Polymer Technologies for the Lockdown and Removal of Radioactive Contamination

Jayne Shelton
Isotron Corporation

1443 N. Northlake Way
Seattle, WA 98103
(206) 632-0173
Fax: (206) 260-7014
http://www.isotron.net
### Contamination vs. Radiation

<table>
<thead>
<tr>
<th>Contamination</th>
<th>Radiation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Mobile</td>
<td>• Ionizing radiation</td>
</tr>
<tr>
<td>- Watersoluble ions</td>
<td>- damage to cells</td>
</tr>
<tr>
<td>- Windborne dust</td>
<td>- Intensity drops with inverse square</td>
</tr>
<tr>
<td>• Intimate contact (d=0)</td>
<td>- Acute or chronic doses</td>
</tr>
<tr>
<td>• Ingestible radiation</td>
<td></td>
</tr>
</tbody>
</table>

**Source:** Univ. of Penn.

Contamination must be suppressed immediately, whereas radiation can be dealt with in a longer timeframe.
Radiation Shielding & PPE

<table>
<thead>
<tr>
<th>Nuclide</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cs-137</td>
<td>beta/gamma</td>
</tr>
<tr>
<td>Sr-90</td>
<td>beta</td>
</tr>
<tr>
<td>Co-60</td>
<td>beta/gamma</td>
</tr>
<tr>
<td>Ru-106</td>
<td>beta</td>
</tr>
<tr>
<td>Pu-239</td>
<td>alpha</td>
</tr>
</tbody>
</table>

Personnel distance and contact time can be controlled.

Possible spent fuel rod inventory.

Jayne working in hot hood at INL.

Jayne training in rad PPE.
ConOps Vision Timeline - Before

- Spent Fuel Exploded near NYSE
- Immediate area shut-down Attempt to establish Isolation Zone
- Contaminated people self present at hospitals
- Personnel cross-contamination
- Reaerosolization of contaminants results in plume spread. Contamination footprint grows.
- Area inaccessible and shut down. Contamination control area still requiring full rad gear due to contamination spread issues.
- Decontamination
Importance of Plume Mitigation

TOPOFF 2 Terrorism Response Exercise
May 2003 in Seattle, WA

Mock contamination from dirty bomb detected within c. 4 hours at San Juan Islands

Foot long stick of Co exploded at Manhattan would contaminate 1,000 sq. km, three states (NY Times, 2004)
ConOps: Immediate Post-Event Activity

Wide area application of IsoFIX lockdown polymer
- Particulate lockdown
- Application from a distance

Isotron lockdown application with hydroteeder prevents personnel contact.

Pilot-scale testing in Seattle.
IsoFIX Lockdown Polymer

Key Features

- Sprayable, elastomeric, removable polymer media
- Prevents transport by rain, wind, traffic

Once applied, the coating is easily and quickly peeled.

Pilot-scale demonstration of IsoFIX with SFD.
IsoFIX Lockdown Polymer Dust Suppression

Airborne lockdown immediate, full polymer properties within 13h

Helicopter dust suspensions cause personnel contamination (Chernobyl)

Helipad dust suppression in Richland, WA.
IsoFIX dust suppression trials in Richland, WA (2005)

56,000 lb. brush truck

IsoFIX withstands foot traffic, emergency ground vehicles

Treated section of ground did not break or lose integrity after brush truck test.
Advantages of IsoFIX Lockdown

- Contamination footprint contained
- Cross-contamination eliminated
- Critical operations may resume (NYSE)
- Personnel contamination is reduced
- Removable media to facilitate downstream decontamination
ConOps: Recovery & Reoccupation

How clean is clean?

DARPA SPO Radiation Decontamination Program, in collaboration with DHS, set performance criterion at 1 mSv/yr at 1m (near background)

Attain level at over variety of surfaces, materials

Source: JZPhotos.com
ConOps: Strippable Decon Coatings

Step 1. Survey suspected areas and determine decon needs
Step 2. Remove IsoFIX lockdown coating
Step 3. Apply optimal decon coating
- conventional spray equipment
- 3 m² coverage per gallon
- 400 m²/hr per spray pump
Step 4. Remove decon coating
- Peelable, no equipment necessary
- 150 m² per man-hr

Step 5. Transport to appropriate waste facility
- Solid waste disposal
- Compression ratio of waste on order of 50% (worst case scenario)
Real World Performance of Strippable Decon Coatings

- Low man hours (Nine Mile NPP)
- Quick return to operations (3 Mile Island)
- Removable from complex surfaces
- Simultaneous locks down and decons (as opposed to scabbling)
Highlights of ConOps Vision via Strippable Lockdown & Decon

- Expedient deployment to reduce personnel radiation exposure
- Cross-contamination avoidance
- Facile removal w/o resuspension risk
- Solid waste disposal (low-risk/low-cost)
ConOps Vision Timeline - After

- IsoFIX: Radionuclide Fixative applied immediately
- Spent Fuel exploded near NYSE
- IsoFIX removed
- Isotron Decon System applied
- Decontamination complete
- Solid waste incinerated for burial
- Restoration of NYSE to full operations
- Contamination plume controlled
- Plainclothes environment established
- Cross-contamination mitigated
- NYSE baseline operations resume
- NYSE baseline operations ongoing
Strippable Coating Products & Experience

- **Isolock-300**
  - Anti-contamination and surface decontamination for reactor cavity
  - Designed for immersion service
  - Deployed at: Houston Power and Light, Nine Mile, Oyster Creek

- **Isolock-HP**
  - Designed for high cross-section “hot” particle capture
  - Deployed at Arizona NPP

- **Isolock-VB (HSARPA)**
  - Vapor barrier portion of 2-step TIC Neutralization and Removal System
  - Wide area application system

- **IsoDEF™ (CB Barrier System)**
  - The first expedient shelter coating designed for barrier protection from chemical, biological and radiological contaminants
  - Demonstrated in live chemical agent trials in Czech Republic (HD Threat)
  - Currently in TRE Evaluation by JPEO ColPRO
Acknowlegdements

- Radionuclide Fixative Technology development is sponsored by the Technical Support Working Group under contract W91CRB-04-C-0021
- Radionuclide Decontamination Program is Sponsored jointly by DARPA and DHS under contract HR0011-04-C-0050
Safety & Toxicity of IsoFIX System

• Water-based Coating System
  ■ Non-flammable solution
  ■ Pre-mixed solution poses low health risk during application; mitigated by donning proper PPE

• Overall Environmental Impact
  ■ IsoFIX is waterborne and low VOC
  ■ No residue is left behind after removal
Safety & Toxicity of Decon Coating System

- **Water-based HASPs**
  - Non-flammable solution
  - Pre-mixed solution poses minuscule health risk during application; mitigated by proper PPE

- **Solvent-based DTS**
  - Flammable solution - proper ventilation needed to reduce flammability limit of air
  - PPE should include solvent respirators

- **Overall Environmental Impact**
  - Solvent-based DTS is based on VOC-exempt solvent (acetone)
  - HASP is waterborne and contains no VOC
  - No residue is left behind after removal of the strippable film
Strippable Coating Products & Experience

- **Isolock-300**
  - Anti-contamination and surface decontamination for reactor cavity
  - Designed for immersion service
  - Deployed at: Houston Power and Light, Nine Mile, Oyster Creek

- **Isolock-HP**
  - Designed for high cross-section “hot” particle capture
  - Deployed at Arizona NPP

- **IsoFIX / HeloTRON (Technical Support Working Group)**
  - Radionuclide and particle contaminant countermeasures
  - Designed for emergency service to “lock down” contaminants during S&R activities
  - Dual use as dust palliative for temporary helicopter landing sites
  - Removable on demand via peeling OR dissolution
  - System was deployed at field scale with TSWG, Seattle Fire Department and US Marine Corps oversight on May 13, 2005

- **“Orion” System (DARPA Radiation Decontamination Program)**
  - Deals with decontamination of dirty-bomb materials from common building surfaces
  - Complete decontamination system leverages strippable coatings to facilitate removal and transport of contaminants
  - Phase I demonstration completed April, 2005

- **Isolock-VB (HSARPA)**
  - Vapor barrier portion of 2-step TIC Neutralization and Removal System
  - Demonstrated for use on: NOx, HSO4, Cyanide, Ammonia, Ethylene Oxide and Cyclohexane remediation
  - Phase I effort will be complete June, 2005

- **IsoDEF™**
  - The first expedient shelter coating designed for barrier protection from chemical, biological and radiological contaminants
  - Demonstrated in live chemical agent trials in Czech Republic (HD Threat)

- **Other systems developed by Isotron Team:**
  - SprayPoly*: Asbestos control system
  - ALARA-1146*: First-generation radionuclide decon coating designed immediately following Three Mile Island accident.