Decontamination, Recovery & Waste Management

Alex Jenkins
Decontamination Expert & Deputy Chair of Sellafield Recovery Working Group
Sellafield Ltd, UK

27-28 October 2022, hosted by IRSN in Fontenay-aux-Roses, France
Themes

• What is decontamination?
• Strategic and tactical options
• Understand situational constraints
• Importance of waste
• Quantifying risk
• Plant example
What Is Decontamination?

Put simply;

• “Mobilisation or removal of a contaminating species from a substrate in part or in full in a controlled way to support a **Safety, Business or Recovery** requirement.”

• Many other permutations and **not** restricted to radiological contamination

NB Decommissioning is the removal and disposal of items.
Strategic Drivers / End States

The situational constraints inform the likelihood and type of methods to meet the following:

- Restricted reuse – initial restricted use for essential services,
- Institutional controls – maintain controls until hazard has decayed by either natural processes or simple treatments. (Only for short half life isotopes.)
- Reuse / reoccupation – return to normal
- Enable alternative reuse – building is used but for a different purpose
- Demolish / dispose – remove material to release for future uses

This level of assessment can be made quickly by an expert to inform potential direction(s) and duration for senior sanction e.g. Minister, Safety Committee.
Understand The Situational Constraints

- What is the scale of the decontamination requirement?
- How urgent is the decontamination required?
- What type of environment? Open, agricultural, low density or high density buildings?
- What can be used for containment to prevent spread of contamination? Only consider techniques that are compatible with the containment.
- Access, utilities, transport etc…
- Availability of skilled resources and equipment.
Typical Tactical Approaches

Hierarchy of approaches;

• Early Phase – stabilisation
  – CONTAIN – Containment of contamination to prevent (primary & secondary) spread e.g. Tenting, covers, coatings
  – CONTROL – Restrict access to the heavily contaminated areas to minimum

• Later Phases – controlled decontamination
  – REMOVE – Complete removal of contamination
  – REDUCE – Bulk removal of contamination
  – INACCESSIBILITY – Rendering the contamination inaccessible
Associated Factors

Characterisation:
- Knowing how much of what, is where?

Deployment:
- The tools needed to access contamination site and deliver the required technology / technique

Decontamination
- Which technique e.g. water jetting, fixing, chemicals, scabbling...

Waste Routes:
- What waste routes are available? Will the wastes generated be acceptable?
UK Nominal Waste Classifications

**LLW**
- <4,000 Bq/g Alpha
- <12,000 Bq/g Beta/Gamma

**ILW**
- >4,000 Bq/g Alpha
- >12,000 Bq/g Beta/Gamma

**HLW**
- >4,000 Bq/g Alpha
- >12,000 Bq/g Beta/Gamma
  + Heat generating
Waste Management Approaches

In addition to the Waste Management Hierarchy, the following approaches may be considered:

- **Waste Re-categorisation** – Create high volumes of a lower classification waste, that may include a much small quantity of higher activity waste
- **Size Reduction** – cut wastes to suit waste packages
- **Re-use** – decontamination of equipment / selected PPE
- **Diversion of wastes to most appropriate route / facility, e.g. smelting of metals**
Waste Constraints

- Is there a valid waste route available? – No solution without a waste solution
- Alongside the Waste Management Hierarchy, is an informal “Waste Acceptability Hierarchy”
- If the waste is solid, keep it solid
- Don’t ‘over process’ the waste.
### Classes Of Decontamination Technique

<table>
<thead>
<tr>
<th>Class</th>
<th>Techniques</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemicals</td>
<td>Mild, Medium, Aggressive, Foams, Gels</td>
</tr>
<tr>
<td>Abrasives</td>
<td>Wet and dry, Sand, Garnet, Bead</td>
</tr>
<tr>
<td>Mechanical / Physical</td>
<td>Scabbling, Needlegun, Laser, Microwave</td>
</tr>
</tbody>
</table>
| Fixatives & Strippable Coatings | To fix for handling (short term) or long term operation requires a recognised coating.  
|                             | Peel off for re-use / contamination control |
| Water Jetting              | Blockage removal, Coatings removal, High Pressure and Ultra High Pressure Water Jetting, Cutting |
Quantifying Risk

• Risk Level weighting to reflect situation specific criteria
• Quantifying risk to illustrate benefits of single and compound approaches;
  – Remove
  – Contain
  – Reduce
  – Control
• Mobility of the contamination
• How clean is safe? & how safe is clean?

<table>
<thead>
<tr>
<th>Color</th>
<th>Value</th>
<th>From</th>
<th>To</th>
<th>Man Hours/m²</th>
<th>Risk Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>1</td>
<td>R</td>
<td>G (Y)</td>
<td>2</td>
<td>200</td>
</tr>
<tr>
<td>Yellow</td>
<td>2</td>
<td>R</td>
<td>A (Y)</td>
<td>0.02</td>
<td>1.67</td>
</tr>
<tr>
<td>Amber</td>
<td>10</td>
<td>R</td>
<td>Y</td>
<td>0.02</td>
<td>1.67</td>
</tr>
<tr>
<td>Red</td>
<td>100</td>
<td>R</td>
<td>G</td>
<td>0.73</td>
<td>3.29</td>
</tr>
</tbody>
</table>

- Remove
- Contain
- Reduce
- Control
Plant Example

**Strategic Options**

1) Operate and control the whole plant with gross contamination in enhanced PPE and RPE

2) Gross removal of loose contamination on essential equipment only to enable an early restart

3) Gross removal of loose contamination on all surfaces but maintain plant as higher contaminated level operating area

4) Remove gross loose contamination, in normal work areas and sub-changerooms, for a restart of plant. Followed by a progressive period of phase decontamination

5) Plant-wide decontamination of accessible areas to previously designated contamination levels where practicable. Some items placed into special controls

Option 5 selected given time for investigation and remediation of the cause.
Tactical Approach

**Phase 1 - Create Human Access**
- Identify the critical items, decontaminate as required
- Vacuum, survey and contain contamination on floors with strippable coatings

**Phase 2 - Improve Working Environment**
- Vacuum, survey, wipe and cover items and surfaces (including walls and cell windows) up to head height
- Remove and reapply strippable coatings to contain residual contamination
- Create access towers to cranes and assess contamination levels at upper levels

**Phase 3 - Reduce Contamination In Rooms / Higher Designated Areas**
- Make progressive entry into sub-changerooms and infrequently accessed areas
- Methodology based on contamination levels
Plant Example

Phase 1 - Strippable Coatings
Phase 2 – Mobile access platform
Phase 2 – Rope access to cables
Nuclear Energy Agency

Plant Example - Completed

• Took 11 months
• 33,000 man hours to decontaminate
• No contamination incidents
• Plant is working better than before
• Demonstration of what an adaptable workforce can achieve.

Contamination Fixed In-Situ

Recovery Completed
### Plant Example – Waste Management

<table>
<thead>
<tr>
<th>Waste Form</th>
<th>Management Strategy</th>
<th>Disposal Route</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC based PPE</td>
<td>Re-use</td>
<td>Re-Use via Site Laundry</td>
</tr>
<tr>
<td>Other PPE (e.g. gloves, Tyvek suits)</td>
<td>Segregate and Diversion</td>
<td>Off Site Incineration</td>
</tr>
<tr>
<td>Vacuum Wastes</td>
<td>Compaction &amp; Disposal</td>
<td>Low Level Waste</td>
</tr>
<tr>
<td>Recovered Strippable Coatings</td>
<td>Segregation, Diversion &amp; Compacted Disposal</td>
<td>High Activity – Compacted Low Level Waste</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low Activity – Off Site Incineration</td>
</tr>
<tr>
<td>PVC Sheets / Bags</td>
<td>Compaction &amp; Disposal</td>
<td>Very Low Level Waste &amp; Low Level Waste</td>
</tr>
<tr>
<td>Sizal-Kraft Paper, decon wipes</td>
<td>Segregate and Diversion</td>
<td>Off Site Incineration</td>
</tr>
<tr>
<td>Higher Activity Waste</td>
<td>Compactions &amp; Disposal</td>
<td>Low Level Waste</td>
</tr>
</tbody>
</table>
Thank you
Merci
Danke
Gracias
ありがとうございます

Alex Jenkins,
Sellafield Ltd, UK
alex.jenkins@sellafieldsnites.com
Nuclear Energy Agency

Aide Memoir

Decontamination

Drivers / Constraints
- Purpose
- Time
- Cost
- Success Criteria
- In or Ex-Situ

Safety Documents
- Hazards
- ALARP
- Risk Assessment
- Method Statement

Nuclear Safety
- Accountancy
- Inventory
- Criticality

Equipment
- Tanks / Pumps
- Modifications
- Storage Areas
- Supply and handling

Resources
- Skilled Personnel
- HP&S
- Plant Operators

Wastes
- Radiological Classification
- Aerial
- Liquid
- Solids
- Routing

Containment Measures
- Tents
- PPE Requirements
- Gloveboxes
- Large Containments

Services / Infrastructure
- Water, Air, Steam, Power...
- Ventilation capability

Plant Constraints
- Plant changes / installation
- Space
- Impact to operations

Access / Deployment
- Manual / Long Tools
- Remote / Robotic
- Semi-Remote

Technical Issues
- Characterisation
- Reliability
- Performance
- Technique Selection

© 2022 Organisation for Economic Co-operation and Development