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Sandia National Laboratories

Operated for the U.S. Department of Energy by
Sandia Corporation

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7 October 2007

Cellular Bioengineering, Inc.
Attn: Mike O'Neill
1946 Young Street, Suite 480
Honolulu, HI 96826

Dear Mike,

Included in this letter are the results from decontamination testing using Decon Gel 1101 on concrete, carbon steel, stainless steel, and Plexiglas coupons contaminated with Am-241, Pu-239 and Cs-137.

For your reference, I have included the approved Technical Work Document used for this experiment.

Radionuclide Solutions

The radionuclide solutions used to contaminate these coupons are NIST traceable. The Am-241 solution was prepared from $AmCl_3$ dissolved 1 N HCl. The Pu-239 solution was prepared from $Pu(NO_3)_4$ dissolved in 4 M HNO_3. The Cs-137 solution was prepared from CsCl dissolved in 0.1 M HCl. I have included all Certificates of Calibration for the stock solutions. For all solutions, a 1 µCi/mL dilution in deionized water was prepared from the stock solutions.

Coupon materials

This testing matrix utilized four types of coupons including concrete, carbon steel, stainless steel and Plexiglas. The concrete coupons were made from construction grade concrete cores. As concrete is poured, contractors are required to pour additional cores that are submitted for testing of the overall strength. We obtained these cores from a local testing company and had them uniformly sectioned for our testing.

The steel coupons were obtained from a local metal working company. The carbon steel was cut into coupons measuring 3" x 3" x 1/8". A 300-series stainless steel was also cut into coupons measuring 3" x 3" x ¼".

The Plexiglas was purchased from a local home improvement store and a single sheet was cut into 3" x 3" coupons.

The uniformity of the thicknesses for all materials was checked by the lab worker due to the importance in the alpha counting method.

Coupon Contamination

Coupons were contaminated using the radionuclide solutions described above. The coupons were placed on wire racks (a) which were placed in secondary containment in the fume hood. The solutions

were deposited on the surface using a pipettor. The carbon steel showed visible signs of corrosion (b). Duplicate samples were prepared for each material and radionuclide.

a) 

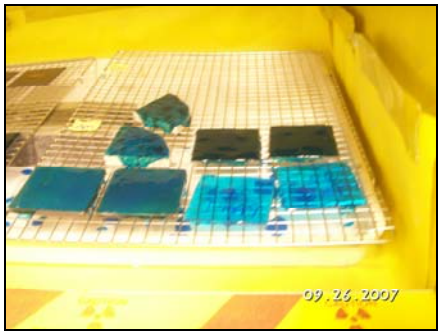
b) 

Coupon Coating Application and Removal

After initial counts were taken, the coupons were coated with the Decon 1101 Gel. The gel was poured from the bottle to the surface of the coupon. The gel was spread over the surface using a spatula and the excess gel was allowed to drip off (c).

Prior to the radiological testing, two tests were performed to determine optimum drying time both inside and outside of a fume hood. It was determined that 24 hours would be sufficient for the gel to dry completely without any residue sticking to the surface. The coupons in this test were allowed to dry for 24 hours before being stripped.

All of the coupons were easy to peel, with the most difficult being concrete. The coatings were all removed in a single sheet. None of the coatings fractured during removal. The Plexiglas coupons had a visible oily residue on the surface after the coating was removed. The carbon steel coupons no longer had visible corrosion on the surface.

(c) 

Analytical Method and Data Workup

The Cs-137 coupons were counted on a Canberra high purity germanium detector. Photographs of the detector (d) and sample holder (e) are shown below. Each coupon was counted for 1000 seconds (16.67 minutes) and the peak area was determined to calculate the activity of the sample. Cs-137 was counted using the 662 keV energy line. Calibration coupons were prepared to validate the data. The calibration coupons were 1 µCi, 0.5 µCi and 0.1 µCi.

d) 

e) 

The Am-241 and Pu-239 coupons were counted using a Ludlum 43-1 alpha scintillator (f) connected to an Eberline E600 programmed to take a 2 minute scalar count. A platform was manufactured to maintain consistent orientation and spacing for each coupon from the detector face. Calibration coupons were prepared for each type of coupon material with 1 µCi, 0.5 µCi and 0.1 µCi of Am-241 or Pu-239.

(f) 

Results

The results for the experimental matrix are listed below. The % decon was calculated using the equation below:

$$\%\ \text{decon} = \frac{\text{Initial Activity} - \text{Final Activity}}{\text{Initial Activity}} \times 100$$

Key: CCs = concrete, cesium; CSCs = carbon steel, cesium; SSCs = stainless steel, cesium; PCs = Plexiglas, cesium; Am = americium, Pu = plutonium, etc.

Results for Cs-137 samples as determined by gamma spectroscopy.

Sample #	Coupon Name	Initial Area	Initial Activity (uCi)	Final Area	Final Activity (uCi)	% decon	Avg. Error*
1	CCs-1	2.46E+04	1.0062	2.04E+04	0.83439	**17.07%**	0.67%
2	CCs-2	2.38E+04	0.9735	2.01E+04	0.82212	**15.55%**	0.68%
7	CSCs-1	2.44E+04	0.9980	2.38E+02	0.00973	**99.02%**	3.56%
8	CSCs-2	2.45E+04	1.0021	3.39E+02	0.01387	**98.62%**	3.05%
13	SSCs-1	2.44E+04	0.9980	9.48E+02	0.03877	**96.11%**	1.95%
14	SSCs-2	2.41E+04	0.9857	4.68E+02	0.01914	**98.06%**	2.65%
19	PCs-1	2.23E+04	0.9121	1.24E+02	0.00507	**99.44%**	4.91%

20	PCs-2	2.33E+04	0.9530	8.83E+01	0.00361	**99.62%**	5.78%

* Based on uncertainty measurements of net peak area by gamma spec software.

Results for Am-241 and Pu-239 as determined by alpha scintillation.

Sample #	Coupon Name	Initial Counts (k cpm)	Initial Activity (uCi)	Counts after Decon (k cpm)	Activity after Decon (uCi)	% decon
3	CAm-1	351	0.9799	60.4	0.1686	**82.79%**
4	CAm-2	318	0.8878	53.4	0.1491	**83.21%**
5	CPu-1	350	1.0052	61.3	0.1761	**82.49%**
6	CPu-2	314	0.9018	89.6	0.2573	**71.46%**
9	CSAm-1	333	0.9939	3.99	0.0119	**98.80%**
10	CSAm-2	318	0.9491	10.49	0.0313	**96.70%**
11	CSPu-1	288	0.9834	2.63	0.0090	**99.09%**
12	CSPu-2	286	0.9766	6.07	0.0207	**97.88%**
15	SSAm-1	351	0.9611	76.5	0.2095	**78.21%**
16	SSAm-2	346	0.9474	62.5	0.1711	**81.94%**
17	SSPu-1	326	1.0450	56.6	0.1814	**82.64%**
18	SSPu-2	305	0.9777	17.34	0.0556	**94.31%**
21	PAm-1	337	1.0021	3.59	0.0107	**98.93%**
22	PAm-2	307	0.9129	3.96	0.0118	**98.71%**
23	PPu-1	230	0.8585	107.9	0.4027	**53.09%**
24	PPu-2	242	0.9033	108.5	0.4050	**55.17%**

Please let me know if you have any questions or comments regarding this report. Also, please let me know by October, 15, 2007 if you would like any follow up tests (i.e. second coating, new materials, new radionuclides). If no additional tests are needed, I will proceed with disposing all of the testing materials.

Sincerely,

Kathleen C. Holt

Enclosed:

TWD-6772-2007-017 Technical Work Document
Certificates of Calibration for Cs-137, Am-241 and Pu-239

Sandia National Laboratories	TWD #:	TWD-6772-2007-017
	Issue No:	1
	Effective Date:	9/19/07
	Total Pages:	14

Testing for Radiological Decontamination Strippable Coating for Cellular Bioengineering, Inc. (Cs-137, Pu-239, Am-241)

Radiological Consequence Management & Emergency Response Department (Org. 6772)
PROCEDURE

Prepared By: _____
Kathleen Holt Date
Radiological Consequence Management & Emergency Response

Job Coordinator: _____
Kathleen Holt Date
Radiological Consequence Management & Emergency Response

Concurrence By: _____
Steve Farmer Date
Radiation Protection Line Support Project Leader

Approved By: _____
Kevin McMahon, Manager Date
Radiological Consequence Management & Emergency Response

1.0 – SCOPE & Purpose

Scope: Provide a brief description of the work to be performed under this TWD and identify the responsible department/program.

Purpose: This section should describe why you are performing the work.

This project will evaluate the efficiency of the CBI product, Decon Gel, for removing radionuclides from various material surfaces, including but not limited to, carbon steel, stainless steel, Plexiglas and concrete.

The work will be completed in 823/B59.

PHS #: SNL8A00204-015

Responsible Organization: 06772

Affected Organizations: None

Location: 823/B59

Start Date: ____ **End Date:** _____

RWP Required: YES , RWP# _____

Potentially affected personnel or operations notified? YES

2.0 – RESPONSIBILITIES

Call out specific responsibilities as required for performance of the work. General responsibilities can be stated as being the same as those specified in the appropriate chapter(s) of the RPPM or ES&H Manual. Ensure that the document clearly states who is responsible for what.

PI/Project Lead: Kathleen Holt, Org 6772
Job Coordinator: Kathleen Holt, Org 6772
Department Manager: Kevin McMahon, Org 6772
Members of the Workforce: Kathleen Holt, Org 6772; Brian Foskett, Org. 41281

The responsibilities outlined above correlate to the responsibilities identified in both the RPPM and the ES&H Manual.

3.0 – QUALIFICATIONS/TRAINING

List specific training requirements required for performance of the work. General requirements can be stated as being the same as those specified in the appropriate chapter(s) of the RPPM or ES&H Manual.

Training Requirements as identified by the PHS & SOP are listed below. All have been completed by the Radiological Lab Worker.

- ESH100 ES&H Awareness
- LAB100 Laboratory Standard Information and Training
- RAD230 Radiological Worker II Training

(Note: RAD230 satisfies the requirement for RAD210)

- ENV112 Chemical Waste Generator Training

  (Note: ENV112 is a prerequisite for ENV189)

- ENV189 Radioactive & Mixed Waste Generator Training
- ENV252 Radioactive & Mixed Waste Generator Refresher Training
- GL-SST General Laboratory Site Specific Training
- RW-SST Radiological Worker Site Specific Training
- PKX100 Packaging and Transportation of Hazardous Materials

  (Note: PKX100 required only by those members of the workforce transporting samples or hazardous materials.)

4.0 – RADIOLOGICAL HAZARD IDENTIFICATION

Identify radiological hazards present in the work area to which Members of the Workforce may be exposed during routine activities or foreseeable emergencies (e.g., RGDs, sources, waste material).

This discussion should include:

- Radionuclide (activity and form), type of RGD, etc.
- Current radiological conditions.
- Expected radiological conditions.
- Specific neutron characteristics (including TLD Neutron Code), if neutrons are an expected hazard.

Identify those conditions that may be caused by conduct of the work that will cause work to stop or pause for evaluation here.

Identify potential impacts on other personnel or operations not involved in the radiological work

The primary hazard for this work is the potential for contamination from working with liquid radioactive material. If contamination is found or suspected, work will be paused for evaluation by an RCT.

If contamination is identified outside of the Contamination Area above RPPM Ch. 6 App. 6-1 levels, pause work, have Radiation Protection evaluate the extent of contamination, decontaminate as per RCT direction, and post area accordingly.

Stock radionuclide solutions: Cs 137= 100.4 µCi (consumable), Pu239 = 1.004 mCi (consumable) and Am241=100.4 µCi (consumable)

Contamination solutions: Cs 137= 10 µCi (10 ml), Pu239= 13.1 µCi (15 ml) and Am241=15.5 µCi (15 ml)

Current radiological conditions: Dose rates 1.2mR/hr contact, 0.01mR/hr general area.

Contamination level: <1000 dpm 100cm^2 Beta and <20 dpm 100cm^2 Alpha

Expected radiological conditions: Dose rates 36 mR/hr on contact, 3 mR/hr at 30cm, 0.01 mR/hr general area

Expected contamination levels: 300 dpm/100cm^2 Beta. 400 dpm/100cm^2 Alpha.

5.0 – HAZARD CONTROLS

Identify hazards present in the work area to which Members of the Workforce may be exposed during routine activities or foreseeable emergencies.

Engineering Controls: Fume hood, spill tray.

Administrative Controls: TWD, and laboratory SOP471436 Issue J.

- **Hold Points:** None

Job Reviews: Types and frequencies:

- Pre-Job Brief prior to individuals working under this TWD.
- Post-Job Review by (at least) the job coordinator and RP Representative.

PPE: Goggles, Tyvek disposable lab coat, 2 pairs surgical gloves (1st pair taped at cuff), disposable booties.

Additional PPE may be required based on RCT recommendation.

When handling Radioactive Material outside the Contamination Area the user should wear disposable gloves.

Alarming Equipment (or other special equipment): None

Type of Dosimetry Required: Whole Body TLD

RCT Coverage: CONTINUOUS

ALARA Review Required: NO

Required Interfaces: None

Required RCT Surveys: Job Coverage, Release

Radiological Posting: Contamination Area/Radioactive Materials/Controlled Area

Frisking Requirements: Whole body frisk required when exiting Contamination Area. Only hand and foot frisk required if Radiological Buffer Area was entered.

6.0 – EQUIPMENT AND MATERIALS

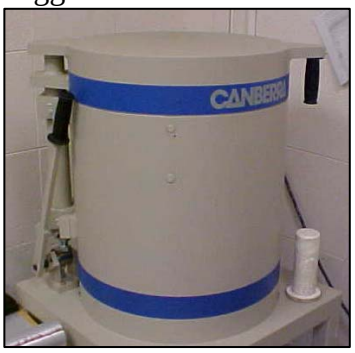
List all equipment and materials needed to complete the job.

Job-site setup

This section should include job-site information. This could include herculite placement, waste drums, pre-job meetings, notification of potentially affected individuals, etc.

Required Tools and Equipment: Gamma spectroscopy system, Alpha Scintillator

The Gamma spectroscopy system (pictured below) is located in a room adjacent to the contamination area. For sample counting by gamma spectroscopy, the samples will be double bagged and counted for 30 minutes.



The Alpha Scintillator (pictured below) will be connected to a survey meter (E600) and will be located in the fume hood for counting alpha emitting samples. The meter will have a plastic bag taped around the exterior (except for detector area) to avoid contamination. There will be a special sample holder that will be manufactured to keep the detector approximately ¼" from the surface of the coupon while counting the sample.

7.0 – PROCEDURE

This should be a step by step account of how to perform the work. This should include descriptions of safety checks, survey requirements, maintenance processes and other related information.

Note: Hold points which require an action by an RCT require a space for the RCT to initial and date to confirm that the survey was performed. In cases where it is impractical to initial directly on the TWD, an attachment page shall be provided for each required survey specifying which step is being completed.

Pictures should be used when possible to make the TWD as visual as possible. Such as, do step A in a fume hood, then remove from fume hood and do step B.

Overview

This work will involve pipetting a solution containing approximately 1 µCi of Cs-137, Am-241 or Pu-239 onto the surface of carbon steel, stainless steel, Plexiglas and concrete coupons. The coupons will be counted for their initial activity by gamma spectroscopy and alpha scintillation in 823/B59. Then, a strippable coating will be applied, allowed to dry, and then removed. The decontaminated coupon will then be recounted and a percent decontamination will be calculated. This TWD will also allow for a second application of the gel for decontamination efficiency.

Testing Matrix

The CBI gel will be tested on the following coupons. This matrix includes duplicates for each sample. With the concurrence of Radiation Protection, this matrix can be expanded to include additional samples if necessary.

Sample #	Coupon Name	Material	Radionuclide	Activity
1	CCs-1	Concrete	Cs-137	1 µCi
2	CCs-2	Concrete	Cs-137	1 µCi
3	CAm-1	Concrete	Am-241	1 µCi
4	CAm-2	Concrete	Am-241	1 µCi
5	CPu-1	Concrete	Pu-239	1 µCi
6	CPu-2	Concrete	Pu-239	1 µCi
7	CSCs-1	Carbon Steel	Cs-137	1 µCi
8	CSCs-2	Carbon Steel	Cs-137	1 µCi
9	CSAm-1	Carbon Steel	Am-241	1 µCi
10	CSAm-2	Carbon Steel	Am-241	1 µCi
11	CSPu-1	Carbon Steel	Pu-239	1 µCi
12	CSPu-2	Carbon Steel	Pu-239	1 µCi
13	SSCs-1	Stainless Steel	Cs-137	1 µCi
14	SSCs-2	Stainless Steel	Cs-137	1 µCi
15	SSAm-1	Stainless Steel	Am-241	1 µCi
16	SSAm-2	Stainless Steel	Am-241	1 µCi
17	SSPu-1	Stainless Steel	Pu-239	1 µCi
18	SSPu-2	Stainless Steel	Pu-239	1 µCi

19	PCs-1	Plexiglas	Cs-137	1 µCi
20	PCs-2	Plexiglas	Cs-137	1 µCi
21	PAm-1	Plexiglas	Am-241	1 µCi
22	PAm-2	Plexiglas	Am-241	1 µCi
23	PPu-1	Plexiglas	Pu-239	1 µCi
24	PPu-2	Plexiglas	Pu-239	1 µCi

Coupon Contamination Process

1. Read, understand & sign TWD.
2. Conduct Pre-job brief.
3. Verify that the frisker is on and ready for use.
4. Verify routine dosimetry (TLD).
5. Place in the buffer area: Towels, calibrated pipette, pipette tips, coupons, Cs-137, Pu-239 and Am-241 stock solutions.
6. Don appropriate PPE identified above.
7. Place towels in the containment tray where work will be performed.
8. Prepare the radionuclide solutions for contaminating the coupons as follows:
    a. Cs-137: Using RS#1940 (100.4 µCi in 5 mL), take 0.5 mL stock and add to 9.5 mL H_2O
    b. Am-241: Using RS#1734 (100.4 µCi in 5 mL), take 0.77 mL stock and add to 14.23 mL H_2O
    c. Pu-239: Using RS#1056 (1.004 mCi in 5 mL), take 65.2 µL stock and add 14.9 mL H_2O.
9. Place the labeled coupons on a wire rack inside the containment tray that has towels below.
10. Using the pipette, carefully transfer 1.0 mL of Cs-137, Pu-239 or Am-241 radionuclide solutions on the appropriately labeled coupon.
11. Dispose of the pipette tip in the radioactive waste container.
12. Close the solution vials.
13. Allow the coupons to dry in the fume hood for at least 2 hours.
14. Take initial activity counts.
    a. For the Cs-137 samples (gamma spectroscopy), double bag the coupons and have them swiped by the RCT to be removed from the Contamination Area. Proceed using the "Coupon Gamma Counting Process" listed below.
    b. For the Am-241 and Pu-239 samples, use the alpha scintillator counter that is set up in the fume hood. Lift the scintillator from the sample holder and place the coupon in the designated space. Place the scintillator detector above the sample in the sample holder. Start the counts using the E600 meter, count for 2 minutes. Record the information. Place the coupon back on the wire rack in the fume hood.
15. Decon the area and any items to be removed from the Contamination Area using RadCon foam and towels.
16. Dispose of any waste into the radioactive waste container.
17. When complete, ask the RCT to survey items for removal from the Contamination Area.
18. Doff PPE
19. Perform the appropriate frisking procedure according to posted instructions.

Coupon Gamma Counting Process (Pre- & Post-decontamination)

1. Ensure the double-bagged coupons have been surveyed and approval to move them from the Contamination Area to the counting room within 823/B59 has been given by the RCT.
2. Read, understand & sign TWD if not already completed.
3. Ensure that you have attended the Pre-job brief.
4. Verify routine dosimetry (TLD)
5. Verify frisker is on and ready for use.
6. Don appropriate PPE for activity.
7. Enter Contamination Area and load double bagged coupons into container on cart within the Buffer Zone or hand to worker within the Buffer Zone to load into container on cart outside the Buffer Zone.
8. Doff PPE
9. Perform the appropriate frisking procedure according to posted instructions.
10. It is a best practice to make sure the coupons while being stored have the contaminated side face down to reduce exposure.
11. Be sure to store the coupons as far away from the detector as possible to reduce the background.
12. Place each coupon (while still bagged), one-by-one in the gamma spectrometer for analysis using the Plexiglas holder. It is a good practice to wear disposable gloves when handling the coupons,
13. Each coupon will be counted for approximately 30 minutes.
14. After each coupon is counted, place back in the container for movement back to the fume hood.
15. For the post-decontamination counting, the coupons will now be disposed of in a radioactive waste container.

Coating Application & Removal Process

1. Read, understand & sign TWD
2. Verify that the frisker is on and ready for use.
3. Ensure that you have attended the Pre-job brief.
4. Verify routine dosimetry (TLD).
5. Place in the buffer area: Strippable coating poured into secondary container, spreader (i.e. brush, disposable transfer pipette), double bagged coupons, tweezers and towels.
6. Don appropriate PPE identified above.
7. Place towels in the containment tray where work will be performed.
8. Open the double bags within the fume hood and slide each coupon contaminated side up on to the wire rack in the towel-covered containment tray.
9. Pour enough coating on to each coupon to cover. Be sure it is thick enough to ensure easy removal.
10. If necessary, use a spreader to uniformly distribute the coating taking care not to cross-contaminate samples.
11. Allow the samples to dry overnight.
12. To remove the coating, simply use tweezers to grab a corner of the coating and remove.
13. Dispose of the coating as waste into the radioactive waste container.
14. Once all of the coatings have been removed, follow the counting procedures identified above for either gamma spectroscopy or alpha scintillation.

15. Decon the area and any items to be removed from the Contamination Area using RadCon foam and towels.
16. Dispose of any remaining waste into the radioactive waste container.
17. When complete, ask the RCT to survey items for removal from the Contamination Area.
18. Doff PPE
19. Perform the appropriate frisking procedure according to posted instructions.

Results

Results will be documented in a spreadsheet similar to the following. Results will be communicated to the customer in report format.

Sample #	Coupon Name	Initial Activity	Activity after Decon	% decon
1	CCs-1			
2	CCs-2			
3	CAm-1			
4	CAm-2			
5	CPu-1			
6	CPu-2			
7	CSCs-1			
8	CSCs-2			
9	CSAm-1			
10	CSAm-2			
11	CSPu-1			
12	CSPu-2			
13	SSCs-1			
14	SSCs-2			
15	SSAm-1			
16	SSAm-2			
17	SSPu-1			
18	SSPu-2			
19	PCs-1			
20	PCs-2			
21	PAm-1			
22	PAm-2			
23	PPu-1			
24	PPu-2			

Change in Conditions

If there is a substantive change in process, hazards or radiological conditions at any time throughout this project, you must pause work and consult with the RCT and Job Coordinator immediately. If there is a suspected loss of control of radioactive material or radioactive contamination is suspected, pause work and consult with an RCT and Job Coordinator immediately.

8.0 – POST-JOB

This section should include remediation steps to return the area to normal. What to do with generated wastes, how to down post the area, what surveys need to be performed, etc.

When work is completed, the work area will be surveyed and down posted (if possible or necessary) to a Radioactive Materials/Controlled Area. All equipment used in the area during the work will have a Release Survey performed if appropriate or discard as waste.

Conduct Post-job briefing at a minimum with the Job-Coordinator and a representative from RP.

Waste Management:

During this process, concrete, carbon steel, stainless steel and Plexiglas coupons, contaminated coating debris, pipette tips, PPE, and decon waste will be generated. This waste will be disposed of in radioactive waste containers or bags. No liquid waste will be generated from this work. No mixed waste will be generated from this work. I have received confirmation from Mike O'Neill at Cellular Bioengineering that the formulation contains less than 1% chelating agents.

Waste will be disposed of as per the ES&H Manual Chapter 19.

9.0 – RECORDS

List records associated with this work and where the record needs to be retained. This would include radiological surveys, RWP, logs, etc.

SF 2001-RPW, Radiological Planning Worksheet
SF 2001-SSA, Technical Work Document Sign-In Sheet
SF 2001-AJR, ALARA Post-Job Review Form
RP Surveys of Record

10.0 – REFERENCES/ATTACHMENTS

List reference documents. Include equipment operating manuals, business procedures, and general operating procedures for the org/center. Don't forget to also list the PHS and RWP as references.

List attached documents. These could be drawings, user lists, survey performance records, etc.

Research in the Sandia Tomography and Radionuclide Transport (START) Laboratory: SOP 471436, Issue J
Radiological Protection Procedures Manual: MN471016, Issue AZ
ES&H Manual: MN471001, Issue HC

11.0 – EMERGENCY RESPONSE

In the event of a small spill (less than 1 L) members of the workforce will clean-up the spill using appropriate materials as directed by RCT. RCT will then conduct a survey to evaluate the area and re-post as necessary.

Large Spill (greater than 1 L) or injury: stop work and place in a safe configuration; notify RCT, call 911 and Managers of Organizations and RP Project Lead.

If Decon Gel 1101 gets on skin, in eyes, is inhaled, or ingested, consult attached MSDS for first aid.

By reading and signing this document, I agree to comply with the above work description and process requirements, and that I have attended a Pre-Job Brief. I certify that I am in compliance with all training requirements stated by the current issue of the Standard Operation Procedure SP471436.

Lab Worker	Date
Lab Worker	Date
Lab Worker	Date
Lab Worker	Date
Lab Worker	Date
Lab Worker	Date

Isotope Products Laboratories
An Eckert & Ziegler Company

24937 Avenue Tibbitts
Valencia, California 91355

Tel 661•309•1010
Fax 661•257•8303

CERTIFICATE OF CALIBRATION
GAMMA STANDARD SOLUTION

Radionuclide:	Cs-137	**Customer:**	SANDIA NATIONAL LABS
Half-life:	30.17 ± 0.16 years	**P.O. No.:**	489814
Catalog No.:	7137	**Reference Date:**	1-Oct-05 12:00 PST
Source No.:	1133-31	**Contained Radioactivity:**	100.4 µCi 3715 kBq

Physical Description:

A. Mass of solution:	5.00449 g in 5 mL V-Vial
B. Chemical form:	CsCl in 0.1M HCl
C. Carrier content:	10 µg Cs/mL of solution
D. Density:	0.9996 g/mL @ 20°C

Radioimpurities:

None detected

Radionuclide Concentration: 20.06 µCi/g, 742.2 kBq/g

Method of Calibration:

This source was prepared from a weighed aliquot of solution whose activity in µCi/g was determined using gamma ray spectrometry.

Peak energy used for integration:	661.7 keV
Branching ratio used:	0.851 gammas per decay

Uncertainty of Measurement:

A. Type A (random) uncertainty:	± 0.2 %
B. Type B (systematic) uncertainty:	± 3.0 %
C. Uncertainty in aliquot weighing:	± 0.0 %
D. Total uncertainty at the 99% confidence level:	± 3.0 %

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (as in NRC Regulatory Guide 4.15).
- Nuclear data was taken from IAEA-TECDOC-619, 1991.
- This solution has a working life of 5 years.

RS# 1940

J Mulford — Quality Control

6 Sep 05 — Date

IPL Ref. No.: 1133-31

CERTIFICATE OF CALIBRATION
ALPHA STANDARD SOLUTION

Radionuclide:	Am-241	Customer:	SANDIA NATIONAL LABS.	
Half Life:	432.7 ± 0.5 years	P.O.No.:	AI-3657	
Catalog No.:	7241	Reference Date:	January 1 1994	12:00 PST.
Source No.:	445-87-2	Contained Radioactivity:	100.4	μCi
		Contained Radioactivity:	3,720	kBq.

Description of Solution

a. Mass of solution:	5.2324 g (in a 5 ml Flame Sealed Ampoule)	
b. Chemical form:	AmCl3 in 1 N HCl	
c. Carrier content:	None added	
d. Density:	1.0171	g/ml @ 20°C.

Radioimpurities: None detected

Radioactive Daughters: None

Radionuclide Concentration: 19.19 μCi/g.

Method of Calibration

Weighed aliquots of the solution were assayed using a liquid scintillation counter.

Uncertainty of Measurement

a. Systematic uncertainty in instrument calibration:	±2.1%
b. Random uncertainty in assay:	±1.7%
c. Random uncertainty in weighing(s):	±0.0%
d. Total uncertainty at the 99% confidence level:	±2.7%

NIST Traceability

This calibration is implicitly traceable to the National Institute of Standards and Technology.

Leak Test(s)

See reverse side for Leak Test(s) applied to this source.

Notes

1. Nuclear data were taken from "Table of Radioactive Isotopes", edited by Virginia S. Shirley, 1986.
2. IPL participates in an NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (As in NRC Regulatory Guide 4.15).

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QUALITY CONTROL

Dec. 27, 1993
Date Signed

RS # 1734

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CERTIFICATE OF CALIBRATION
ALPHA STANDARD SOLUTION

Radionuclide:	Pu-239	**Customer:**	SANDIA NATIONAL LABS
Half-life:	(2.411 ± 0.003)E+04 years	**P.O. No.:**	172312/R2533
Catalog No.:	7239	**Reference Date:**	1-Jan-04 12:00 PST
Source No.:	1026-66	**Contained Radioactivity: (Pu-239 only)**	1.004 **mCi** 37.15 **MBq**

Physical Description:

A. Mass of solution:	5.65438 g in 5 mL V-Vial
B. Chemical form:	$Pu(NO_3)_4$ in 4M HNO_3
C. Carrier content:	None
D. Density:	1.1296 g/mL @ 20°C.

Radioimpurities:

See Technical Data Sheet

Radionuclide Concentration: 0.1776 mCi/g, 6.571 MBq/g

Method of Calibration:

This source was prepared from a weighed aliquot of solution whose activity in µCi/g was determined using a liquid scintillation counter.

Uncertainty of Measurement:

A. Type A (random) uncertainty:	± 1.0 %
B. Type B (systematic) uncertainty:	± 3.0 %
C. Uncertainty in aliquot weighing:	± 0.0 %
D. Total uncertainty at the 99% confidence level:	± 3.2 %

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (As in NRC Regulatory Guide 4.15).
- Nuclear data was taken from "Table of Radioactive Isotopes", edited by Virginia Shirley, 1986.
- This solution has a working life of 5 years.

RS# 1056

Daniel James Van Dalsem — **Quality Control**

4-Dec-03 — **Date Signed**

IPL Ref. No.: 1026-66