Final Status Surveys & License Termination

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New Brunswick Laboratory, US DOE
Speaker Background

- CHP
- Former Certified Senior Reactor Operator
- 20 years commercial reactor experience at 3 multi-unit sites and fleet-wide (13 total power reactors) technical support & direction – included D&D planning and execution for 3 reactors, and fleet wide planning
- 10 year decommissioning consulting to industry/gov’t – including consultation to IAEA
- Continuing lecturer in D&D for UK masters degree program
- Co-author, The Decommissioning Handbook, ASME/ANS/DOE
Outline

• License Termination Considerations
• License Termination Dose Assessment
• Material Release
• Final Status Surveys
• Lessons Learned
• Example
• Conclusion
• References
License Termination Considerations

- A dose assessment and Final Status Survey (FSS) are key parts of license termination but not the only ones of significance in preparing for final site closure.

- Other Issues Include
  - Remediation required for non-rad contaminants (if any)
  - Additional building demolition (if any)
  - Site restoration to meet end state requirements
  - Development of any programs for long term monitoring (if required)
  - Verification Surveys (radiological and non-radiological)
  - Regulator interaction including legal request for license termination
  - Stakeholder interaction
The ultimate purpose of decommissioning is to permanently remove any needed controls for a facility so that it may be reused for alternate purposes. All decommissioning tasks are focused on the dose assessment and final status survey which is performed to demonstrate that the facility has been sufficiently decontaminated that it meets the release requirements of the relevant regulatory authority.
Approach to Dose Assessment/Final Site Release
- *Entire lecture on one slide*

- Assure agreement on site release criteria
- Develop and obtain agreement on site specific dose modeling parameters
- Develop DCGLs (Derived Concentration Guideline Levels) and obtain agreement
- Use DCGLs to develop final status survey (FSS) program in accordance with MARSSIM or other approved approach
- Conduct FSS on a survey unit basis
- Analyze survey unit results – validate using MARSSIM or other approved protocols
- Develop survey unit documentation package for independent review
License Termination Dose Assessment

- Site release criteria often dose based (e.g., NRC 0.25 mSv/y all pathways + ALARA or EPA 0.01 mSv/y all pathways + 0.004 mSv/y drinking water) rather than contaminant level based – result is the need to perform dose modeling to provide field personnel with a measurable derived contaminant limit (DCGL) which would represent an all pathways exposure

- Computer codes often used to develop DCGLs in US include DandD and RESRAD
License Termination Dose Assessment (cont’d)

- RESRAD – Developed for USDOE by ANL in the early 1980’s – has continued updates
- DandD – Developed for USNRC by Sandia in 1998
- Others lesser used
  - Microshield
  - CAP88PC
  - GENII-S
  - PRESTO
RESRAD Overview

• Pathways Evaluated
  – Direct Exposure
  – Inhalation of particulates and radon
  – Ingestion of plant foods, meat, milk, aquatic foods, water and soil

• Default values installed in code with wide range of user variables possible
### Key Differences between RESRAD and DandD

<table>
<thead>
<tr>
<th>Parameter</th>
<th>DandD</th>
<th>RESRAD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dose Calculation</strong></td>
<td>Annual Average</td>
<td>Instantaneous</td>
</tr>
<tr>
<td><strong>Contamination Depth in soil</strong></td>
<td>Fixed at 15 cm.</td>
<td>Variable</td>
</tr>
<tr>
<td><strong>Groundwater pathways</strong></td>
<td>No delay between contamination zone to aquifer</td>
<td>Delay based on soil parameters</td>
</tr>
<tr>
<td><strong>Radon</strong></td>
<td>Not considered</td>
<td>Considered</td>
</tr>
</tbody>
</table>

Both codes provide reasonable agreement for direct radiation, Inhalation, and soil ingestion when using same input parameters.
Use of RESRAD and DandD

- Typically use DandD first as a screening tool – fewer inputs/simpler to use. If acceptable results, you are done. Otherwise proceed to a site specific model and use RESRAD. Closure agreements may also specify the codes/models which are acceptable.

- In all cases it is important to gain agreement early in the process with stakeholders on input assumptions, parameters, pathways to be evaluated and other “ground rules”.
## Impact of Ground Rules – Release Limits for Tritium

<table>
<thead>
<tr>
<th>Regulator</th>
<th>Standard</th>
<th>Contamination Limit (dpm/100 cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRC</td>
<td>Reg. Guide 1.86</td>
<td>5,000</td>
</tr>
<tr>
<td>NRC</td>
<td>Federal Register</td>
<td>120,000,000</td>
</tr>
<tr>
<td>DOE</td>
<td>Rad Con Manual</td>
<td>10,000</td>
</tr>
</tbody>
</table>
Three types of parameters for input to the dose assessment codes

- Physical – e.g., resuspension factor, soil porosity, annual rainfall, crop yields
- Behavioral – e.g., exposure period, area of land cultivated, irrigation rate
- Metabolic – e.g., breathing rate, water ingestion rate, food (many varieties) ingestion rate

Regulatory (and sometimes stakeholder) approval needed for selected parameters
License Termination Dose Assessment (cont’d)

- Current computer codes can run in deterministic or probabilistic modes – appropriate approach often needs regulator concurrence
- Calculate unit-based (e.g., 10 Bq/100 cm² or 1Bq/g) projected doses based on characterized contaminant mix
- Multiple code iterations will allow the generation of DCGLs based on site specific conditions and release criteria
Material Release Dilemma

• Currently we have clear guidance for release criteria for lands and structures post remediation
  – 0.25 mSv/y all pathways (NRC)
  – 0.01 mSv/y all pathways + 0.004 mSv/y drinking water pathway

• This means that a license may be terminated – meaning no further action required – with low but measurable radioactivity remaining onsite
Material Release Dilemma (cont’d)

• All materials and components removed during operations or during the course of decommissioning come under different regulatory guidance.
• Essentially, if you can detect any radioactivity above background, you can’t free release the materials. Few specific exemptions include:
  – Specific facility license conditions
  – 10 CFR 20.2002
Current US regulatory basis

• MARSSIM – Multi-Agency Radiation Survey and Site Investigation Manual – Issued December 1998 (Rev. 1 issued August 2000). Documents the combined result of USDOE, USEPA, USNRC, USDOD.

• MARSSIM works with a dose based standard vs. contaminant level standard

• Acceptable Release Levels are Derived Concentration Guideline Levels (DCGL) – Obtained through computer modeling
• The MARSSIM protocols are similar to USEPA CERCLA investigations.

• Structures and Grounds are initially grouped into two categories:
  – Non-Impacted (No chance of contamination – typically buffer zones)
  – Impacted (Varying chance of contamination)
Final Status Surveys (cont’d)

• Impacted areas are further split into three classes to reflect the levels of contamination before remediation
  – Class 1 Areas – High likelihood of exceeding the DCGL (> 90%)
  – Class 2 Areas – Some likelihood of exceeding the DCGL (~ 50%)
  – Class 3 Areas – Low likelihood of exceeding the DCGL (< 10%)
SITE CLASSIFICATION IN AREAS

Monitoring effort level

Highest

Class 1

Class 2

Class 3

Lowest
Additional Ground Rule Issues

- Level of confidence required
- Tolerance for false conclusions
  - False Positives ($\alpha$) – Licensee Risk
  - False Negatives ($\beta$) – Regulator Risk
- Potential for discrete contamination (hot particles)
- Presence of radionuclides of concern in background (mainly Cs-137 – “natural” background ~ 10 Bq/g in soil)
Step 1. State the Problem - Define the problem; identify the planning team; examine budget; schedule

Step 2. Identify the Decision - State decision; identify study question; define alternative actions

Step 3. Identify the Inputs to the Decision - Identify information needed for the decision (information sources, basis for Action Level, sampling/analysis method).

Step 4. Define the Boundaries of the Study - Specify sample characteristics; define spatial/temporal limits, units of decision making

Step 5. Develop a Decision Rule - Define statistical parameter (mean, median); specify Action Level; develop logic for action

Step 6. Specify Tolerable Limits on Decision Errors - Set acceptable limits for decision errors relative to consequences (health effects, costs)

Step 7. Optimize the Design for Obtaining Data - Select resource-effective sampling and analysis plan that meets the performance criteria
Final Status Surveys (cont’d)

Survey Design

- Know the radionuclides of concern and radiation emitted
- Know the likely distribution of radionuclides
  - Surface,
  - Subsurface
  - Volumetric
- Know the standards/ground rules to be applied
- Know the required MDAs/MDCs
Final Status Surveys (cont’d)

• Surveys will typically consist of direct measurements and scan measurements performed with portable instrumentation in the field, and sample removal and analysis (typically offsite).

• Measurements and sample acquisition must be performed with proper protocols (both MARSSIM and MARLAP – similar protocols for laboratory analysis)
Final Status Surveys (cont’d)

• Perform background checks and source check prior to surveys for portable equipment.
• Perform post survey source check to assure instrument stability.
• Document instrument pre/post checks along with survey data.
Final Status Surveys (cont’d)

- Understand the facility history
- Some surfaces/finishes may concentrate activity
- Some locations collect activity over time (“crud traps”)
  - Cracks and joints
  - Drains and traps
  - Trenches and sumps
  - Ductwork and elevated horizontal areas
- Obtain agreement with regulator on survey approaches for hot particles
**SIMPLE MONITORING INSTRUMENTS**

<table>
<thead>
<tr>
<th>Application</th>
<th>Detector</th>
<th>Characteristics</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha emitters</td>
<td>proportional – various windows sizes</td>
<td>0.4 to 3 Bq/100 cm$^2$ sensitivity for scanning</td>
<td>Sensitivity depending on type of surface</td>
</tr>
<tr>
<td></td>
<td>scintillation</td>
<td>3 Bq/100 cm$^2$ sensitivity for scanning</td>
<td>Sensitivity depending on type of surface</td>
</tr>
<tr>
<td>Beta emitters</td>
<td>proportional – various windows sizes</td>
<td>3 Bq/100 cm$^2$ sensitivity for scanning</td>
<td>Sensitivity depending on type of surface</td>
</tr>
<tr>
<td></td>
<td>Geiger-Muller</td>
<td>3 Bq/100 cm$^2$ sensitivity for scanning</td>
<td>Sensitivity depending on type of surface</td>
</tr>
<tr>
<td>Gamma emitters</td>
<td>Geiger-Muller</td>
<td>Measurement at 50% above background</td>
<td>Better sensitivity with time integration</td>
</tr>
<tr>
<td></td>
<td>proportional</td>
<td>Measurement at 50% above background</td>
<td>Better sensitivity with time integration</td>
</tr>
<tr>
<td></td>
<td>scintillation</td>
<td>Measurement at 50% above background</td>
<td>Better sensitivity with time integration</td>
</tr>
</tbody>
</table>

Note: These instruments can be used for scanning or in a time integration mode for increased precision during direct measurements.
### RADIATION DETECTORS FOR DOSE RATE MEASUREMENTS

<table>
<thead>
<tr>
<th>Application</th>
<th>Detector</th>
<th>Characteristics</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active</td>
<td>pressurised ionisation chamber</td>
<td>&lt;100 nSv/h sensitivity</td>
<td>high precision</td>
</tr>
<tr>
<td></td>
<td>Geiger-Muller</td>
<td>100 nSv/h sensitivity</td>
<td>Energy compensation needed</td>
</tr>
<tr>
<td></td>
<td>proportional</td>
<td>100 nSv/h sensitivity</td>
<td>Energy compensation needed</td>
</tr>
<tr>
<td></td>
<td>scintillator</td>
<td>&lt;100 nSv/h sensitivity</td>
<td>Dual phosphor or tissue for flat energy response</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(used in current mode)</td>
</tr>
<tr>
<td>Passive</td>
<td>Thermoluminescence dosemeter</td>
<td>&lt;50 nSv/h in 1 month</td>
<td>Good for wide area deployment</td>
</tr>
<tr>
<td></td>
<td>Film badge</td>
<td>100 μSv/month</td>
<td>Sensitivity not sufficient for background measurements</td>
</tr>
<tr>
<td></td>
<td>Electret ionisation chamber</td>
<td></td>
<td>Measures radon as well</td>
</tr>
<tr>
<td>Active/passive</td>
<td>Electronic dosemeter</td>
<td></td>
<td>Good for personal monitoring</td>
</tr>
</tbody>
</table>
### FIELD RADIATION DETECTORS FOR NUCLIDE-SPECIFIC MEASUREMENTS

<table>
<thead>
<tr>
<th>Application</th>
<th>Detector</th>
<th>Characteristics</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha emitters</td>
<td>Sealed –large area proportional counter</td>
<td>Minimum detectable activity (MDA) of 0.3 Bq/g or 2 Bq/100 cm²</td>
<td>Used as X ray spectrometer</td>
</tr>
<tr>
<td></td>
<td>FIDLER (Field Instrument for Determination of Low Energy Radiation)</td>
<td>MDA of 70 Bq/100 cm² for Pu mix</td>
<td>Can be used for scanning, detects X rays</td>
</tr>
<tr>
<td></td>
<td>Array of Si or Ge crystals</td>
<td>MDA of 0.03 Bq/g for Pu mix in 1 hour</td>
<td>Detects X rays or 60 keV line of ²⁴¹Am</td>
</tr>
<tr>
<td>Beta emitters</td>
<td>Scintillating fibres</td>
<td>MDA of 0.2 Bq/g for ⁹⁰Sr in 1 minute</td>
<td>Provides some nuclide/energy discrimination</td>
</tr>
<tr>
<td>Gamma emitters</td>
<td>NaI gamma spectrometer</td>
<td>10×10 cm crystall measures background nuclide concentrations in minutes</td>
<td>Low energy resolution</td>
</tr>
<tr>
<td></td>
<td>Ge gamma spectrometer</td>
<td>Larger types can measure 0.004 Bq/g in 10 minutes</td>
<td>High energy resolution</td>
</tr>
</tbody>
</table>
Gamma Screening Surveys
Monitoring for Compliance

• Survey preparation
  – Radionuclides of concern after remediation
  – Limits and criteria
  – Categorization of areas according to contamination potential
  – Determination of boundaries and survey units
  – Selection of background areas
  – Survey reference coordinate system
• Conducting Monitoring
  – Determination of background levels
  – Determine scan coverage
  – Minimum detectable activities vs limits
  – Calibration, counting efficiency
  – Sampling – preparation, collection and quality control
  – Use of multiple monitoring techniques
Requirements for the Samples

• Samples must be **representative**;
• Samples must be collected in **representative** places;
• Samples must be taken consistent with analysis requirements;
• Requirements should be documented
Tracking System for Samples

- Intended for guaranteeing the traceability of each sample during all the process of assessment in order to avoid mistaken inferences from the obtained results;
- It is a key component in a quality assurance program for any assessment based on samples analysis;
- It is necessary to keep records with all the relevant information;
- Previously designed worksheets should be used.

<table>
<thead>
<tr>
<th>Completed By</th>
<th>WORKSHEET #</th>
<th>RECEIVED #</th>
<th>WO #</th>
<th></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Environment/Ingestion Sampling Team</th>
<th>SOIL SAMPLING RECORD</th>
<th>RECEIVED #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepared by: _______________ (Full name)</td>
<td>_______________ (Full name)</td>
<td>__________</td>
</tr>
<tr>
<td>Provided to: ☐ Sample Analysis</td>
<td>_______________ (Name of recipient)</td>
<td>__________</td>
</tr>
</tbody>
</table>

| Sampling performed by: _______________ (Full name) | _______________ (Full name) | __________ |
| Sampling date: _______________ | Sampling time: _______________ | __________ |
| Sampling location: _______________ | GPS. Lat. _______________ Long. _______________ | __________ |
| Soil sample area: __________ [sqm] by __________ [sqm] | depth: __________ [cm] | __________ |
| Type of soil: ☐ sandy ☐ gravitational ☐ forest | ☐ mountain ☐ peatland marshes | __________ |
| Soil sample code: | | __________ |
| Vegetation sampled: ☐ Yes ☐ No | | __________ |
| Type of vegetation: _______________ | | __________ |
| Vegetation sample area: __________ [sqm] by __________ [sqm] | | __________ |
| Vegetation sample code: | | __________ |

| Average distance while sampling [cm], | | __________ |

<table>
<thead>
<tr>
<th>Water content</th>
<th>Certified</th>
<th>Certified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Dry</td>
<td>Y</td>
<td>Y</td>
</tr>
</tbody>
</table>

| Nutrient type: _______________ | Model: _______________ | Source: _______________ | __________ |
| Remarks: | | | __________ |

35
It is important to know the exact location whenever samples are taken, and record it properly;

Use of positioning traditional techniques require trained personnel and can be slow;

Modern positioning techniques: global positioning system (GPS) and microwaves, ultrasound and laser ranging systems.
Tracking System for Samples

- Samples should be coded for identification
- Samples codes must be as simple as possible, but they must allow distinguishing between samples, and between their associated obtained data
- Samples codification should be explicitly documented in a special procedure, and personnel must be well trained in this procedure
- Especial care should be taken when labelling samples
Sampling Techniques for Soil and Soil Subsurface

- Simplest way:
  - Digging a hole
  - Collect samples at different depths
- More sophisticated methodologies:
  - Augers, penetrometers and borehole technologies
- Avoid cross contamination of samples
- Reduce waste generation
Sampling

- Soil
  - Uniform cross section
  - Surface (to about 15 cm depth)
  - Subsurface, as needed
  - Trowel or tube
  - 100 grams to multiple kg (depends on analysis)
  - Consider sample composites
  - Documented sampling procedure
Final Status Surveys (cont’d)

- Ensure proper advanced planning in accordance with MARSSIM to minimize number of survey points/samples needed for acceptance
- Provide ongoing communications with regulators on progress and interim results. Work with regulator on survey schedules – joint surveys often beneficial for licensee and regulator
- Provide thorough documentation on process, results and analyses to demonstrate compliance
• Evaluation of Results
  – Basic Assessment
  – Background correction
  – Conversion to activities
  – Treatment of uncertainties
  – Graphical display of results
  – Final assessment
  – Comparison between measured and expected values
  – Decision of compliance
Final Survey - Background Radiation Variability

Terrestrial Gamma-Ray Exposure at 1m above ground

Source of data: U.S. Geological Survey Digital Data Series DDS-9, 1993
Data Management Tools
Additional tools

For tabular data presentation & necessary calculations:

- Spreadsheet software
- Database software
Lessons Learned (NRC and ORISE)

- Frequent and early communication between regulators, licensee and stakeholders essential
- Licensees conduct insufficient ground water monitoring
- In progress inspections beneficial (essential)
- Licensees need to justify parameters used in dose models and those used to derive DCGLs
- Inadequate HSA and current contamination documentation – need more info on:
  - Transport routes and possible spills
  - Predominant wind direction
  - Potential burial sites
  - Results of subsurface soil investigations
  - Don’t use old records as sole source for HSA
Lessons Learned (cont’d)

- Some Environmental Assessments haven’t provided enough information on non-rad impacts of proposed remediation actions
- Need sufficient characterization info to classify survey units
- Improvements needed on surveys & classification of embedded pipes
Lessons Learned (cont’d)

- Many issues relative to use of instrumentation:
  - Scan MDCs not provided or inadequate
  - Calibration procedures not in accordance with MARSSIM which recommends use of ISO-7503
  - Not listening to audio response while scanning
  - Cold weather effects on gas flow proportional counters
Example

- You are the licensee of a radioisotope processor – you obtain bulk high activity quantities of liquid Co-60 and Cs-137, dilute the liquids, package and ship to meet client needs. The facility ended operations, disposed of all in-process materials and decontaminated the building and contents to meet regulator and stakeholder requirements – all that remains is the 10,000 m² property.
Example (cont’d)

• HSA and characterization have noted several onsite locations with prior spills. Remediation has occurred at these known locations and you believe the site is ready for FSS.

• The release criterion is 0.25 mSv/y all pathways

• The following present the facts known and the general approach for dose assessment and FSS
• Characterization has shown a 50/50 mix of Co-60 and Cs-137 in the soil to a depth of 30 cm
• No contamination has spread beyond your property and the regulator concurs
• The regulator has concurred with your use of RESRAD v 6.5 with all default parameters
• An area of 2000 m$^2$ is class 1, 3000 m$^2$ is class 2 and 5000 m$^2$ is class 3
• You assume that all Cs-137 found is from your facility (no background correction)
Pre-MARSSIM survey approaches would require 1000 soil samples (one sample every ten square meters)
Example (cont’d)

• Using a value of 1 Bq/g each of Co-60 and Cs-137 in RESRAD with 10,000 m² affected area and 30 cm affected depth results in a projected peak dose of ~ 2.9 mSv/y (~ 2.3 mSv/y from Co-60 and ~ 0.6 mSv/y from Cs-137)

• Therefore for your site, 2.9 mSv/y is projected to be the maximum exposure through all pathways if there is no more than 1 Bq/g of Co-60 and 1 Bq/g of Cs-137 in the soil.
Contaminated Zone Dimensions

Area: 10000.00 square meters  
Thickness: 0.30 meters  
Cover Depth: 0.00 meters

Initial Soil Concentrations, Bq/g

<table>
<thead>
<tr>
<th>Element</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Co-60</td>
<td>1.000E+00</td>
</tr>
<tr>
<td>Cs-137</td>
<td>1.000E+00</td>
</tr>
</tbody>
</table>

Total Dose TDOSE(t), mSv/yr

Basic Radiation Dose Limit = 2.500E-01 mSv/yr

Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

<table>
<thead>
<tr>
<th>t (years)</th>
<th>TDOSE(t)</th>
<th>M(t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.000E+00</td>
<td>2.887E+00</td>
<td>1.155E+01</td>
</tr>
<tr>
<td>1.000E+00</td>
<td>2.584E+00</td>
<td>1.034E+01</td>
</tr>
<tr>
<td>3.000E+00</td>
<td>2.083E+00</td>
<td>8.333E+00</td>
</tr>
<tr>
<td>1.000E+01</td>
<td>1.057E+00</td>
<td>4.228E+00</td>
</tr>
<tr>
<td>3.000E+01</td>
<td>3.174E-01</td>
<td>1.270E+00</td>
</tr>
<tr>
<td>1.000E+02</td>
<td>5.147E-02</td>
<td>2.059E-01</td>
</tr>
<tr>
<td>3.000E+02</td>
<td>6.926E-10</td>
<td>2.771E-09</td>
</tr>
<tr>
<td>1.000E+03</td>
<td>0.000E+00</td>
<td>0.000E+00</td>
</tr>
</tbody>
</table>

Maximum TDOSE(t): 2.887E+00 mSv/yr at t = 0.000E+00 years
Example (cont’d)

DOSE: All Nuclides Summed, All Pathways Summed

- Co-60
- Cs-137
- Total

Years

Years

mSv/yr

mSv/yr

C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\SITE6.RAD  04/19/2012  07:45  GRAPHICS.ASC  Includes All Pathways
Example (cont’d)

• So if 1 pCi/g each of Cs-137 and Co-60 would result in total exposures of ~ 2.9 mSv/y, the soil activity limit (DCGL) for the example facility (equal to release limit of 0.25 mSv/y) is ~ 0.09 Bq/g each of Cs-137 and Co-60 (total of ~ 0.18 Bq/g)

• Now we go to MARSSIM to develop the FSS approach
• Based on agreed upon $\alpha$ and $\beta$ values of 5% (0.05) and a relative shift of 2.0 (see your MARSSIM expert for relative shift) you would need 15 soil samples for each survey unit for a total of 45 samples compared to 1000 samples with pre-MARSSIM guidance.

• For land survey units a Class 1 area can be up to 2000 m$^2$, Class 2 areas can be up to 10,000 m$^2$ and Class 3 areas can be any size. Based on this, our Class 1, 2, and 3 areas are each one survey unit.

• In addition to soil samples, each survey unit would need to have scan surveys.
Example (cont’d)

• Class 1 area would need 100% scan,
• Class 2 area would need between 10% and 100% on a judgmental and systematic basis
• Class 3 would need only judgmental scans
• Scanning instruments and approaches must meet appropriate MDCs
• Compare results to DCGLs, if all below, you’re OK, if some above, must use MARSSIM based statistical testing to determine if area is releasable
Example (cont’d) – FSS Results

Class 3 Area

Class 1 Area

Class 2 Area

Field Measurements > 0.12 Bq/g and < 0.18 Bq/g

Field Measurements > 0.09 Bq/g and < 0.12 Bq/g
All other measurements < 0.09 Bq/g
Conclusions

- The purpose of all decommissioning actions is to demonstrate that the facility is safe for reuse.
- Final Status Surveys and License Termination procedures provide the regulator the assurance that the requirements are met.
- These actions require substantial up-front planning and ongoing attention to execution to assure successful results.
- Design your plans and surveys with the end in mind for your facility.
- Be comfortable with change.
References

- IAEA WS-G-5.1, Release of Sites from Regulatory Control on Termination of Practices Safety Guide
- IAEA TRS-450, Management of Long Term Radiological Liabilities: Stewardship Challenge
- OECD/NEA 6187, Releasing the Sites of Nuclear Installations
- NUREG-1501 Background as a Residual Radioactivity Criterion for Decommissioning
- NUREG-1507 Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions
References (cont’d)

• NUREG-1575r1 Multi-Agency Radiation Survey and Site Investigation Manual (MARRSSIM)
• NUREG-1757v2 Consolidated NMSS Decommissioning Guidance – Characterization, Survey and Determination of Radiological Criteria
• NUREG/CR-5512v3 Residual Radioactive Contamination from Decommissioning – Parameter Analysis
• EPA 402-B-04-001 A,B,C – Multi Agency Radiation Laboratory Analytical Protocols (MARRLAP)
• NUREG-1575, Sup 1, - Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual (MARSAME)