeopardize their safety, the safety of others, or the quality of the environment. They are responsible to immediately report unsafe conditions to their supervisor or site contact, whether radiological or due to general safety conditions. All persons have the right and obligation to pause work if unsafe conditions are suspected, and such stop-work authority is conveyed without fear of reprisal. Job-specific responsibilities and authority of management are described in the sections that follow.

3.1 Project Manager

The Project Manager (PM) has responsibility and authority to direct all work operations. The PM coordinates safety and health functions, has the authority to oversee and monitor the performance of the project, and bears ultimate responsibility for the proper implementation of this Plan. The specific duties of the PM are:

- Managing the project and overseeing the technical and programmatic activities of the health and safety program;
- Ensuring that adequate health and safety systems (policies, plans, procedures, materials, etc.) are in place and operational;
- Assigning sufficient resources to execute the project;
- Ensuring effective emergency response;
- Serving as primary site liaison with Curium and site contractors;

- Ensuring site monitoring, worker training, medical surveillance, and effective selection and use of personal protective equipment (PPE);
- Ensure the correct field execution of the Plan;
- Assessing site conditions for unsafe acts and conditions and providing corrective action;
- Maintaining project records; and
- Coordinating with the emergency response personnel and others as necessary for safety and health efforts.

3.2 Radiation Protection Personnel

Ameriphysics will provide radiological oversight and support for the activities it conducts. Ameriphysics will be responsible for assessing radiological conditions, specifying required controls, conducting radiological training, performing radiological surveys, specifying protective clothing requirements, determining personnel exposure monitoring requirements, and monitoring persons and equipment for contamination.

Ameriphysics will provide radiological support to the project with the following organizational elements and required monitoring equipment.

3.2.1 Radiation Safety Officer

Ameriphysics' Radiation Safety Officer (RSO) is responsible for executive-level administration of the corporate radiological control program in accordance with prevailing procedures and industry practices. Specific responsibilities include the following:

- Establishing standards and guidelines for radiological operations;
- Limiting occupational radiation exposures to levels that are as low as reasonably achievable (ALARA);
- Suspending any operation that presents a radiological or safety threat to employees, the environment, or the general public;

- Ensuring the quality of protective equipment for personnel and prescribing usage standards;
- Establishing procedures for radiological protection and monitoring; and
- Overall responsibility for the radiation protection training program.

Tim Pratt is Ameriphysics' corporate RSO. Because he is an executive-level manager, he does not need to be present in the field, and his work will be conducted from Ameriphysics' corporate office in Knoxville, TN.

3.2.2 Heath Physicist

The project will be supported by a Certified Health Physicist (CHP) that is responsible for any professional-level validation that arises over the course of the project. The project Health Physicist is Tom Hansen, Jr., PhD. Support from the Health Physicist may be accomplished off-site.

3.2.3 Radiological Control Supervisor

A Radiological Control Supervisor (RCS) reports to the RSO and oversees field implementation of the radiological control and safety program at the project level. Such implementation is described in Section 5 of this Plan and the current version of Ameriphysics RCM and implementing RCPs. The RCS has the authority to, and shall, order any operations suspended when such operations present an imminent radiological or safety threat or hazard to employees, the environment, or the public. The PM, RSO, or project Health Physicist may also serve as the RCS.

The RCS will be on-site any time work is conducted. If the designated RCS must be away from the site, his or her responsibilities will temporarily be assigned to an appropriately experienced health physics technician so that continuity of radiological supervision is always maintained. The designated RCS is only allowed to temporarily pass his or her responsibilities onto an individual that the RSO has approved to serve in such a capacity.

3.2.4 Health Physics Technicians

Health physics technicians are assigned by the RCS for specific day-to-day oversight of radiological workers and radiological operations. They act as the RCS's representative(s) in specifically implementing the radiological control and safety practices as assigned.

3.3 Radiation Workers

Radiation Workers are any persons, regardless of employer, who engage in work activities in RCAs and are not classified as visitors by the RCS according to Section 5.10 of this Plan. Radiation Workers will follow the instructions from Radiation Protection Personnel but do not perform the duties assigned to Radiation Protection Personnel unless specifically authorized to do so by the RCS.

3.4 Coordination of Efforts

The organizations on this site that could be affected by the tasks and operations associated with the Plan are listed in Table 1 below.

Table 1. Other Site Contractors and Subcontractors

Organization	Function
Curium	*Owner/Site License Owner*
Ameriphysics	*Prime Contractor/Licensee*
Hayden Wrecking	*Subcontractor/Concrete Demolition*

All work shall be performed by Ameriphysics and its subcontractors under Ameriphysics' radioactive material license. The following organizations will be participating to accomplish the work:

- Curium owns the facility and has contracted Ameriphysics to perform the activities described in the scope document and this Plan; therefore, Curium is responsible for ensuring that Ameriphysics accomplishes the work for which they have been contracted. Curium is responsible for providing site access and for completing any site preparations to which it has agreed. Curium may, at its discretion, inspect Ameriphysics work, and Curium is entitled to

copies of calibrations, instrument checks, and other documents generated as a result of the project. Curium reserves the right to temporarily shut down work if any unsafe radiation conditions are identified by its staff until such time as the problem is remedied.

- Ameriphysics is the prime contractor and is responsible for radioactive material licensure, oversight, transportation, waste management, and compliance. Ameriphysics' PM shall be the person directly responsible for radiation protection work that is accomplished according to this Plan.
- Hayden Wrecking is a subcontractor and is responsible for concrete demolition as directed by Ameriphysics and for adhering to the instructions of Ameriphysics PM and radiation protection personnel. Accordingly, Hayden Wrecking's personnel will be trained and monitored according to Ameriphysics radiological control procedures.

4 RADIOLOGICAL CONTAMINANTS OF CONCERN

The primary radionuclides of concern for remediation and radiological waste disposal are nuclides produced by activation of concrete. From a dose perspective, the most significant nuclides are Eu-152 and Co-60 in activated concrete and steel rebar – these two nuclides typically account for greater than 90% of the dose. Concrete samples were collected after the cyclotron was removed in February 2021. Additional nuclides present in the concrete were H-3, Na-22, Mn-54, Fe-59, Zn-65, Cs-134, and Eu-154. Ge-68 was also present on the samples from the storage of contaminated materials in the cyclotron vault, and Ge-68 decays to radioactive Ga-68. These radionuclides and corresponding properties from International Commission on Radiological Protection (ICRP) Publication 107, Nuclear Decay Data for Dosimetric Calculations, are demonstrated on Table 2.

Table 2. Radionuclides of Concern

Nuclide	Half-Life[1] Daughter	Decay Mode[2] Fraction	Energy Emitted (MeV/transformation)			
			Alpha	Electron	Photon	Total
Cs-134	2.0648 y Ba-134 Xe-134	B-, EC 1.00 3.00E-06	-	0.1639	1.5551	1.7190
Co-60	05.2713 y Ni-60	B- 1.00	-	0.0969	2.5038	2.6007
Eu-152	13.537 y Gd-152 Sm-152	EC, B+, B- 2.79E-01 7.21E-01	-	0.1286	1.1759	1.3045
Eu-154	8.593 y Gd-154 Sm-154	B-, EC 9.998E-01 2.000E-04	-	0.2730	1.2493	1.5223
Fe-59	44.495 d Co-59	B- 1.00	-	0.1179	1.1883	1.3062
Ga-68	67.71 m Zn-68	EC, B+ 1.00		0.7379	0.9487	1.6866
Ge-68	270.95 d Ga-68	EC 1.00	-	0.0050	0.0041	0.0091
H-3	12.32 y He-3	B- 1.00	-	0.005	-	0.0057
Mn-54	313.12 d Cr-54 Fe-54	EC, B+, B- 1.00 2.90E-06	-	0.0042	0.8360	0.8402
Na-22	2.6019 y Ne-22	EC, B+ 1.00	-	0.1941	2.1926	2.3866
Zn-65	244.06 d Cu-65	EC, B+ 1.00	-	0.0069	0.5819	0.5888

[1] Key to half-life: m is minutes, d is days, and y is years

[2] Key to decay mode: B- is beta minus, B+ is beta plus, EC is electron capture

Thus, radiations of concern are beta and gamma. Based on radiological surveys that were performed during the removal of the cyclotron in January and February 2021, there is detectable Ge-68 residual surface contamination with maximum removable activity on the floors of approximately 6,000 disintegrations per minute per 100 square centimeters (dpm/100 cm^2). General area dose rates at that time were 0.5-1.0 millirem per hour (mrem/hr). Contamination from Ge-68 production exists on all floor surfaces and potentially on wall and ceiling surfaces.

5 RADIATION PROTECTION PROGRAM ELEMENTS

Maintaining personnel exposures ALARA is the primary goal of the radiation protection program. This is accomplished with a combination of engineering and administrative controls and PPE as described in the following subsections.

5.1 Training

Persons must possess the Radiation Safety Training required by Ameriphysics procedure RCP 2-1, *Radiation Safety Training Procedure*, to access RCAs unless designated as visitors according to Section 5.10 of this Plan and escorted. Workers who receive or are likely to receive an occupational effective dose equivalent in excess of 0.1 rem in one year are provided Radiation Worker Training. The approximately 1-day course familiarizes trainees with the following concepts:

- Radiation and its effects on the body;
- Federal dose limits and administrative controls;
- ALARA and personnel monitoring programs;
- Radiological postings;
- Contamination controls; and
- Federal and state regulations.

A worker who is not likely to receive an occupational effective dose equivalent in excess of 0.1 rem in one year is provided Radiation Awareness Training. This training familiarizes workers with site hazards and provides instructions for avoiding contact with radioactive material and for keeping individual doses less than 0.1 rem.

The initial Radiation Safety Training required by this section shall consist of instructor-led training and may be provided by personnel qualified at a minimum as a health physics technician. This training may be administered at any location, provided additional training is administered

covering any specific procedures in effect for jobsite operations. Qualification is good for one year and is attained by completing the required coursework and passing a written examination with a score of 70% or better. Requalification can be attained by completing the exam in lieu of classroom training, provided a passing score is attained on the first attempt, correct responses to missed questions are reviewed with the trainee, and any new rules or revisions to the radiation safety program are explained.

Position-specific training and qualifications required for persons described in Section 3.2 are described in Section 2 of Ameriphysics' RCM.

5.2 Occupational Exposure Limits and Monitoring

Occupational dose limits for adults are set forth in 10 CFR § 20.1201, and the dose limit for the embryo/fetus of a declared pregnant woman is specified in 10 CFR § 20.1208. As a measure to prevent exceeding these limits, Administrative Limits equal to 80% of the prescribed limits are used. These limits are tabulated in Table 3.

Table 3. Occupational Dose Limits

	Occupational Dose	Administrative Limit
Total effective dose equivalent (TEDE)	5 rem/yr	4 rem/yr
Sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye	50 rem/yr	40 rem/yr
Skin (shallow-dose equivalent)	50 rem/yr	40 rem/yr
Lens of the eye (shallow-dose equivalent)	15 rem/yr	12 rem/yr
Dose equivalent to the embryo/fetus	0.5 rem for entire pregnancy	0.4 rem for entire pregnancy

An ALARA goal of 0.1 rem/yr Total Effective Dose Equivalent (TEDE) is initially established for this project, meaning no person is allowed to exceed this goal without the consent of the RSO.

In accordance with 10 CFR 20.1502(a), *Conditions requiring individual monitoring of external and internal occupational dose*, external exposure dosimetry shall be worn by:

1. Adults likely to receive, in 1 year from sources external to the body, a dose in excess of 0.5 rem per year;
2. Declared pregnant women likely to receive during the entire pregnancy, from radiation sources external to the body, a deep dose equivalent in excess of 0.1 rem; and
3. Individuals entering a high or very high radiation area as defined by 10 CFR § 20.1003, *Definitions*.

Minors are also required to wear external exposure dosimetry if they are likely to receive, in one year from radiation sources external to the body, a deep dose equivalent in excess of 0.1 rem, a lens dose equivalent in excess of 0.15 rem, or a shallow dose equivalent to the skin or to the extremities in excess of 0.5 rem; however, the presence of minors at the project is not anticipated.

Permanent-record dosimetry shall be issued by Ameriphysics to each individual that is required by this section to wear external exposure dosimetry. When a dosimeter is issued, the individual will be briefed on its proper use and care. A dosimeter can only be worn by the person to which it is assigned. The dosimeters will be returned to Ameriphysics at the end of the work activity or at the end of the shift, as required by the RCS. If a dosimeter is lost, the individual shall immediately leave the area and notify the RCS so an investigation can be conducted.

The RSO will report individual monitoring results to workers annually and at the request of any individual formerly wearing dosimetry provided by Ameriphysics. These reports are provided directly to the monitored individuals and not their employers unless the worker directs the RSO otherwise in writing.

5.3 Airborne Exposure Limits and Monitoring

Airborne radioactive material means radioactive material dispersed in the air in the form of dusts, fumes, particulates, mists, vapors or gases.

Airborne radioactivity area means a room, enclosure, or area in which airborne radioactive materials exist in concentrations:

1. In excess of the derived air concentrations (DAC) specified in Appendix B to 10 CFR § 20; or
2. To such a degree that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an intake of 0.6% of the annual limit on intake (ALI) or 12 DAC-hours.

ALI means the derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man that would result in a committed effective dose equivalent of 5 rems or a committed dose equivalent of 50 rems to any individual organ or tissue. The unit for ALI is the microcurie (μCi).

DAC means the concentration of a given radionuclide in air which, if breathed by the reference man for a working year of 2,000 hours under conditions of light work, results in an intake of one ALI. The unit for DAC is μCi per milliliter (μCi/ml).

DAC-hour is the product of the concentration of radioactive material in air (expressed as a fraction or multiple of the derived air concentration for each radionuclide) and the time of exposure to that radionuclide, in hours. Thus, 2,000 DAC-hours is one ALI, equivalent to a committed effective dose equivalent of 5 rems.

The most-restrictive stochastic inhalation ALIs and DACs from 10 CFR § 20, Appendix B, for site-specific radionuclides of concern are shown on Table 4.

.

Table 4. ALIs and DACs for Radionuclides of Concern

Nuclide	ALI (µCi)	DAC (µCi/ml)
Cs-134	1E+2	4E-8
Co-60	3E+1	1E-8
Eu-152	2E+1	1E-8
Eu-154	2E+1	8E-9
Fe-59	3E+2	1E-7
Ga-68	4E+4	2E-5
Ge-68	1E+2	4E-8
H-3	8E+4	2E-5
Mn-54	8E+2	3E-7
Na-22	6E+2	3E-7
Zn-65	3E+2	1E-7

The most restrictive ALI (i.e., 2E+1 µCi) and DAC (i.e., 8E-9 µCi/ml) are for the radionuclide Eu-154. Consequently, the Eu-154 values will be used for planning and evaluating airborne radioactivity controls for workers.

In addition, the Air Effluent concentration limits from Table 2 of 10 CFR § 20, Appendix B, are applicable to the assessment and control of public dose. The most restrictive value is 3E-11 µCi/ml for the radionuclides Eu-152 and Eu-154 and will be used for planning and evaluating airborne radioactivity controls in outside areas.

Airborne particulate surveys shall be performed by Radiation Protection Personnel daily in the vicinity of any work that exhibits a potential to disturb radioactive material. These surveys will be performed according to Ameriphysics procedure RCP 4-4, *Airborne Radioactivity Control Procedure*. The use of personnel air samplers is not anticipated.

The system used for counting air samples shall be capable of achieving a minimum detectable concentration not greater than 3E-11 µCi/ml (i.e., the effluent air limit). Individual samples may be obtained over more than one shift or day if deemed necessary to obtain sufficient volume.

The use of respiratory protection equipment is not anticipated for this project. The RSO will be consulted to establish appropriate controls and protections if airborne concentrations exceeding 10% of the Eu-154 DAC are encountered.

5.4 Exposure and Contamination Control

Work in areas where radioactive material is handled, used, or stored shall be performed in accordance with approved procedures and work instructions to ensure that the regulatory limits in Section 5.2 are maintained. Ameriphysics procedure RCP 4-1, *Exposure and Contamination Control Procedure*, describes in detail procedures for:

- Working in an RCA;
- Proper use of a radiation work permit (RWP);
- Access control point;
- Shielding;
- Administrative controls;
- Engineering controls; and
- Postings and labels.

A few of the engineering controls that may be implemented to ensure worker doses are ALARA include:

- Wetting of concrete to minimize the suspension of contaminated material;
- Use of berms and coverings as appropriate during operations; and
- Using mechanical equipment to handle contaminated material rather than by hand.

The following important administrative controls will be implemented to ensure worker doses are ALARA.

- Any work activities conducted within the RCA will be defined and delineated using job-specific RWPs;
- All nonessential personnel will be restricted from RCAs; and
- No eating, drinking or smoking will be allowed in RCAs.

The RCS ensures that engineering and administrative controls are sufficient to maintain worker protection. In doing so, the RCS coordinates with the PM and other supervisory personnel to ensure that controls are understood, effective, and not unnecessarily impeding work.

5.5 Postings

Areas where radiation or the potential for radiation exist will be posted in accordance with 10 CFR § 20.1902, *Posting requirements*. The following postings are likely or possible based on known contaminants and concentrations.

- Each radiation area will be posted with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, RADIATION AREA." Radiation area means an area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.
- Each airborne radioactivity area (as defined in Section 5.3) will be posted with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, AIRBORNE RADIOACTIVITY AREA" or "DANGER, AIRBORNE RADIOACTIVITY AREA."
- Unless already posted as a radiation area or airborne radioactivity area, each RCA will be posted with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL(S)" or "DANGER, RADIOACTIVE MATERIAL(S)."

5.6 Surveys, Monitoring, Action Levels, and Decontamination

Radiological surveys are performed by Radiation Protection Personnel as necessary to ensure personnel do not exceed radiation exposure limits, to meet requirements for posting radiation

areas, and to control the spread of contamination. These surveys shall be performed at prescribed locations and intervals according to approved procedures. These procedures are described in detail in Ameriphysics procedure RCP 4-2, *Surveys and Monitoring Procedure*.

Area radiation surveys are performed by Radiation Protection Personnel:

1. Daily, at boundaries and access control points of radiation areas;
2. Weekly, in occupied radiation areas, areas where radioactive material and waste is stored, and at boundaries of worksites where the public could be exposed;
3. Whenever operations are performed that might be expected to change existing radiation levels;
4. When highly radioactive equipment (i.e., radiation level at 30 cm is greater than 0.1 rem per hour) is moved; and
5. When performing operations that could result in personnel being exposed to small intense beams of radiation.

Surface contamination surveys are performed by Radiation Protection Personnel:

1. Prior to initial entry to an area where contamination is possible;
2. In-process to verify appropriateness of contamination controls, control processes, direct remedial efforts, and free release items or areas.

Removable contamination surveys are performed by Radiation Protection Personnel:

1. Daily, in active work areas where contamination is possible and at access control points;
2. Weekly, in areas where handling of radioactive material occurs and areas where radioactive material is stored; and
3. In-Process, during any of the following:
    a. Decontamination and release of equipment;

b. In areas where airborne radioactivity has exceeded the concentrations specified in Ameriphysics procedure RCP 4-4, *Airborne Radioactivity Control Procedure*; and

c. When determining the need for anti-contamination clothing and to determine the extent of contamination in an area.

Removable contamination is evaluated by obtaining representative wipes and counting the contamination on the wipe using a Ludlum 3030E or equivalent.

Ameriphysics' surface contamination survey limits are based on Regulatory Guide 1.86, Table 1, *Acceptable Surface Contamination Limits*. These limits are commensurate with limits from Regulatory Guide 8.23, Table 3, *Acceptable Surface Contamination Levels for Uncontrolled Release of Equipment*. Of the known site contaminants, the most restrictive limits are 5,000 dpm/100 cm^2 total activity and 1,000 dpm/100 cm^2 removable activity for beta-emitting nuclides. These limits serve as the action levels at which decontamination of equipment is required. Radiation Protection Personnel will decide if decontamination can be accomplished or assisted by persons qualified as Radiation Workers. For example, it is reasonable to expect Radiation Workers to be able to clean equipment that is contaminated with materials they are already authorized to handle during their regular work. Nonetheless, Radiation Workers will not undertake decontamination on their own without authorization.

Surveys of personnel (i.e., "frisking") will be performed when exiting an RCA. The type of scan (i.e., whole body, hand and foot, etc.) will be designated on the RWP. Unlike surveys of equipment, the action level for contamination of skin or clothing is any detectable contamination. Radiation Workers will not attempt to decontaminate themselves; only Radiation Protection Personnel are allowed to decontaminate people.

Ameriphysics procedure RCP 4-9, *Decontamination Procedure*, describes general techniques for decontamination. Due to the nature of the work that is planned and the physical characteristics

of the site's residual radioactivity, decontamination beyond basic tape-presses or cleaning with damp cloths and a mild over-the-counter detergent is not expected.

5.7 Survey Instrumentation

Radiation Protection Personnel will make an adequate number of calibrated radiation detection and measurement instruments available. Instruments shall be calibrated at least annually or after each repair. Instruments will be checked before use according to Ameriphysics procedure RCP 4-3, *Survey Instrument Procedure*.

5.8 Access Control Points

An access control point is a location on the perimeter of an RCA through which all entries and exits are made and where precautions are taken to prevent unnecessary exposure or the spread of radioactive contamination to adjacent uncontaminated areas.

The following items outline the basic considerations for establishing an access control point:

1. Determine the extent of the area to be isolated and the location where entry and exit shall be controlled;
2. Plan for physical boundaries to prevent inadvertent or unauthorized access. Boundaries shall be conspicuously marked and posted;
3. Cover the floor of the control point using paper or plastic sheet or other material provided for this purpose (optional in outdoor areas). The intent is to provide an easily removable walking surface within the control point to prevent tracking of contamination from the area. Maintain a supply of the material to replace floor covering as necessary;
4. Provide a "step-off pad" at the exit from the control point (optional in outdoor locations). This is to be used when removing clothing during exit from the area;
5. Provide easily accessible receptacles for used PPE, respirators, and equipment at the control point. A supply of plastic bags shall be available as necessary for receiving contaminated

equipment and tools. Radiation tags or labels shall be available to identify contaminated items being removed from the area;

6. Provide radiation detection instruments for monitoring personnel and equipment. Frisking should be performed in a low radiation background and where the audible response of the frisker can be heard;
7. Provide means of recording stay times, as may be required, at the entrance of the areas for personnel. It may be necessary to provide a record of previous radiation exposures received by personnel entering an RCA so that maximum allowable time in the RCA can be determined;
8. At the entrance to the access control point, information shall be posted concerning radiation and contamination conditions, precautions for entry, precautions for exit, step-off points, clothing and waste receptacles, and personnel survey. A copy of the applicable RWP shall be posted at the access control point;
9. Radiological Protection Personnel shall designate, stock, staff, and otherwise maintain the control point;
10. Only personnel in assigned PPE should enter RCAs;
11. Adequately trained personnel may be permitted to assist in frisking other personnel and themselves; and
12. Contaminated individuals shall be processed in accordance with Ameriphysics procedure RCP 4-9, *Decontamination Procedure*.

5.9 Personal Protective Equipment

The term PPE is used to describe any equipment that is worn by an individual to prevent exposure to workplace hazards. In the usual sense where radioactivity is a concern, PPE is used to prevent contamination of a person's skin or clothing or inhalation or ingestion of radioactive material.

PPE categorically consists of anti-contamination clothing and respiratory protective equipment. Because the use of respirators on this project is not expected, the descriptions herein are limited to anti-contamination clothing.

A full set of anti-contamination clothing consists of a hood, coveralls, rubber gloves, booties, and shoe covers. Points where contamination may enter clothing should be sealed with tape. A partial set of anti-contamination clothing consists of an ensemble that does not contain all of the items comprising a full set.

A full or partial set of anti-contamination clothing should be worn in the following instances:

1) During initial entry into an area that may be contaminated, prior to determining the extent and level of contamination;

2) Anytime work is conducted in an area with, or when directly handling items or material with, removable contamination exceeding the limits in Table 4-1 of Ameriphysics' RCM;

3) Initially opening a radioactive system without containment; and

4) Whenever personnel contamination is probable.

The decision to assign a full or partial set of clothing is made by the RCS who will consider the potential for contamination and other human health risk factors such as temperature and humidity. If there is a reasonable potential that a person's skin or clothing could become contaminated to a level exceeding the limits in Table 4-1 of the RCM or the work area is posted as an airborne radioactivity area, then a full set should be prescribed.

5.10 Visitors

Management, technical, and other personnel who require occasional access to RCAs and areas where radioactive material is stored and who enter these for observation or similar purposes, or to perform work not involving radioactive material, shall have the radiological control training necessary for the radiological conditions expected to be encountered or shall be escorted by

appropriately qualified personnel at all times. The RCS or designee will be required to escort all visitors, and these personnel are not allowed to receive an exposure exceeding the 10 CFR § 20.1301, *Radiation Dose Limits for Individual Members of the Public*, of 0.1 rem per year or 0.002 rem in any one hour.

6 RADIOACTIVE WASTE MANAGEMENT PROGRAM

All solid radioactive waste will be packaged in appropriate U.S. Department of Transportation (DOT) compliant shipping containers, where required, for shipment to the 1,338-acre Waste Control Specialists (WCS) site in Andrews County, Texas. As the waste is generated, it will be possessed and stored while it is on-site under Ameriphysics' radioactive materials license, but at all times the waste and any secondary waste that is generated (e.g., spent PPE) will remain the property of Curium. All radioactive waste will be transported via DOT compliant carriers and manifested by qualified waste shippers.

Ameriphysics will make reasonable efforts to minimize the amount of radioactive waste that is generated. Example waste management techniques that should be employed include salvage or re-use by others, using only the materials that are necessary to complete the task, using radiologically dedicated tools and equipment, decontaminating tools and equipment instead of disposing of them, preventing the mixing of radioactive waste with non-radioactive waste or released material, and avoiding the spread of contamination while handling radioactive material and waste.

Water that is used to cool and lubricate concrete cutting tools will be collected. The resulting "slurry" will be mechanically filtered, and any solids that are collected will be disposed at WCS with other solid waste. The remaining liquid waste will be emptied into the site's existing waste tank system via a drain in the cyclotron vault and managed by Curium according to its handling practices for contaminated and potentially contaminated liquids.

7 EMERGENCY RESPONSE

In the event of a medical emergency, fire, or explosion involving radioactive materials, priority shall always be given to injured personnel and personnel safety, then to combating of the emergency itself. Radiological controls shall be secondary to these tasks. The following steps shall be carried out concurrently with each other, although not necessarily in the order given unless specifically required.

7.1 Medical Emergency

Immediately notify the RCS to report the person's injury and location. The RCS is responsible to ensure proper emergency personnel are summoned.

7.1.1 Immediate Actions

1. Do not move any individual who is unconscious or has had a back, neck, or head injury unless they are in immediate, life threatening danger.
2. Check unconscious individuals for respiration and pulse. Administer CPR if individual does not have pulse and respiration. Administer rescue breathing if individual has a pulse but is not breathing.
3. Administer first aid within your training and capabilities. Use a blanket to keep victim warm and apply direct pressure to stop bleeding.
4. After proper notifications have been made and first aid has been rendered, take steps to prepare the individual for transport to an aid station or hospital. Remove protective clothing and collect dosimetry if this can be accomplished without contaminating the individual or interference to responders.
5. Make preparations to support emergency medical personnel when they arrive. Provide lab coats, boots, and gloves to emergency personnel if victim is in contaminated area and if time permits. Do not delay response waiting for protective clothing.

6. Issue self-reading pocket dosimeters or other dosimetry if time permits. Do not delay the ambulance personnel response to issue dosimetry.
7. If injured person cannot be surveyed out of contamination area, treat the individual as being contaminated until the individual can be surveyed. Line the stretcher with plastic to contain any contamination. Line the ambulance floor with plastic to contain contamination, if necessary. Do not delay emergency response to place plastic sheeting.
8. If transporting a radioactively contaminated individual, dispatch a health physics technician with the ambulance to provide guidance on controlling contamination in the ambulance and at the hospital. The health physics technician should perform surveys of materials and maintain control of items that may have become radioactively contaminated in the process of treating the injured individual.

7.1.2 Supplementary Actions

Once initial response actions have been completed, take the following supplementary actions:

1. Survey all personnel who entered contaminated areas in response to the injury;
2. Perform surveys of contamination area boundaries where personnel entered and exited to confirm contamination has not been spread as a result of the response;
3. Survey materials and equipment used in response to the injury. Decontaminate or discard items determined to be radioactively contaminated;
4. Restock and restore first aid kits and equipment used in response to the injury;
5. Survey, and decontaminate as necessary, emergency response personnel and equipment including the ambulance, emergency medical personnel, hospital areas, and personnel;
6. Collect any personnel dosimetry issued to medical personnel and other responders. Have dosimeters processed as necessary; and
7. Evaluate the incident and make regulatory notifications as required.

7.2 Fire

For all fires, immediately notify the RCS to report the fire. The RCS is responsible to ensure proper emergency personnel are summoned.

7.2.1 Immediate Actions

1. Immediately notify other area occupants and have them exit the area. On area evacuation, personnel should gather at designated emergency assembly areas to take roll and to identify any missing persons.
2. After proper notifications have been made, take steps to fight the fire if this can be done so without putting yourself in danger. Small fires can be extinguished with portable fire extinguishers by aiming the extinguishing agent at the base of the fire. DO NOT use water on Class B (liquid/oil) fires.
3. De-energize affected electrical circuits if possible to do so without putting yourself in danger.
4. Prepare to support fire-fighting personnel when they arrive. Turnout gear is sufficiently protective that additional protective clothing is not necessary.
5. Issue self-reading dosimeters or other dosimetry if time permits. Do not delay the firefighting response to issue dosimetry.
6. Warn response personnel of possible radiological hazards inside the area including expected contamination and radiation levels. Advise them of any radiation sources which are present which could elevate radiation levels if the shielding failed. Identify potential chemical hazards in the area or area to response personnel.
7. Advise the emergency responders to approach the fire from the upwind side of the area if possible.

7.2.2 Supplementary Actions

Upon completion of initial response actions, take the following supplementary actions to support fire-fighting activities and to return to normal conditions when the fire is under control.

1. Collect air samples downwind from the release of material and in breathing zones of event responders;
2. Take water samples during the fire for assessment of off-site liquid releases;
3. If possible, collect firefighting runoff water in bermed areas or direct it to storm water retention ponds for later analysis and treatment;
4. Establish area boundaries and conduct contamination and radiation surveys to confirm that boundaries are properly located. Establish a step off pad for personnel exiting the area. Update radiological postings to reflect current conditions;
5. Monitor personnel evacuated from the area and near the area during the fire for contamination and decontaminate as necessary. Consider the need for bioassay to evaluate doses to individuals internally exposed;
6. Prepare to survey firefighting personnel and equipment as they exit the area and establish decontamination areas; and
7. Evaluate the incident and make regulatory notifications as required.

7.3 Reports

RCS shall report to the RSO immediately any incidents or emergencies defined by RCM Section 3.5.2, *Notifications of Incidents*. Additionally, the RCS will complete Form HSF 5-2, *Incident Report and Investigation*, which shall be provided to the RSO in accordance with the timeline established on the form. Other documentation required for the incident will be determined by the RSO.

8 RECORD KEEPING

Ameriphysics is required to maintain and retain records of the radiation protection program and to make certain notifications. The RSO is responsible for administering the program, and the RCS is responsible for maintaining radiation protection project records generated during the project. Records shall be maintained in accordance with Ameriphysics' Quality Assurance Manual Section 17. Radiological records are retained according to Table 5.

Table 5. Project Records Retention

Record	Retention Period
Characterization Records	7 years
Background Data	7 years
Calibration Records	Permanent
Instrument Setup Sheets	Permanent
Daily Instrument Checks	Permanent
Survey Logs	Permanent
Survey Raw Data	7 years
Surveys	Permanent
Field Log Books	Permanent
Chain of Custody Forms	Permanent
Laboratory Reports	Permanent
Radiation Work Permit Logs	Permanent
Radiation Work Permits	Permanent
Air Sample Logs	Permanent
Air Sample Results	Permanent
Dosimetry Records	Permanent
Exposure Reports	Permanent
Pathway Models	Permanent