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Technology Evaluation Report

CBI Polymers DeconGel® 1108 for Radiological Decontamination of Americium

Office of Research and Development
National Homeland Security Research Center

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National Homeland Security Research Center
Office of Research and Development
U.S. Environmental Protection Agency
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Cincinnati, OH 45268

DISCLAIMER

The U.S. Environmental Protection Agency (EPA), through its Office of Research and Development's National Homeland Security Research Center (NHSRC), funded and managed this technology evaluation partially through Chemical, Biological, Radiological Nuclear Defense Information analysis Center (CBRNIAC) Technical Area Task #794 (contract number SP0700-00-D-3180) and partially through contract No. EP-C-10-001 with Battelle. This report has been peer and administratively reviewed and has been approved for publication as an EPA document. Mention of trade names or commercial products does not constitute endorsement or recommendation for use of a specific product.

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FOREWORD

The U.S. Environmental Protection Agency (EPA) holds responsibilities associated with homeland security events: EPA is the primary federal agency responsible for decontamination following a chemical, biological, and/or radiological (CBR) attack. The EPA's Homeland Security Research Program (HSRP) was established to conduct research and deliver scientific products that improve the capability of the Agency to carry out these responsibilities.

An important goal of the HSRP's research is to develop and deliver information on decontamination methods and technologies to clean up CBR contamination. When supporting or directing such a recovery operation, EPA and other stakeholders must identify and implement decontamination technologies that are appropriate for the given situation. The EPA's National Homeland Security Research Center (NHSRC) has created the Technology Testing and Evaluation Program (TTEP) in an effort to provide reliable information regarding the performance of homeland security-related technologies. Through TTEP, the HSRP provides independent quality assured performance information that is useful to decision makers in purchasing or applying the tested technologies. Potential users are provided with unbiased, third-party information that can supplement vendor-provided information. Stakeholder involvement ensures that user needs and perspectives are incorporated into the test design so that useful performance information is produced for each of the tested technologies. The technology categories of interest include detection and monitoring, water treatment, air purification, decontamination, and computer modeling tools for use by those responsible for protecting buildings, drinking water supplies and infrastructure, and for decontaminating structures and the outdoor environment.

The NHSRC is pleased to make this publication available to assist the response community to prepare for and recover from disasters involving CBR contamination. This research is intended to move EPA one step closer to achieving its homeland security goals and its overall mission of protecting human health and the environment while providing sustainable solutions to our environmental problems.

Jonathan G. Herrmann
National Program Director
Homeland Security Research Program

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Abbreviations/Acronyms

Am	americium
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
Bq	Becquerel(s)
CBR	chemical, biological, and/or radiological
cm	centimeter(s)
DARPA	Defense Advanced Research Projects Agency
DF	decontamination factor
DG	CBI Polymers DeconGel®
DHS	U.S. Department of Homeland Security
EPA	U.S. Environmental Protection Agency
Eu	europium
g	gram(s)
IEEE	Institute of Electrical and Electronics Engineers
INL	Idaho National Laboratory
keV	kilo electron volt(s)
L	liter(s)
m	meter(s)
mL	milliliter(s)
mm	millimeter(s)
nCi	nanoCuries(s)
NHSRC	National Homeland Security Research Center
%R	percent removal
PE	performance evaluation
PPE	personal protective equipment
QA	quality assurance
QC	quality control
QMP	quality management plan
RML	Radiological Measurement Laboratory
RSD	relative standard deviation
RDD	radiological dispersal device
RH	relative humidity
TSA	technical systems audit
TTEP	Technology Testing and Evaluation Program
Th	thorium

Executive Summary

The U.S. Environmental Protection Agency's (EPA's) Homeland Security Research Program (HSRP) is helping to protect human health and the environment from adverse impacts resulting from acts of terror by carrying out performance tests on homeland security technologies. Through its Technology Testing and Evaluation Program (TTEP), the National Homeland Security Research Center (NHSRC) evaluated the performance of the CBI Polymers (Honolulu, HI) DeconGel® (DG) 1108. The objective of evaluating DG 1108 was to test its ability to remove radioactive americium (Am)-243 from the surface of unpainted concrete.

DG 1108 is designed to be applied as a gel coating to bind the Am-243 physically and chemically so that the Am-243 along with the cured coating can be removed from the surface causing little or no surface damage. Prior to the evaluation of DG 1108, 15 centimeters (cm) × 15 cm unpainted concrete coupons were contaminated with Am-243 at an activity level of approximately 50 nanoCuries (nCi), measured by gamma spectroscopy. The contaminated coupons were then placed in a vertical test stand and, following manufacturer's recommendations, two coats of DG 1108 were applied to all of the coupons in the test stand. The coupons in the test stand were then allowed to dry overnight. The coating was then peeled from the coupons and collected for disposal. This procedure was performed twice and then the residual activity on the contaminated coupons was measured to determine the decontamination efficacy achieved. This report documents the decontamination efficacy achieved along with important deployment and operational factors determined based on the laboratory experience and material properties. A summary of the evaluation results for DG 1108 is presented below. Discussion of the observed performance can be found in Section 5 of this report.

Decontamination Efficacy: The decontamination efficacy (in terms of percent removal, %R) attained by DG 1108 was evaluated following the contamination of the coupons with approximately 50 nCi Am-243. These coupons were placed on a test stand to create a vertical concrete surface to which DG 1108 was applied and removed. Overall, DG 1108 decontaminated the concrete coupons with an average %R of 84% ± 5.7%. A limited evaluation of cross contamination was performed, and the results confirmed that slight cross contamination did occur.

Deployment and Operational Factors: DG 1108 is supplied "ready for use" as a coating with a gel consistency somewhat more viscous than wall paint. DG 1108 was applied to the surfaces with a standard 10 cm wide paint brush following the manufacturer's recommendation. The concrete coupons used during this evaluation totaled 0.16 square meters (m^2) and each application (two coats) required three minutes for application of each coat separated by a two hour drying time between coats. The DG 1108 was applied to a thickness sufficient to cover the surface by visual inspection, but not so thick that the coating ran down the wall. Following the two coat application, the DG 1108 was allowed to dry overnight and was then removed by pulling the coating from the surface by hand (technician was in anti-contamination personal protective equipment [PPE]). This two-coat application followed by removal was performed twice. The combined time required to remove both applications of the coating was 17 minutes,

which translates to approximately 0.56 m^2 per hour. The amount of waste generated (removed coating) was 37 grams, or approximately 232 grams (g)/m^2 for each two coat application. In most cases, the DG 1108 was removed in a single piece from each coupon, but usually not across the gaps between coupons (a distance of approximately 0.3-0.7 cm) that created an irregular surface. The surface finish of the concrete was affected very little by the application and removal of the DG 1108, as only very small pieces (~ 1 millimeter (mm) in length) of surface concrete residue were visibly removed.

1.0 Introduction

The U.S. Environmental Protection Agency's (EPA's) Homeland Security Research Program (HSRP) is helping to protect human health and the environment from adverse effects resulting from intentional acts of terror. With an emphasis on decontamination and consequence management, water infrastructure protection, and threat and consequence assessment, HSRP is working to develop tools and information that will help detect the intentional introduction of chemical, biological, or radiological contaminants into buildings or water systems, the containment of these contaminants, the decontamination of buildings and/or water systems, and the disposal of material resulting from cleanups.

The National Homeland Security Research Center (NHSRC), through its Technology Testing and Evaluation Program (TTEP), works in partnership with recognized testing organizations; with stakeholder groups consisting of buyers, vendor organizations, and permitters; and with the participation of individual technology developers in carrying out performance tests on homeland security technologies. The program evaluates the performance of innovative homeland security technologies by developing evaluation plans that are responsive to the needs of stakeholders, conducting tests, collecting and analyzing data, and preparing peer-reviewed reports. All evaluations are conducted in accordance with rigorous quality assurance (QA) protocols to ensure that data of known and high quality are generated and that results are defensible. High-quality information is provided that is useful to decision makers in purchasing or applying the evaluated technologies. Potential users are provided with unbiased third-party information that can supplement vendor-provided information. Stakeholder involvement ensures that user needs and perspectives are incorporated into the evaluation design so that useful performance information is produced for each of the evaluated technologies.

The performance of the CBI Polymers DeconGel® 1108 strippable coating (DG 1108) for decontamination of radioactive americium-243 (Am-243) from unpainted concrete was recently evaluated. Americium was selected as a radiological contaminant because of its availability for possible use in a radiological dispersal device (RDD) as the result of its common application in smoke detectors. Concrete was selected as a surface because of its prevalence as a building material. This evaluation was conducted according to a peer-reviewed test/QA plan entitled, "The Performance of Strippable Coatings for Decontamination of Americium from Urban Substrates", Version 1.0, dated November 21, 2011, that was developed according to the requirements of the TTEP Quality Management Plan (QMP) Version 3, January 2008 (both are available upon request. The following performance characteristics of DG 1108 were evaluated:

- Decontamination efficacy defined as the extent of radionuclide removal following two cycles of application and removal of DG 1108. Another quantitative parameter evaluated was the potential for cross contamination of adjacent uncontaminated surfaces due to the decontamination procedure.
- Deployment and operational characteristics including rate of surface area decontamination, applicability to irregular surfaces, skilled labor requirements, utilities

requirements, extent of portability, shelf life of media, secondary waste management including the estimated amount and characteristics of the spent media, and cost.

This evaluation took place in December 2011 at the U.S. Department of Energy's Idaho National Laboratory (INL). This report describes the quantitative results and qualitative observations gathered during this evaluation of DG 1108.

2.0 Technology Description

This technology evaluation report provides results on the performance of DG 1108 under laboratory conditions. The following is a description of DG 1108, based on unverified information provided by CBI Polymers.

DG 1108 is a strippable coating designed for safely removing radioactive contamination from surfaces or as a covering to contain contamination. DG 1108 is sold as a paint-like formulation and application options include use of a paint brush, roller, or sprayer. The water-based wet coating (hydrogel) can be applied to horizontal, vertical or inverted surfaces and can be applied to most surfaces including bare, coated and painted concrete, aluminum, steel, lead, rubber, plexiglas, herculite, wood, porcelain, tile grout, and vinyl, ceramic and linoleum floor tiles. For non-horizontal surfaces, the suggested number of coats is one or two coats for nonporous and semiporous materials and up to four coats for porous surfaces such as concrete or wood, with about two hours drying time between coats to ensure a final coating thickness sufficient to allow the coating to be peeled. Following application, the coating requires approximately 12 hours to cure prior to removal. When dry, the product binds the contaminants into a polymer matrix. The dried coating containing the encapsulated contamination can then be peeled off the surface and disposed. More information is available at www.decongel.com [accessed 9/18/12].

Figure 2-1. DeconGel 1108.

3.0 Experimental Details

3.1 Experimental Preparation

3.1.1 Concrete Coupons

The concrete coupons were prepared in a single batch of concrete made from Type II Portland cement. The ready-mix company that supplied the concrete for this evaluation provided the data shown in Table 3-1 about the cement clinker used in the concrete mix. The American Society for Testing and Materials (ASTM) C150[1] requirement for Type II Portland cement is that the tricalcium aluminate is less than 8% of the overall cement clinker. As shown in Table 3-1 the cement clinker used for the concrete coupons was 4.5% tricalcium aluminate. Because the only difference between Type I and II Portland cements is the maximum allowable tricalcium aluminate content, and the maximum for Type I is 15%, the cement used during this evaluation meets the specifications for both Type I and II Portland cements.

Table 3-1. Concrete Characterization

Cement Constituent	Percent of Mixture
Tricalcium Silicate	57.6
Dicalcium Silicate	21.1
Tricalcium Aluminate	4.5
Tetracalcium Aluminoferrite	8.7
Minor constituents	8.1

The wet concrete was poured into 0.9 m square plywood forms (approximately 4 cm deep) with the surface exposed The surface was “floated” to allow the smaller aggregate and cement paste to float to the top (the surface used for this evaluation), and the concrete was then cured for 21 days. Following curing, the 4 cm thick squares were cut with a laser guided rock saw to the desired concrete coupon size of approximately 15 cm ×15 cm. The coupons had a surface finish that was consistent across all the coupons. This concrete was judged to be representative of exterior concrete commonly found in urban environments in the United States as shown by INL under a previous U.S. Department of Defense, Defense Advanced Research Projects Agency (DARPA) and U.S. Department of Homeland Security (DHS) project[2].

3.1.2 Coupon Contamination

Six contaminated coupons were spiked with 2.5 milliliters (mL) of unbuffered, slightly acidic aqueous solution containing 20 nCi/mL Am-243 which corresponds to an activity level of approximately 50 ± 5 nCi per coupon. Application of the Am-243 in an aqueous solution was justified because even if Am-243 were dispersed in a dry particle form following an RDD event, morning dew or rainfall would likely occur before the surfaces could be decontaminated. Such an event would increase the likelihood that the Am-243 would no longer be bound to the particles and that a chemical decontamination technology for decontaminating the concrete surface would be preferable. In addition, from an experimental standpoint, the ability to apply liquids homogeneously across the surface of the concrete coupons greatly exceeds that capability for dry particles. The liquid spike was delivered to each coupon using an aerosolization technique developed by INL under the DARPA/DHS project[2] and described in detail in the test/QA plan. Coupons were contaminated approximately two weeks before use and were stored in a steel drum used for transport to the INL Radiological Measurement Laboratory (RML). Storage conditions were not monitored during this time period, but aside from the vehicle transport (a few hours) the drum remained unopened and located in working laboratories.

The aerosol delivery device was constructed of two syringes. The plunger and needle were removed from the first syringe and discarded. Then a compressed air line was attached to the rear of the syringe. The second syringe contained the contaminant solution and was equipped with a 27 gauge needle, which penetrated through the plastic housing near the tip of the first syringe. Compressed air flowing at a rate of approximately 1 - 2 liters (L) per minute created a turbulent flow through the first syringe. When the contaminant solution in the second syringe was introduced, the contaminant solution became nebulized by the turbulent air flow. A fine aerosol was ejected from the tip of the first syringe, creating a controlled and uniform spray of fine liquid droplets onto the coupon surface. The contaminant spray was applied all the way to the edges of the coupon, which were taped (after having previously been sealed with polyester resin) to ensure that the contaminant was applied only to the working surfaces of the coupons. The photographs in Figure 3-1 show this procedure being performed using a nonradioactive, nonhazardous aqueous dye to demonstrate that 2.5 mL of contaminant solution is effectively distributed across the surface of the coupon.

Figure 3-1. Demonstration of contaminant application technique.

3.1.3 Measurement of Activity on Coupon Surface

Gamma radiation from the surface of each contaminated concrete coupon was measured to quantify contamination levels both before and after use of DG 1108 on the coupons. These measurements were made using an intrinsic high purity germanium detector (Canberra LEGe Model GL 2825R/S, Meriden, CT). After being placed in the detector, each coupon was measured until the average activity level of Am-243 from the surface stabilized to a relative standard deviation (RSD) of less than 2%. Gamma-ray spectra acquired from Am-243 contaminated coupons were analyzed using the INL RML data acquisition and spectral analysis programs. Radionuclide activities on coupons were calculated based on efficiency, emission probability, and half-life values. Decay corrections were made based on the date and the duration of the counting period. Full RML gamma counting QA/quality control (QC), as described in the test/QA plan, was employed and certified results were provided.

3.1.4 Surface Construction Using Test Stand

To evaluate DG 1108 on vertical surfaces only (simulating walls), a stainless steel test stand that held three rows of concrete coupons was used. The test stand was erected within a radiological hood. As shown in Figure 3-2, three rows of two contaminated concrete coupons were placed on the left side of the test stand and the uncontaminated coupon was placed on the right side of the bottom row and treated with DG 1108 in the same way as the other coupons. This coupon, referred to as the cross contamination blank, was used to observe possible cross contamination caused by use of DG 1108 on contaminated surfaces adjacent to uncontaminated surfaces.

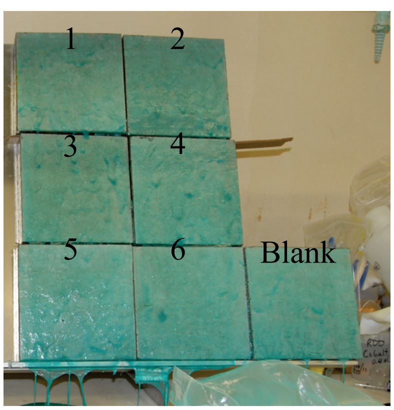

Figure 3-2. Test stand with concrete coupons.

3.2 Evaluation of DG 1108

The seven concrete coupons in the test stand (six contaminated and one blank) were decontaminated using DG 1108. The application of DG 1108 was performed using a standard 10 cm paint brush. The specifications of the paint brush were not critical as a perfectly smooth application was not required. The paint brush was loaded by dipping the brush into a plastic bag containing the wet DG 1108 and then the wet DG 1108 was applied generously until the entire surface of the coupon was covered. The wet DG 1108 was then worked into the coupon surfaces by brushing in a circular motion across the coupons. Then the brush was used to smooth the applied DG 1108 on each concrete coupon. If there were areas of the coupons that were not covered completely, additional wet DG 1108 was added. The first coat of DG 1108 was allowed to dry for 2 hours and a second coat was added on top of the initial coat following the same procedure. The coupons were then allowed to dry overnight. Removal of the dried DG 1108 was begun by pulling on the coating near the bottom of the coupons where the gel thickness was greatest and then the broader surfaces could easily be started and removed by hand. The application time included only the time for painting the coating onto the coupon surface and then working the coating into the surface. The dry, removed coating from one of the

DG 1108 applications was weighed to determine the amount of waste generation per unit area. The overall decontamination method (two applications) for DG 1108 included:

1. Apply coating followed by two hour drying time and apply a second coat
2. Dry overnight
3. Remove dried coatings
4. Apply wet coating followed by two hour drying time and apply a second coat
5. Dry overnight
6. Remove final dried coatings.

The experimental timeline may be summarized as follows. The six coupons were contaminated on November 30. The first application (two coats) of DG 1108 was completed on December 12 and allowed to dry overnight. The first removal of dried coating was performed on December 13. The second and final application/removal cycle was performed in an identical way on December 13 and 14. Therefore, the final removal of DG 1108 was performed 15 days following application of the Am-243 to the coupons. The temperature and relative humidity (RH) were recorded during the application and removal of the DG 1108. Over the duration of testing, the temperature and humidity in the laboratory where the coupons were stored and the evaluation was performed was always within the range of 22–23°C and 16% RH respectively.

4.0 Quality Assurance/Quality Control

QA/QC procedures were performed in accordance with the QMP and the test/QA plan for this evaluation.

4.1 Intrinsic Germanium Detector

The germanium detector was calibrated weekly during the overall project. The calibration was performed in accordance with standardized procedures from the American National Standards Institute (ANSI) and the Institute of Electrical and Electronics Engineers (IEEE).[3] In brief, detector energy was calibrated using thorium (Th)-228 daughter gamma rays at 238.6, 583.2, 860.6, 1620.7, and 2614.5 kilo electron volts (keV). Table 4-1 gives the calibration results across the duration of the project. Each row gives the difference between the known energy levels and those measured following calibration (rolling average across the six most recent calibrations). Pre-contamination measurements were performed in early December, and the post-contamination results were measured mid December. Each row represents a six week rolling average of calibration results. In addition, the energies were compared to the previous 30 calibrations to confirm that the results were within three standard deviations of the previous calibration results. All the calibrations fell within this requirement.

Table 4-1. Calibration Results – Difference (keV) from Th-228 Calibration Energies

	Calibration Energy Levels in keV				
Date Range (2011)	**Energy 1 238.632**	**Energy 2 583.191**	**Energy 3 860.564**	**Energy 4 1620.735**	**Energy 5 2614.511**
10-18 to 11-22	-0.002	0.007	-0.002	-0.205	0.020
10-24 to 12-6	-0.003	0.009	-0.028	-0.160	0.019
11-1 to 12-13	-0.001	0.003	-0.010	-0.060	0.007
11-8 to 12-20	-0.004	0.014	-0.039	-0.278	0.027

As described in the Quality Assurance Project Plan (QAPP), gamma ray counting was continued on each coupon until the activity level of Am-243 on the surface had an RSD of less than 2%. This RSD was achieved during the first hour of counting for all the coupons measured during this evaluation. The final activity assigned to each coupon was a compilation of information obtained from all components of the electronic assemblage that comprise the "gamma counter," including the raw data and the spectral analysis described in Section 3.1.3. Final spectra and all data that comprise the spectra were sent to a data analyst who independently confirmed the "activity" number arrived at by the spectroscopist. When both the spectroscopist and the data analyst independently arrived at the same value, the data were considered certified. This process defines the full gamma counting QA process for certified results.

The background activity of the concrete coupons was determined by analyzing two arbitrarily selected coupons from the stock of concrete coupons used for this evaluation. The ambient activity level of these coupons was measured for one hour. No activity was detected above the minimum detectable level of 0.2 nCi on these coupons. Because the background activity was not detectable (and the detectable level was approximately 10 times lower than the post-decontamination activity levels), no background subtraction was required.

Throughout the evaluation, a second measurement was taken on two coupons to provide duplicate measurements to evaluate the repeatability of the instrument. Both of the duplicate pairs showed a difference in activity levels of 5% or less, at or within the acceptable range of 5%.

4.2 Audits

4.2.1 Performance Evaluation Audit

RML performs monthly checks of the accuracy of the Th-228 daughter calibration standards by measuring the activity of a National Institute of Standards and Technology (NIST)-traceable europium-152 (Eu-152) standard (in units of Becquerels, Bq) and comparing the results to the accepted NIST value. Results within 7% of the NIST value are considered to be within acceptable limits as per the INL RML QC requirements. The Eu-152 activity comparison is a routine QC activity performed by INL, but, for the purposes of this evaluation, serves as the performance evaluation (PE) audit, an audit that confirms the accuracy of the calibration standards used for the instrumentation critical to the results of an evaluation. Table 4-2 gives the results of each of these audits of the detector that was used during this evaluation. All results are within the acceptable difference of 7%.

Table 4-2. NIST-Traceable Eu-152 Activity Standard Check

Date	Eu-152 (keV)	NIST Activity (Bq)	INL RML Result (Bq)	Difference
12-15-2011	Average	124,600	122,600	0.5%
	122	124,600	118,900	1.6%
	779	124,600	122,200	1.3%
	1408	124,600	118,700	1.5%

4.2.2 Technical Systems Audit

A TSA was conducted during testing at INL to ensure that the evaluation was performed in accordance with the test/QA plan and the TTEP QMP. As part of the audit, the actual evaluation procedures were compared with those specified in the test/QA plan. In addition, the data acquisition and handling procedures were reviewed. No significant adverse findings were noted in this audit. The records concerning the TSA are stored indefinitely with the QA Manager.

4.2.3 Data Quality Audit

At least 10% of the data acquired during the evaluation were audited. The QA Manager traced the data from the initial acquisition, through reduction and statistical analysis, to final reporting, to ensure the integrity of the reported results. All calculations performed on the data undergoing the audit were checked. No significant findings were noted.

4.3 QA/QC Reporting

Each assessment and audit was documented in accordance with the test/QA plan and the QMP.

There were two deviations from the test/QA plan during this evaluation. First, the target coupon contamination levels were slightly outside the acceptable limits for two coupons. The upper limit of the acceptable range was 55 nCi and two coupons had activities of 57 nCi and 58 nCi. There was no negative impact to the evaluation due to this deviation because the levels were just slightly outside the acceptable limits. Second, the test/QA plan stated that a single coupon test stand would be used for strippable coating application. This text was included as a typographical error as all parties involved understood that the expectation was that a multi-coupon test stand would be used.

5.0 Evaluation Results

5.1 Decontamination Efficacy

The decontamination efficacy was determined for each contaminated coupon in terms of percent removal (%R) and decontamination factor (DF) as defined by the following equations:

$$\%R = (1 - A_f/A_o) \times 100\% \text{ and } DF = A_o/A_f$$

where A_o is the radiological activity from the surface of the coupon before application of DG 1108, and A_f is radiological activity from the surface of the coupon after removal of the strippable coating. While the DFs are reported in the following data tables, the narrative describing the results will focus on the %R.

Table 5-1 gives the %R and DF for DG 1108. The coupon position numbers indicate the location within the surface (position 1-6) as defined in Figure 3-2. The activity for each of the contaminated coupons (pre-decontamination) was between 48 nCi and 58 nCi. The overall average (plus or minus one standard deviation) of the contaminated coupons was 53 ± 3.1 nCi, a variability of 6%. The post-decontamination coupon activities were significantly less than the pre-decontamination activities with an average %Rs of 84 ± 5.7%.

Table 5-1. Decontamination Efficacy Results

Coupon Position	Pre-Decontamination Activity (nCi/coupon)	Post-Decontamination Activity (nCi/coupon	%R	DF
1	48	6.9	86	7.0
2	52	7.4	86	7.1
3	53	6.1	89	8.8
4	58	6.8	88	8.4
5	52	8.8	83	6.0
6	53	14	73	3.7
Avg	**53**	**8.4**	**84**	**6.8**
SD	**3**	**3**	**6**	**1.8**
Cross contamination blank	**<0.2**	**1.3**	**NA**	**NA**

NA-removal data not applicable to the cross contamination blank coupon

As described above in Section 3.1, the cross contamination blank was included in the test stand to evaluate the potential for cross contamination due to application and removal of the DG 1108. This coupon had not been contaminated, and pre-decontamination activity measurements indicated extremely low background levels (below the 0.2 nCi detection limit) of activity. This coupon was decontaminated using DG 1108 along with the other contaminated coupons. When all of the coupons were removed from the test stand following the two application and removal cycles of DG 1108, the cross contamination blank coupon indicated an activity level that was 1.3 nCi, an activity of 1.1 nCi higher than the detection limit of the gamma counter (i.e., above background). This increased level of activity, approximately 2% of the activity added to each of the contaminated coupons (~50 nCi), was therefore not a large amount, but enough to note that the possibility exists that cross contamination to locations previously not contaminated is a possibility when using DG 1108 in a wide area application. The most likely route of cross contamination would be contamination of the bulk DG 1108 during application with a paint brush. However, another possible scenario would include touching the cross contamination blank with a gloved hand that had just been used to apply or remove DG 1108 from the contaminated coupons.

5.2 Deployment and Operational Factors

Table 5-2 summarizes various pieces of practical information (both qualitative and quantitative) gained during the evaluation of DG 1108. A number of operational factors were documented by the technician who performed the testing. The application process as described in Section 3.2 included application with a paint brush that was 10 cm wide. Three minutes was required to apply each coat of DG 1108 to all seven coupons. The overall time required to remove the dried coating from all seven coupons was 17 minutes. These application and removal times are applicable only to the experimental scenario using small concrete coupons. If DG 1108 were to be applied to larger surfaces, larger paint application tools such as rollers or sprayers would likely be used. Use of rollers or sprayers would impact the application rate. In addition, larger sections of dry coating could likely be removed in an amount of time similar to the amount of time that was required for the small coupons.

Figure 5-1 shows the application and removal of DG 1108. In most cases during the evaluation, the dry coating could be removed as one large piece from each coupon, but the dry DG 1108 generally could not be removed across the gaps between coupons of 0.3-0.7 cm. Figure 5-2 shows that the coupon surfaces were left largely unchanged by the DG 1108 as only very small

Figure 5-1. Application and removal of DG 1108.

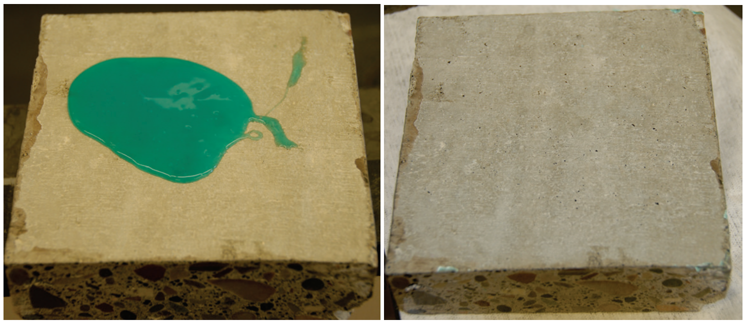

Figure 5-2. Coupons before (left) and after (right) decontamination with DG 1108.

pieces (~1 mm in length) of concrete residue were removed from the surface. Technicians were required to use full anti-contamination PPE because the work was performed in a radiological hood using Am-243. Whenever radioactively contaminated material is handled, anti-contamination PPE is required and any waste (e.g. peeled coating) will be considered low level radioactive waste and must be disposed of accordingly. The level of PPE required was not driven by the use of DG 1108, which is not hazardous, but by the interaction with surfaces contaminated with Am-243.

All of the operational information gathered during this evaluation was gathered during use of DG 1108 on relatively small surfaces (0.16 m^2) that were built with concrete coupons. Some of the information given in Table 5-2 could therefore differ if DG 1108 were to be applied to a larger surface or to a surface with a significantly different surface texture or porosity.

Table 5-2. Operational Factors for DG 1108

Parameter	Description/Information
Decontamination rate	Coating preparation: Provided ready for use. Application: Approximately 3 minutes at 250 mL per coat onto 0.16 m^2 for an application rate of 3.2 m^2/hour and a DG 1108 volumetric use rate of 1.56 L/m^2 for each coat Drying time: overnight Removal time: 17 minutes for all seven coupons for a rate of 0.56 m^2/hour
Applicability to irregular surfaces	Application to more irregular surfaces than what was encountered during this evaluation would not seem to be much of a problem as a paint brush can coat most types of surfaces accessible to an operator. DG 1108 cures to a relatively strong but flexible film that is conducive for use on the surfaces made from concrete as were used during this evaluation. In most cases, DG 1108 was removed coupon by coupon, but not across gaps between coupons.
Skilled labor requirement	After a brief training session to explain the procedures, no special skills would be required to successfully perform both the application and removal procedures.
Utilities requirement	No utilities were required in this case because paint brush application was used. DG 1108 can be applied using a paint sprayer which would require a minimum of 120 Vac power.
Extent of portability	With the exception of extreme cold that would prevent the application of the water-based DG 1108 the technology is not limited due to portability.
Shelf life of media	Shelf life is advertised as one year.
Secondary waste management	Solid waste production: approximately 464 g/m^2 for two applications of two coats
Surface damage	No visible surface damage; removed only loose particles that were consequently stuck to the removed coating.
Cost	The material cost is approximately \$40/L which corresponds to approximately \$240/m^2 if used similarly to this evaluation. Labor costs were not calculated.

6.0 References

1. ASTM Standard C 150-07, 2007, "Standard Specification for Portland Cement," ASTM International, West Conshohocken, PA, www.astm.org [accessed 9/18/12].
2. Radionuclide Detection and Decontamination Program, Broad Agency Announcement 03-013, U.S. Department of Defense (DOD) Defense Advanced Research Projects Agency (DARPA) and the U.S. Department of Homeland Security.
3. Calibration and Use of Germanium Spectrometers for the Measurement of Gamma Emission Rates of Radionuclides, American National Standards Institute. ANSI N42.14-1999. IEEE New York, NY (Rev. 2004).

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