www.epa.gov/nhsrc

technical BRIEF

Evaluation of Nine Chemical-Based Technologies for Removal of Radiological Contamination from Concrete Surfaces

Background

Because of its potential for deployment as a terrorist weapon in an urban setting, the radiological dispersion device (RDD), or "dirty bomb," is a very real and significant danger. Cesium-137 is one of many radioactive isotopes with the potential to be employed in an RDD. The National Response Framework, the federal document that details how the nation responds to such threats, identifies the U.S. Environmental Protection Agency (EPA) as a lead federal agency for decontamination following such a radiological incident. This response to a radiological incident could include decontamination of buildings, equipment, and outdoor areas. In support of this role, the EPA's National Homeland Security Research Center (NHSRC) evaluated the performance of nine chemical-based decontamination technologies for their ability to remove Cesium-137 from the surface of unpainted concrete. In addition, NHSRC evaluated various deployment-related characteristics of the products.

The work, completed in 2011, is described in a series of reports. *These peer-reviewed reports provide rigorous evaluations of the efficacy of nine commercially-available surface cleaning technologies of the type that could be employed to decontaminate concrete surfaces following an RDD incident releasing Cs-137.* These reports, which can be accessed via the NHSRC website (www.epa.gov/nhsrc/), provide information that emergency responders and their support personnel can use in recommending or selecting appropriate technologies for use during cleanup operations. This information can also be used to assist federal, state, and local emergency management authorities and emergency response planners to prepare for radiological homeland security events.

As part of U. S. EPA's Office of Research and Development, the National Homeland Security Research Center (NHSRC) provides products and expertise to improve our nation's ability to respond to environmental contamination caused by terrorist attacks on our nation's water infrastructure, buildings and outdoor areas.

NHSRC conducts research related to:

- Detecting and containing contamination from chemical, biological, and radiological agents
- Assessing and mitigating exposure to contamination
- Understanding the health effects of contamination
- Developing risk-based exposure advisories
- Decontaminating and disposing of contaminated materials.

August 2011

EPA/600/R-11/086

Results

A summary of the decontamination efficacy results is presented in Table 1. Unpainted concrete coupons (standardized samples) were contaminated with Cs-137 and the amount of contamination (radiological activity) deposited on each coupon was measured. Each coupon was then treated with the decontamination technology under investigation and the amount of contamination remaining was measured. The efficacy of the decontamination technology is expressed both in terms of percent of contamination removed (%R) and decontamination factor (DF). These efficacy measures are determined based on the following relationships:

$$\%R = (1-A_f/A_o) \times 100\%$$

$$DF = A_o/A_f$$

%R = percent of contamination removed
DF = decontamination factor

A_o = radiological activity from the surface of the coupon before decontamination A_f = radiological activity from the surface of the coupon after decontamination

For each technology, the product name in Table 1 is hyperlinked to the corresponding report in the EPA's Science Inventory database. Operational-related characteristics are presented in Table 2.

Table 1. Decontamination Efficacy

Product	Application Type	Decontamination Efficacy	
		%R	DF
Argonne SuperGel	Liquid Spray/Vacuum	73 ± 5	3.8 ± 0.7
CBI DeconGel 1101	Strippable Coating	49 ± 7	1.9 ± 0.2
CBI DeconGel 1108	Strippable Coating	67 ± 9	3.2 ± 0.9
EAI Rad-Release I	Liquid Spray/Rinse/Vacuum	71 ± 13	3.9 ± 1.5
EAI Rad-Release II	Liquid Spray/Rinse/Vacuum	85 ± 2	7.0 ± 1.1
INTEK ND-75	Liquid Spray/Rinse/Vacuum	47 ± 6	1.9 ± 0.2
INTEK ND-600	Liquid Spray/Rinse/Vacuum	52 ± 12	2.1 ± 0.4
RDS Liquid	Liquid Spray/Wipe	53 ± 7	2.1 ± 0.3
RDS Foam	Foam Spray/Wipe	51 ± 8	2.1 ± 0.4

%R, percent of contamination removed; DF, decontamination factor

Table 2. Operational Characteristics

Parameter	Description
Decontamination Rate	• Argonne SuperGel: Applied by trowel (paint scraper), scale up would require spray equipment (similar to airless paint sprayer) or roller. Requires 1-2 hour dwell time. • DeconGel 1101 and 1108: Applied with paint brush, scale up would require spray equipment or roller. Requires overnight drying before stripping dry coating. • EAI Rad-Release I and Rad-Release II: Applied using spray bottles in just seconds. Rad-Release I is a single step process requiring approximately 30 minute dwell time. Rad-Release II is two-step process requiring a total of 60 minutes dwell time. Scale-up would require spray or foam generating equipment, but dwell time would be the same. • INTEK ND-75 and ND-600: Applied using spray bottles in just seconds. ND-75 requires three 15 minute application cycles. ND-600 requires three 30 minute application cycles. Scale-up would require spray equipment, but dwell times would be the same. • RDS Liquid and Foam: Applied using spray/foam bottles in seconds. Requires six cycles of application with two solutions and wiping with towels. Required 3-6 minutes for each 225 cm^2 concrete coupon.
Applicability to irregular surfaces	All technologies were judged to be applicable to irregular surfaces, but those requiring vacuum removal (Argonne, EAI, INTEK) may prove to be more difficult depending on the surface and available vacuum attachments.
Skilled labor requirement	As evaluated, a brief training session is adequate. Scale up would require somewhat more complex equipment and/or contractor support with corresponding training requirements for equipment operation.
Utilities required	110v for vacuum; scale up would require more complex equipment such as sprayers.
Extent of portability	Very portable; limited by need for utilities for vacuum and possible scaled-application tools.
Setup time	Less than 15 minutes for all technologies as tested. Scaled up application would require increased set-up time consistent with commercial spraying equipment.
Secondary waste management	• towels was not reached due to the relative size of the coupons, Argonne SuperGel: 5 L/ m^2 gel waste collected in wet vacuum. • DeconGel 1101 and 1108: 319 g/m^2 of dried coating and a volumetric waste generation of 252 cm^3/m^2. • EAI Rad-Release I and Rad-Release II: Approximately 1 L/m^2 collected by the wet vacuum • INTEK: Approximately 1 L/m^2 collected by the wet vacuum • RDS Liquid and Foam: 4 L/m^2 mostly collected by the towels used to wipe the surface; 2000-3000 cm^3 of towels used during this evaluation. The maximum effective collection capacity of the therefore the total secondary waste volume for a scaled up scenario is not a direct comparison. The capacity of the toweling material was not evaluated.

Surface damage	None of the technologies caused visible surface damage.
Cost (material only; does not include labor, equipment, or waste management)	• Argonne SuperGel: approximately $2/m^2 • DeconGel 1101 and 1108: approximately $40/m^2 (both 1101 and 1108) • EAI Rad-Release I and Rad-Release II: approximately $33-55/m^2 • INTEK: approximately $1/m^2 for ND-75 and $2/m^2 for ND-600

Technology Evaluation Reports Referenced

Drake, J. 2011. *Argonne National Laboratory Argonne SuperGel for Radiological Decontamination*. Washington, D.C.: U.S. Environmental Protection Agency. EPA/600/R-11/081.

Drake, J. 2011. *CBI Polymers DeconGel® 1101 and 1108 for Radiological Decontamination*. Washington, D.C.: U.S. Environmental Protection Agency. EPA/600/R-11/084.

Drake, J. 2011. *Environmental Alternatives, Inc. Rad-Release I and II for Radiological Decontamination*. Washington, D.C.: U.S. Environmental Protection Agency. EPA/600/R-11/083.

Drake, J. 2011. *INTEK Technologies ND-75 and ND-600 for Radiological Decontamination*. Washington, D.C.: U.S. Environmental Protection Agency. EPA/600/R-11/085.

Drake, J. 2011. *Radiation Decontamination Solutions, LLC "Quick Decon" Solutions for Radiological Decontamination*. Washington, D.C.: U.S. Environmental Protection Agency. EPA/600/R-11//086.

Contact Information

For more information, visit the NHSRC Website (http://www.epa.gov/nhsrc)

Technical Contact: John Drake (drake.john@epa.gov)

General Feedback/Questions: Kathy Nickel (nickel.kathy@epa.gov)

If you have difficulty accessing this PDF document, please contact Kathy Nickel (Nickel.Kathy@epa.gov) or Amelia McCall (McCall.Amelia@epa.gov) for assistance.