U.S. DEPARTMENT OF ENERGY

INNOVATIVE AND EMERGING TECHNOLOGIES FOR D&D

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WASTE MANAGEMENT SYMPOSIA

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TECHNOLOGY INNOVATION AND DEVELOPMENT

Technology Innovation and Development results in:

- Improved worker safety
- Reduced technical risk
- Accelerated cleanup
- Resolution of complex technical challenges
- Significant lifecycle savings

RADBALL

UK NATIONAL NUCLEAR LABORATORY

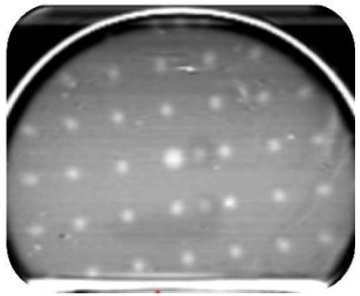
A novel, passive, radiation detection device which provides 3D visualization of radiation from areas where effective measurements have not been previously possible.

How it works

- Radiation sensitive polymer the size of tennis ball
- Permanently opaque when exposed to radiation.
- Degree of opaqueness depends upon absorbed dose.
- NNL creates a three dimensional visualization of the deployment environment and the radiation sources found.

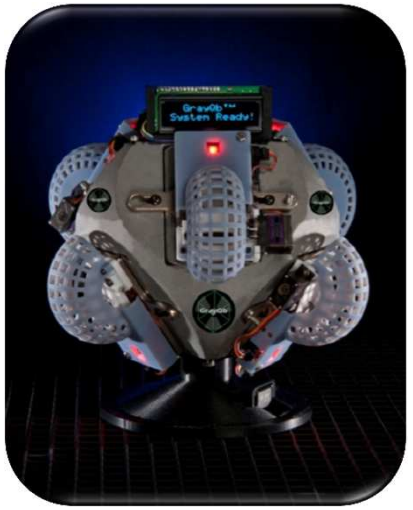
Characteristics

- Can be combined with visualization software to create 3D representations of deployment area and radiation detected
- Device responds to total doses of between 20 mGy - 100 Gy
- Sensitive to gamma radiation and tested with Co-60, Cs-137 and Am-241



GrayQb™
A 3D Radiation Mapping Device
Savannah River National Laboratory

Locates, identifies, and generates a 3D map of radioactive contamination within an enclosed area



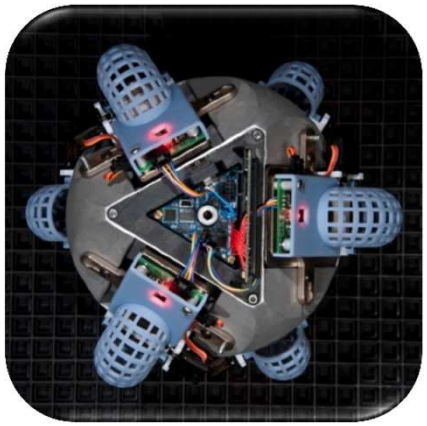
How it works

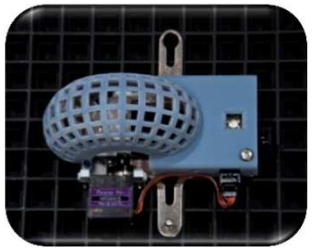
- GrayQb™ is placed in a confined area for a predetermined span of time based on expected dose rates.
- A set of motorized shutters shield the Phosphor Storage Plates (PSPs) during placement and removal of the device.
- Once in position, the attenuated PSP layers are exposed to the sources in the area through a unique collimation apparatus.
- GrayQb™ is then removed from the area where the PSPs are read in an optical scanner.
- Using special software, the data from the PSPs is translated into a map of the locations, intensities, and energies of the source contamination.

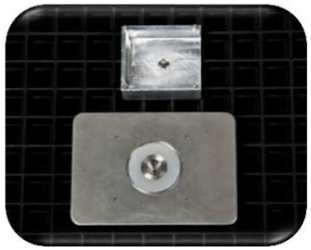
GrayQB™
A 3D Radiation Mapping Device
Savannah River National Laboratory

Characteristics

- Uses multiple layers of Phosphor Storage Plates (PSPs) as its detection material
- Characterizes contamination at a wide range of dose rates (0.01 to over 1000 mGy/hr; 1 to over 100,000 mR/hr)
- Minimizes exposure to personnel
- Currently able to detect gamma, but it could detect alpha, beta, and neutron radiation with some modifications
- On board electronics provides remote control and monitoring of the device
- Low exposure times due to the high sensitivity of Phosphor Storage Plates (PSPs)
- Full 360˚coverage in all directions
- Provides results in minutes
- Patent pending







DECONGEL

DOE-EM COMMERCIAL TRANSITION TECHNOLOGY

Easy and Peelable Environmentally Friendly Decontamination Solution with a Broad Spectrum of Uses

Highlights:

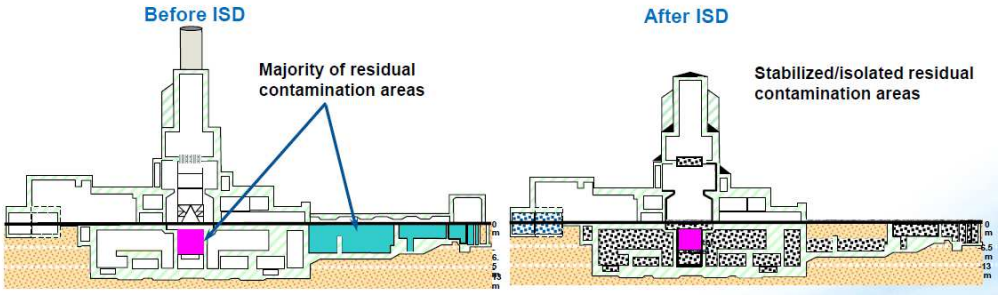
- Developed first "green" hydrogel technology and improved formulation from 1101 to 1108
- Commercially transitioned, currently selling world-wide
- Improved formula effective against TRU waste, radionuclides, heavy metals, and hydrophilic and hydrophobic contaminants including organics
- Reduces waste generation upwards of 80%; labor costs upwards of 70% and decreases turn-around time
- In Japan the product is being used in decontamination activities for radioactive isotopes and chemical decontamination
- On the USS Missouri the product is decontaminating PCBs
- At Joint Naval Base Pearl Harbor the product decontaminated lead dust
- At nuclear facilities across the nation the product is gaining traction because of its efficacy, reduction in waste generation and lowered labor costs

IN-SITU DECOMMISSIONING AND LONG TERM MONITORING

SAVANNAH RIVER NATIONAL LABORATORY

In Situ Decommissioning (ISD) process at the Savannah River Site physically stabilizes and isolates intact, structurally sound facility as (part of) the final facility disposition action – end state.

- ISD provides significant reduction in worker risk and prevents human and ecological receptors from direct contact with radiological contaminated materials compared to traditional demolition and deactivation-decommissioning approaches.



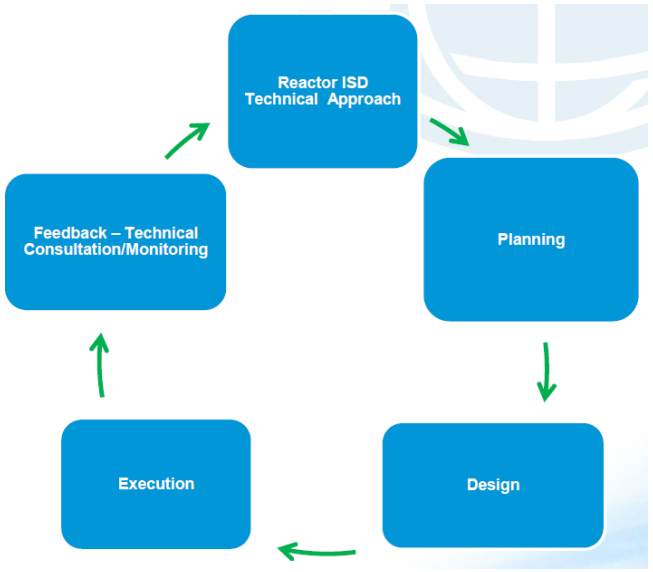
Heat Exchanger Pit @ - 6 m

Pump Motor Room @ - 12 m

IN-SITU DECOMMISSIONING AND LONG TERM MONITORING

SAVANNAH RIVER NATIONAL LABORATORY

Reactor In-Situ Decommissioning requires a systems engineering approach to address unique challenges



Planning

Technical Requirements Supporting End State Goal

- Rapid Prototype Models
- Identify fill material characteristics
- Residual contamination & water management

Feasibility -- Constructability

- Conventional industry practice
- Identify technical gaps

Design

Fill Material Purpose

- Provide a radiological shielding layer over irradiated debris and sludge to encapsulate debris
- Fill voids to provide physical stabilization of the below- grade spaces
- Encapsulate debris to reduce contact with infiltrating water.

Execution

- Remote camera system for remote area grout placement
- Thermocouple arrays for grout as-placed quality confirmation
- Ultrasonic velocity apparatus
- Grout thermal transient model
- Hydrogen generation model

IN SITU DECOMMISSIONING SENSOR NETWORK (ISDSN) MESO-SCALE TEST BED (MSTB)

Purpose

ISDSN-MSTB demonstrates the feasibility of installing and operating a remote sensor network to assess cementitious material durability, moisture-fluid flow through cementitious material and resulting transport potential for contaminate mobility in a decommissioned closed nuclear facility.

Initial Objective

Construct a grout-filled meso-scale test bed to assess an embedded sensor network, evaluate sensor response during curing, and establish network baseline data set.

Sensor Network Array

- Electrical Resistivity Tomography-Thermocouple and Advanced Tensiometer sensors
- Fiber Optic Sensor - Loop Ring-down sensor
- Fiber Optic Sensor - Bragg Grating & Piezoelectric - Smart Aggregate sensors
- Piezoelectric – Acoustic Emission & pH sensors

Phase 2 Preliminary Results

- Sensor systems operational
- Internal moisture movement detected
- Internal material cracks detected
- Sensor network complimentary and validates internal physical material changes

D&D Technology Development Accomplishments
Idaho National Laboratory

Sodium Treatment

Developed and Implemented Revolutionary Approaches for Passivated Sodium Treatment

- Citric Acid Treatment of Sodium
  - EBR-II Vessel (saved $8M)
  - EBR-II Heat Exchanger (saved $1M)
  - EBR-II Secondary Piping System (in progress)

Long-Reach Tools

Long-Reach Pipe-Tapping Tool

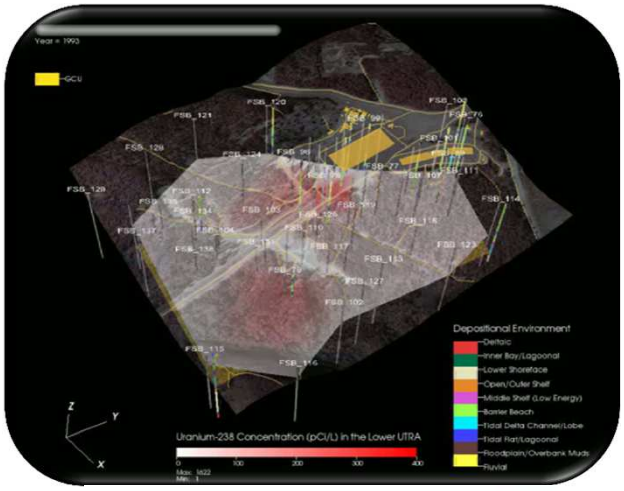
- Tap and drain radioactive contaminated solution from pipes while minimizing exposure to workers
- Long-reach (34 ft) cutting tool used to safely cut NaK lines inside the EBR-II reactor vessel (no other viable option identified)

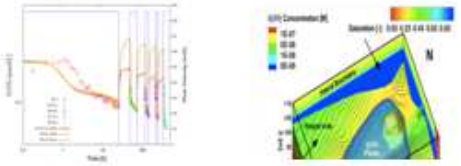
ADVANCED SIMULATION CAPABILITY FOR ENVIRONMENTAL MANAGEMENT (ASCEM)

A State-of-the-art tool for predicting contaminant fate and transport through natural and engineered systems

Highlights:

- The modular and open source design will facilitate a new approach for integrated modeling and site characterization
- Will enable robust and standardized future performance and risk assessments for EM cleanup and closure
- Reduce time required and financial cost of remedial actions at sites within EM complex by providing scientifically defensible modeling and simulation tools that accurately address complex environmental management situations
- Develop an integrated, high-performance computer modeling capability to simulate multiphase, multi-component, multi-scale flow and contaminant transport, waste degradation and contaminant release, including
- Provide tools for decision making: parameter estimation, visualization, uncertainty quantification, data management, risk analysis, and decision support
- Leverage investments made by SC, NE, RW, and FE as well as other Federal agencies to capitalize on significant investments and reduce the lifecycle development time and costs





Wide Range of Complexity

Wide Range of Platforms

ADVANCED FOGGING TECHNOLOGIES

IDAHO NATIONAL LABORATORY

How it works

- Fogger head (end effector) is positioned at HVAC inlet, or within contamination zone, typically has slight vacuum to move fog through room.
- Coats airborne particles (<10uM) and precipitates them as agglomerates.

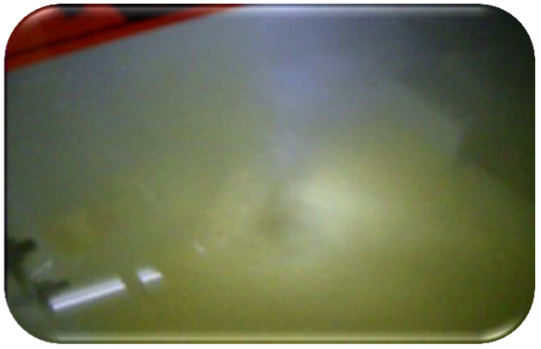
Characteristics

- Uses less material to cover same area.
- Better coverage, reduces contamination more effectively; fog acts like gas not like paint spray.
- "Passive" application, doesn't require entry.
- Faster

Applications

- Areas where there are high airborne contamination levels.
- Areas where there is loose, flighty dust.

Contaminated duct awaiting D&D



Gas-like Advanced Fog

ADVANCED FOGGING TECHNOLOGIES

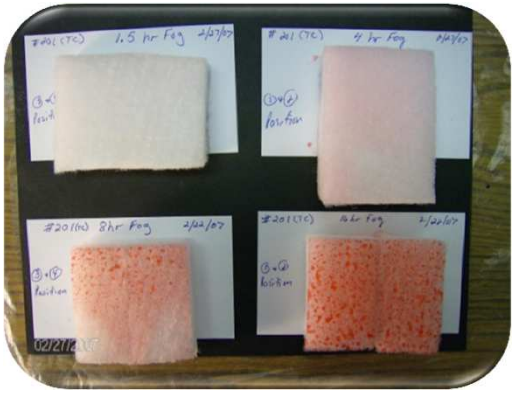
IDAHO NATIONAL LABORATORY

Early test results

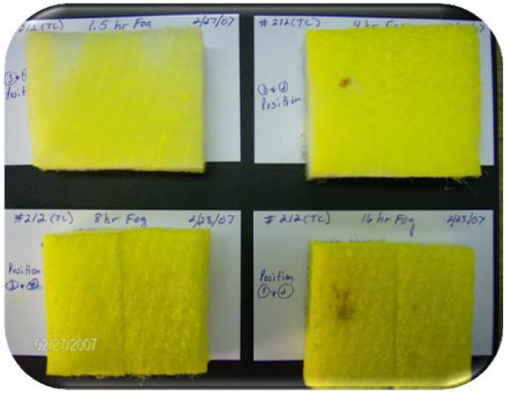
- Results of a DOE-EM SBIR showed that the advanced solution chemistry performed much better than the baseline "glycerin" fog.

A Recent test (Oct. 2012) with this solution was performed in the UK

- Fogger (NNL's Aerosonix) produces far more fog in less time
- Formula met most requirements except for drying time (next test will modify formula for drying time (ultrasonics vs pneumatics))



Baseline with commercial glycerin fog. Test coupons show lack of penetration (visible beading) and inconsistent coverage.



Advanced fog shows much better coverage and penetration.

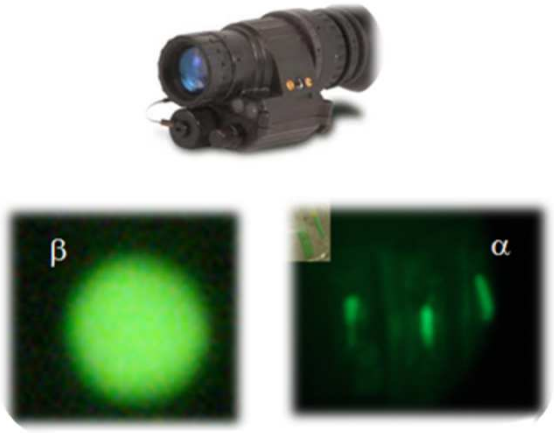
SCINTILLATING PHOSPHOR SPRAY AND PAINT SYSTEMS FOR THE DETECTION OF 99TC

OAK RIDGE NATIONAL LABORATORY

Objective: Develop a novel, highly efficient scintillator spray and paint system that can be used to indicate the presence of radioactive contamination.

Detailed tasks include:

- Identify the most efficient scintillator that emits in the solar blind UV, visible, near-infrared, or short-wave infrared regions.
- Down select to the best scintillator based upon limits of detection for ^{99}Tc.
- Identify one or more imaging sensors that support the detection of ^{99}Tc contamination when exposed to the selected scintillating phosphor.
- Develop a scintillating phosphor spray and sprayer that would support wide area contamination detection.
- Demonstrate capability.



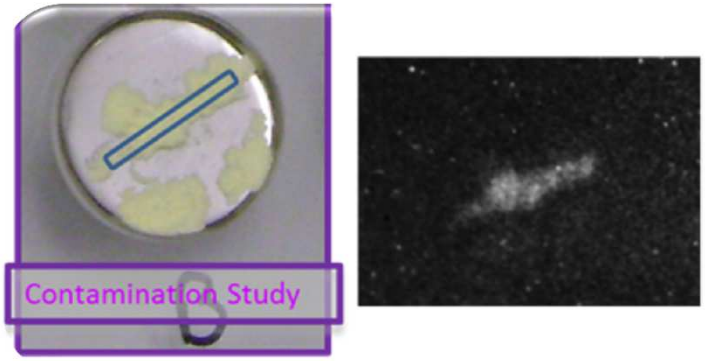
NIR phosphor scintillation detected through a filtered night vision device for beta (left) and alpha (right) activated radio-luminescence.

SCINTILLATING PHOSPHOR SPRAY AND PAINT SYSTEMS FOR THE DETECTION OF 99TC

OAK RIDGE NATIONAL LABORATORY

Current Status:

- The down-selected phosphor is $Y_3Al_{3.5}Ga_{1.5}O_{12}$:Ce, a visible emitting scintillator with a detection limit of approximately 7 μCi/cm^2. A commercially available phosphor is available for this application.
- A filtered low light imaging system, as well filtered night vision may be utilized to detect scintillation events originating from ^{99}Tc.
- The phosphor has been successfully sprayed and evenly distributed onto a large area.
- The scintillating phosphor spray development is near completion. It will be a non-hazardous water based formulation.
- A spraying apparatus has been selected for wide area coverage.
- Steps to demonstrate the technology on a variety of surfaces are underway.



This sample represents applying the scintillator to a contaminated surface. The contamination was dried onto the surface prior to addition of the scintillator. Note that no emission occurs from the portion of the scintillator that is not on top of the Tc-99.

Sprayer Configurations