Radiological Decontamination with Permanent and Removable Coatings

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BACKGROUND

The DOE is always on the search for new innovative products and gadgets that would make deactivation and decommissioning projects safer, cheaper and faster. One of the projects set for D&D is the 235 – F Plutonium Fuel Form (PuFF) Facility, constructed in the 1950's at the Savannah River Site (SRS) in Aiken, SC. This facility was used to receive, store and dispatch plutonium oxide fuel encapsulated in the form of pellets from 1979 through 1984. The fuel was supplied by the conversion of heat from the radioactive decay of plutonium 238 into electrical power; it was used to power 26 space missions for the National Aeronautics and Space Agency (NASA). The radioactive waste left in this facility after the production of plutonium fuel stopped has become a hazard.


Plutonium Heat Source


235-F Plutonium Fuel Form Facility


Glove box at 235-F PuFF

SCOPE OF WORK

This task gathers and evaluates all potential decontamination agents and materials available in the market today. It provides a quick guide to these products and their applications not only for the 235-F Plutonium Fuel Form Facility but for any other project in the need of radioactive decontamination.

In addition, a decision model is being developed to better guide end users in the selection of these types of products depending on their specific needs (e.g. surface type, decontamination factors and isotopes involved in the decontamination).

PURPOSE

To determine reasonable means and methods that would reduce the quantity and/or mobility of residual radioactive materials from and within the PuFF Facility. Focusing specifically on commercially available products designed for decontamination purposes on a large and small scale.

This work also seeks to develop a computer based system that would ease the selection process of strippable and fixative coatings.

METHODOLOGY

The methodology for conducting this research was based on a literature review. In order to create a reliable database, a detailed evaluation of previous reports and demonstrations conducted at FIU-ARC and throughout the DOE Complex was performed. The primary model for the selection process is being developed with Microsoft Excel.

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TYPICAL PRODUCT APPLICATIONS

- Structural surfaces (concrete, wood, steel, metals, plastic).
  - Piping and equipment.
  - Floors, walls, ceilings and stacks.
  - Interior and exterior areas.
- Bench top, glove boxes, and experimental equipment.
- Soils.

NUCLEAR APPLICATIONS/DEPLOYMENTS

- CC FIX (over CC WET): Hanford Site Bldg. 313 , used to control surfaces contaminated with beryllium, allowing a more controlled and safer demolition.
- CC FIX LV : Oak Ridge National Lab (ORNL) Facility Bldg. 4507, used to stabilize contamination in place until demolition.
- DECON GEL: ORNL, used to clean contaminated equipment such as glove boxes contaminated with plutonium.
- POLYSHIELD HT: Hanford Site, used to create a waterproof barrier to mitigate rainwater reaching a leaking containment tank.

FACTORS TO CONSIDER FOR DECONTAMINATION

- **Application process:** Avoid labor intensive techniques and time intensive processes.
- **Cost:** Consider transportation/labor/materials/ waste handling cost.
- **Efficiency:** Mainly based on the Decontamination Factor of the product to be used.
- **Safety:** Minimize application time to avoid long term exposure, use of protective clothing and ensure proper handling to prevent the spread of contamination.
- **Waste management**: Minimize and ensure proper disposal of primary and secondary waste.

DECONTAMINATION FACTOR (DF)

- The Decontamination Factor (DF) is a numerical value that relates to the % of removal of radionuclides from a treated contaminated surface. Given by:
- % of Contamination Removal = (1 - 1/DF) x 100

PREVIOUS STUDIES/RESEARCH

A side by side comparison was performed by Homeland Security with the purpose of testing some commercially available strippable coatings that may be used in the event of a Dirty Bomb. The results are as follows:

DF	% Decontamination Removal
2	50 %
5	80%
10	90%
100	99%

Decontamination Agent	% R	DF
Argonne Gel	73 +/- 5	3.8 +/- 0.7
Decon Gel 1101	49 +/- 7	1.9 +/- 0.2
Decon Gel 1108	67 +/- 9	3.2 +/- 0.9
Rad Release I	71 +/- 13	3.9 +/- 1.5
Rad Release II	85 +/- 2	7.0 +/- 1.1

PRELIMINARY RESULTS

A comprehensive list of strippable coatings, fixatives and decontamination gels were researched based on application parameters established by SRNL.

The information listed under column A was collected for each one of the products identified by this study while those in Column B are currently being collected:

A:

- Product Name
- Manufacturer
- Strippable Coating (Yes/No)
- Application Instructions
- Price/Coverage
- Use
- Advantages
- Previous Use
- Documentation
- Product Website
- Photos
- Contact Information

B:

- Category (Fixative/Strippable/ Washable)
- pH
- Ingredients (Published by Manufacturer)
- Specific Gravity
- Solubility
- Incompatibility
- Boiling Point
- Conditions to Avoid
- State
- Color

PRODUCTS


Absorbent Gel (Argonne Supergel)


Fixative/Paint (Envirolastic AR 425- Sherwin Williams)


Scrubbing Solution (Quick Decon RDS)


Peelable Gel (Decon Gel)


Foam and Paste (Rad-Relaase)

Images sources: http://techportal.eere.energy.gov/technology.do, http://www.preguntaleasherwin.cl, http://decongel.com/, http://web.ornl.gov Data Source: Technical Brief 'Evaluation of 9 Chemical-Based Technologies for Removal of Radiological Contamination from Concrete Surfaces"/ Cellular Bioengineering Inc. "Peelable Decontamination Technology Decon Gel 1101"

DECISION MODEL

A decision model is being developed for the process of deciding what product will give the best results for a specific application. A list of key parameters has been developed. A few of the parameters that are being taken into account at this moment are:

- Surface Properties
- Surface Type
- Isotopes Involved

With the help of a report by Jeffrey L. Hunter from the former ALARA Center at Hanford, a preliminary example of how the model is expected to work has been developed. After using dropdown lists to select the three parameters mentioned above, the expected percent decontamination for each specific product will be provided. See the following table:

Surface Properties	Surface Type	Isotopes Involved	Product	%Decon
Carbon Steel	Smooth	Pu 239	Decon Gel 1101	98
Plexiglass	Smooth	Pu 239	Decon Gel 1101	53
Concrete	Porous	Pu 239	Decon Gel 1101	71

ARC STUDIES/RESEARCH/FACILITIES

In 2010, the Applied research Center (ARC) at Florida International University performed several application tests for some of the strippable coatings that may be used for decontamination . The technology tested was the International Climbing Machine (ICM); it proved its ability to spray the coatings on concrete and metallic surfaces. This application method would greatly reduce workforce exposure to radiation.

The Radiological Lab at the Applied Research Center is equipped with state-of-the-art glove boxes, a three-stage HEPA+activated charcoal filtration system, a fume hood, and a lead brick shielded enclosure for conducting studies on any material emitting alpha, beta, or gamma radiation.


International Climbing Machine (ICM)


Radiological Lab at the Applied Research Center