Evaluating the Efficiency of Decon Gel 1101 for Removal of Cs-137, Co-60, and Eu-154 on Common Commercial Construction Materials

J. D. VanHorne-Sealy, K. A. Higley
Department of Nuclear Engineering and Radiation Health Physics
Oregon State University, Corvallis, OR 97331

Abstract

Decon Gel 1101 is an uncomplicated, low odor, peelable polymer hydrogel for use with radiological decontamination, manufactured by Cellular Bioengineer Inc†. The gel allows for single or repeated material applications to contaminated surfaces. As the gel dries it binds the contaminant by encapsulating and lifting the contaminant into the gel. The result is a non-sticky rubber-like substance that is easily removed.

Through a series of evaluations conducted with Decon Gel 1101, the removal efficiency for materials contaminated with liquid forms of Cs-137, Co-60, and Eu-154 was determined on concrete (both old and new), painted concrete, porcelain tile (with and without grout), granite (with grout), and vinyl composite tile. Initial application with all three nuclides on un-grouted porcelain tile and vinyl composite tile showed greater than 95% removal from the material surface and 80% or greater encapsulated in the gel itself. Both the porcelain and granite grouted tiles showed large standard deviations between repetitions, removing between 25% and 85% of the contaminate from the material, with between 25% and 65% encased in the gel. Painted concrete resulted in greater than 95% removal from the material surface with between 45% and 85%of the deposited activity contained in the gel. Results for both the old and new concrete were similar: between 27% and 71% removal from the material surface and between 19% and 40% encapsulated in the gel.

Background

In a 2004 Report to Congress *, Congressional Research Service consultant Dana A. Shea stated, “Some experts believe that the economic and psychological effects from a Radiological Dispersal Device (RDD) attack would outweigh the direct medical costs. These experts, weighing the current guidelines on radiological contamination and the degree of dispersal expected with a successful RDD attack, state that an RDD attack could contaminate large areas”. This line of thinking creates the need for prompt response and removal of radioactive materials.

While the need for decontamination techniques has been around since the initial determination of radiation hazards, the post 9/11 environment has increased awareness of the necessity for decontamination in a more timely and effective manner. Decon Gel 1101 testing in this experiment focuses on the RDD decontamination.

Materials

Each of the radionuclides used in this experiment was selected for its classification as one of the “Nine Isotopes of Interest” by the Department of Energy‡ or due to its similar chemical properties to the listed nuclides. This list addresses the radionuclides mostly likely to be used in a RDD. The radionuclides selected were ^{137}Cs, ^{60}Co and ^{154}Eu, for its chemical similarities to ^{241}Am.

Each of the materials was selected for its common use in commercial construction. The materials tested were newly poured concrete (~seven months from pour to testing); old concrete (greater than 25 years in age); painted new concrete; vinyl composite tile; ungrouted porcelain tile; and grouted & sealed porcelain and granite tiles.

Historical data and visual inspection of the old and new concretes showed the constituents to be similar, which allowed for a direct comparison of results. No additional sealant was applied to the “old” or “new” concretes.

Methods

A 2” x 2” area for each of the materials was marked off to allow for standardized contamination and testing. The concrete and tiles were each cut with a commercial, water cooled, concrete or tile saw.

Each sample received 0.1ml of liquid containing one of the following:

For ^{154}Eu - ~750 Bq; For ^{137}Cs - ~1850 Bq; For ^{60}Co - ~1300Bq

The samples were counted via 5” x 5” NaI(Tl) detector, with MCA and spectroscopy software. Blanks of each were counted. Nuclides were applied, allowed to dry, counted and then the Decon Gel 1101 was applied, according to manufacturer’s specifications.

Each sample was counted after application of the radionuclide and after the removal of the gel; with gels counted post removal.


Fig. 1 New Concrete

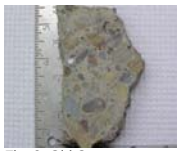
Fig. 2 Old Concrete


Fig. 3 Painted Concrete

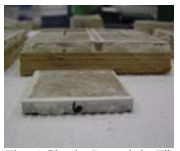
Fig. 4 Single Porcelain Tile

Number of Sampled Materials
n=9 for All three radionuclides & materials except
n=8 for Granite Tile with Co-60,
n=7 for Old Concrete with both Cs-137 & Co-60


Fig. 6 Cut Tiles


Fig. 7 Pre-marked Contamination Area

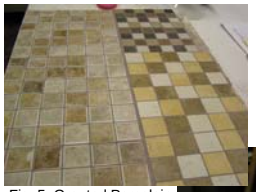
Fig. 5 Grouted Porcelain & Granite Tiles

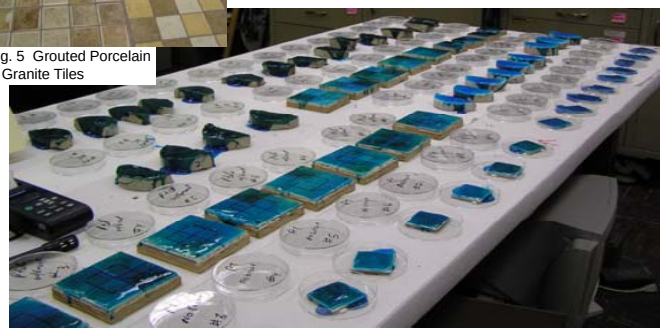
Fig. 8 Sample Materials with Decon Gel 1101

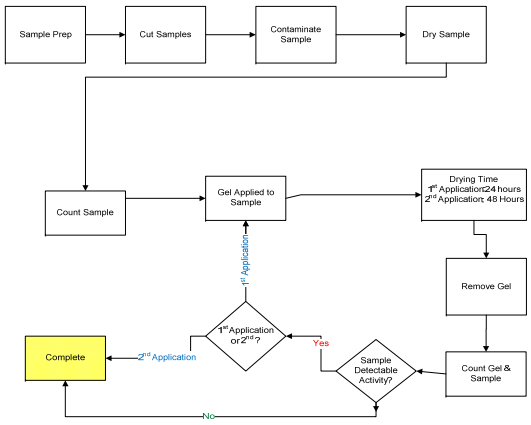

Fig. 10 Methodology Algorithm

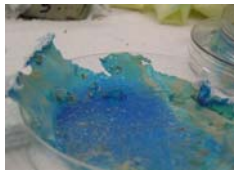
Fig. 9 Post Removal, Dry Decon Gel 1101

Fig. 11 Old Concrete & Dry Gel

Results

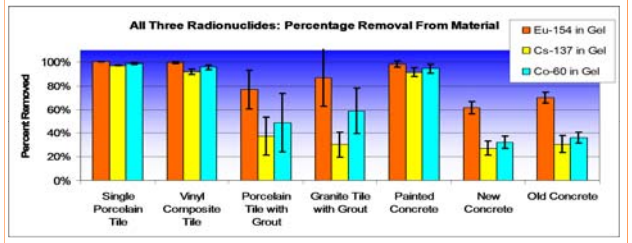

Fig.12 Comparison of First Application Percentage Removed From the Material with All Three Nuclides

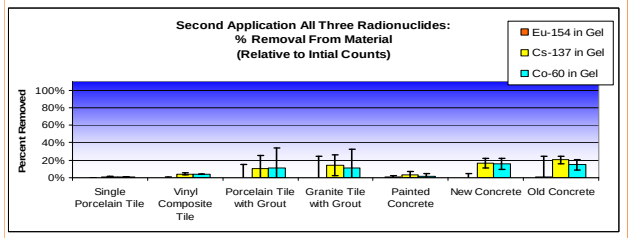

Fig. 13 Comparison of Second Application Percentage Removed with All Three Nuclides from Material

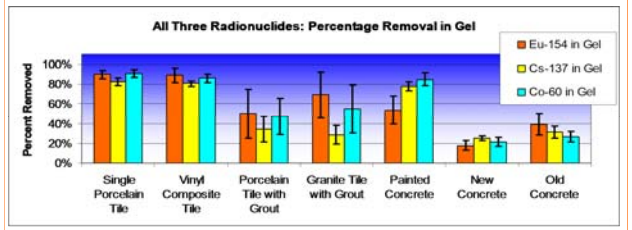

Fig. 14 Comparison of First Application Percentage Removed in the Gel with All Three Nuclides

Conclusion

- Easily applied in an emergency situation by minimally trained personnel
- Allowed for single or repeated material applications
- Recommended for interior RDD removal situations (rehydratable)
- Grouted materials & unsealed concrete did present challenges
  - May require repeated applications or additional and/or different decontamination methods.
- During forensic investigations differences between quantitative analysis of the gel and activity removed from the material should be taken into consideration.

References

† **Cellular Bioengineering Inc. 1946 Young Street, Suite 480, Honolulu, HI 96826**

* **Shea, D. 2004. Radiological Dispersal Devices: Select Issues in Consequence Management. *CRS Report for Congress* RS21766 (December 07).**

‡ **Argonne National Laboratory. 2005. Radiological Dispersal Device. *Human Health Fact Sheet***