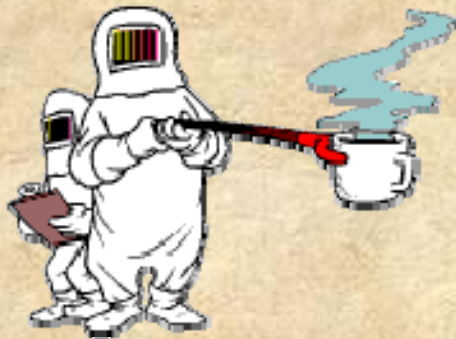


Decommissioning Radiological Laboratories

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Decommissioning Planning

- Management commitment
- Key stakeholders
- Project team
- Establish reasonable timelines
- Development of RFP and project scope
- Early contact with Regulatory Agencies (e.g. NRC or Agreement State)

Estimated Timelines

- Will vary depending on scope
- Typical overall timeline
 - Prepare Decommissioning Plan (15-30 days)
 - Submittal and approval to NRC or State (~60 days)
 - Perform site survey (2-30 days)
 - Prepare Final Status Survey Report (15 days)
 - Submission and approval of report by NRC or State (Variable?)
- Terminating a facility typically takes from 3-6 months on average post FSS
- Make management aware early!!!

Decommissioning Planning

- Perform Historical Site Assessment (HSA)
 - Review facility license and all amendments
 - Employee interviews
 - Monthly inventory logs
 - Source leak test records
 - History of releases or spills
- Performing a complete HSA is critical to maintaining the timeline and terminating the license

Decommissioning Planning (cont.)

- Federal limit of 25 mrem/yr
- State specific criteria
 - California currently has **no** dose based release criteria
 - Massachusetts uses 10 mrem/yr
- Select your facility's criteria
 - ALARA
 - RAM License Conditions
 - Corporate Culture
 - Risk
 - Overall Timing for Decommissioning

Decommissioning Criteria

- Contamination levels on building surfaces
 - Removable
 - Total
- Criteria Specified by
 - NRC Regulatory Guide 1.86
 - Facility RAM License Limits
 - NUREG-1757
 - NUREG-1575 (MARSSIM)

Regulatory Guide 1.86

TABLE I
ACCEPTABLE SURFACE CONTAMINATION LEVELS

NUCLIDE ^a	AVERAGE ^{b c}	MAXIMUM ^{b d}	REMOVABLE ^{b e}
U-nat, U-235, U-238, and associated decay products	5,000 dpm a/100 cm ²	15,000 dpm a/100 cm ²	1,000 dpm a/100 cm ²
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	<u>100 dpm/100 cm²</u>	300 dpm/100 cm ²	20 dpm/100 cm ²
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1000 dpm/100 cm ²	3000 dpm/100 cm ²	200 dpm/100 cm ²
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5000 dpm β-γ/100 cm ²	15,000 dpm β-γ/100 cm ²	1000 dpm β-γ/100 cm ²

Facility RAM License Criteria

- Most conservative limits for Specific Licensees
- Not recommended
 - Increased radioactive wastes
 - Problematic for instrument detection limits
 - Usually only specifies a removable contamination limit

NUREG-1757

- Consolidated NMSS Decommissioning Guidance
- Three volumes addressing following topics:
 - “Decommissioning Process for Materials Licensees”
 - “Characterization, Survey, and Determination of Radiological Criteria”; and
 - “Financial Assurance, Recordkeeping, and Timeliness”

NUREG 1757 (cont.)

- Volume 2 of the NUREG provides guidance on compliance with radiological criteria for license termination
- Many sections of 1757 will reference to MARSSIM
- MARSSIM does not cover DCGL determination, subsurface contamination or materials and equipment, where 1757 does provide guidance

NUREG-1575 (MARSSIM)

- Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)
- Most up to date and statistically valid method for decommissioning
- Recognized by NRC, DOE, DOD, and EPA
- Advantages
 - True dose based assessment
 - Allows higher limits of contamination
 - Produces less radioactive wastes
 - Fewer sample locations required
 - Based on statistical certainties

MARSSIM Process (Data Life Cycle)

- Plan (DQO Process)
- Implement (conduct surveys)
 - Scanning, direct measurements and sampling
- Assess (data quality assessment)
 - Statistical Tests and EMC
- Decide (compliance with release criteria)

Example MARSSIM Based Criteria

- Derived Concentration Guideline Levels (DCGLs) Based on a 25 mrem/yr Dose Criteria

Isotope	DCGL _w 's (DPM/100 cm ²)	Removable DCGL _w 's (DPM/100 cm ²)
H-3	1.25 x 10 ⁸	1.25 x 10 ⁷
C-14	3.75 x 10 ⁶	3.75 x 10 ⁵
P-32	9.5 x 10 ⁶	9.5 x 10 ⁵
P-33	4.25 x 10 ⁷	4.25 x 10 ⁶
S-35	1.25 x 10 ⁷	1.25 x 10 ⁶
I-125	6.75 x 10 ⁵	6.75 x 10 ⁴

- Significant difference from historic guidelines

Determination of DCGL

- Outside scope of MARSSIM, however NUREG 1757 (NUREG-1727) provides guidance
- Consider scenarios
 - Residential, Commercial/Industrial, Recreational, etc.
- Consider pathways
 - External, Ingestion (water, meat, soils, etc.)
 - Drinking water
 - Inhalation
- DandD or RESRAD

Types of DCGLs

- $DCGL_W$
 - DCGL for residual radioactivity evenly distributed over a large area
 - Use with WRS or Sign test
- $DCGL_{EMC}$
 - DCGL for small areas of elevated activity
 - Elevated measurement comparison to identify areas that require further investigation
 - Different assumptions than $DCGL_W$

Example Data Quality Objectives (DQOs)

- Default Screening Values (DSVs)
 - Typically set at 20 to 50% of DCGLs
- Instrument Detection Limits (ideally)
 - Recommendation is the Static MDC is 10 – 50% of the DCGL
- Must be known prior to selecting survey instrumentation
- Dose modeling analysis (RESRAD, DandD)
- Decision Errors (Type I and II)

Instrument Selection

- Research isotopes require sensitive instruments capable of detecting low energy beta emitters
- Separate instruments must be used to detect gamma emitters like I-125 (e^- capture)
- Instruments need to be calibrated at energies similar to isotopes of concern
- Calculate efficiencies correctly (2π vs. 4π)

Typical Instrument Specs

Detector Model	Detector Type	Detector Area	Meter Model	Window Thickness	Typical Total Efficiency
Ludlum 43-68	Gas Flow Proportional	126 cm ²	Ludlum 2350-1	0.4 mg/cm ²	6% (¹⁴ C)
Ludlum 43-37 Floor Monitor	Gas Flow Proportional	582 cm ²	Ludlum 2350-1	0.8 mg/cm ²	6% (¹⁴ C)
Eberline SPA-3	2" x 2" NaI	20.4 cm ²	Ludlum 2350-1	N/A	900 cpm/μR/hr (¹³⁷ Cs)
Beckman LS6000	Liquid Scintillation	N/A	Beckman	N/A	40% (³ H) 80% (¹⁴ C)

Typical Instrument MDCs

Type	Detector Model	Meter Model	Scan Rate	Count Time	Bkg (cpm)	MDC (dpm/100cm ²)
Surface Scans	Ludlum 43-68	Ludlum 2350-1	5 cm/sec	N/A	350	3,420 (¹⁴ C)
Surface Scans	Ludlum 43-37	Ludlum 2350-1	5 cm/sec	N/A	1,200	841 (¹⁴ C)
Surface Scans Soils	Eberline SPA-3	Ludlum 2350-1	0.5 m/sec	NA	10,000	2.03 pCi/g (¹³⁷ Cs)
Total Surface Activity	Ludlum 43-68	Ludlum 2350-1	N/A	1 min.	350	1,500 (¹⁴ C)
Removable Activity	Liquid Scintillation	Beckman	N/A	1 min.	8 (³ H) 12 (¹⁴ C)	41 (³ H) 24 (¹⁴ C)

Typical Instruments

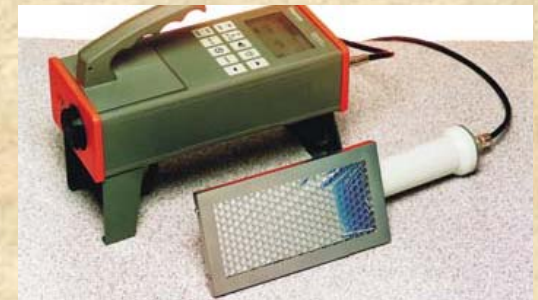


MDC Comparison

$$MDC (dpm / 100cm^2) = \frac{3 + 3.29 \sqrt{(R_b)(T_{s+b})(1 + T_{s+b}/T_b)}}{(Eff.)(T_{s+b})(probe\ area\ cm^2 / 100\ cm^2)}$$

NUREG-1507

- Large Area probe
 - ~6% total efficiency for C-14
 - Probe area 100 cm²
 - Bkg ~350 cpm, 1 min counts
- G-M probe
 - ~3% total efficiency for C-14
 - Probe area 19.6 cm²
 - Bkg ~50 cpm, 1 min counts



MDC Comparison

- Large area probe
 - Static MDC is 1,500 dpm/100 cm²
 - Scan MDC is 3,420 dpm/100 cm²
- G-M probe
 - Static MDC is 6,105 dpm/100 cm²
 - Scan MDC is 18,183 dpm/100 cm²
- If you have restrictive DCGL you can see how instrument selection is critical

Historical Site Assessment (HSA)

- Identify potential sources of contamination
- Differentiate areas of different contamination potential – Impacted vs. Non-Impacted
- Provide input to scoping and characterization survey design
- Provide assessment for potential of contaminant migration
- Classification of Areas (Class 1, 2, 3)

Characterization Surveys

- Biased based on history, material use and storage
- Scan percentages based upon area classification
- Be consistent with planned FSS to potentially use as FSS data
- Combination of scans, static and removable measurements
- Removable contamination measurements obtained in areas of highest activity
- Identifies areas of contamination which require remediation

Scan Surveys

- Scanning
 - Coverage based upon Class
 - Probe $\frac{1}{4}$ inch or closer to surface
 - Move at prescribed scan rate
 - Usually 1-2 inches per second
 - Listen for audible count rate increase
 - Pause over areas of elevated activity
 - Define areas of contamination
 - markers, paint, dots, etc
- Be patient and attentive



Static Measurements

- Measures disintegrations per unit time over a specified area (dpm/100 cm²)
- Survey map
- Probe in direct contact with surfaces
- Make sure surface is in contact with entire detector surface
- Shorter count times result in higher MDCs
- Area correct for probe size

Removable Measurements

- Wipe sample
 - Whatman Filter paper
 - Q-tip swab
- Normal hand pressure over 100 cm² area
 - 10-cm by 10-cm square
 - 8-inch Z pattern
- Templates are typically not used
- Separate wipes to prevent cross contamination
- Keep wiping technique and sample area uniform

Final Status Surveys

- Demonstrate that residual radioactivity in each survey unit satisfies release criteria
- Builds on data from HSA and results from scoping and/or characterization surveys
- Goal is to be able to reject null hypothesis meaning area meets release criteria
- Background reference areas very important
- Sample size calculated that can statistically demonstrate compliance with the derived concentration guideline levels (DCGLs)

Final Status Surveys

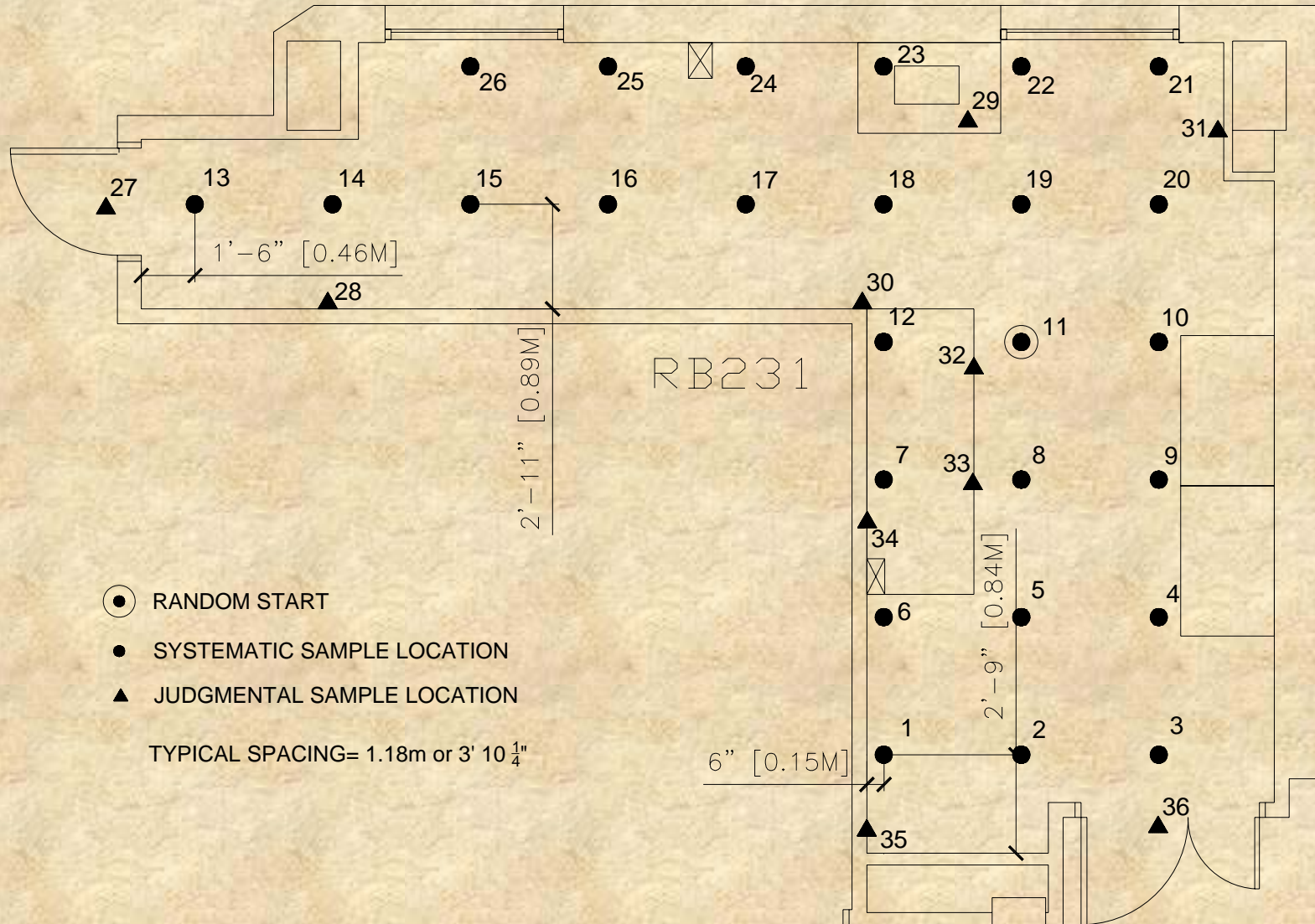
- Fixed Building Components
 - Lab benches
 - Floors
 - Walls
- Utility Systems
 - Local Exhaust (fume hood)
 - Vacuum
 - Drains

Final Status Survey

Building Components

- Fixed Grid Pattern
 - 1-3 meter grids
 - Random Start Location
 - Location should be reproducible
- Obtain static then removable contamination measurements
- Typically use scan survey data from the characterization survey

Example Systematic Lab Design



Utility Systems

- Keep data separate
- Each type of system is evaluated independently
- Many can only be evaluated for removable contamination
- How do we demonstrate contamination levels are acceptable?

Does your lab look like this?



Or this?



FSS Key Considerations

- Accurate HSA & consider decay when appropriate
- Static MDC should be <50% of DCGL
- Scan MDC comparison to DCGL for determination of additional measurements
- Proper classification of areas
- Planning to minimize duplication
- Materials & Equipment Release (Reg. Guide 1.86)
- Keep systems separate (e.g. vacuum, drain, ventilation)
- Managing Costs

FSS Potential Pitfalls

- Poor instrument selection
- Release limits not clearly defined
- Scope of work not clearly defined
- Selecting a DCGL that is too restrictive
- MDCs of Instruments (Static, Scan)
- Gross DCGL
- Incorrect number of samples
- Not addressing systems

Summary

- Plan early & commit resources
- Negotiations with Regulatory Agency
- Internal staff vs. external support
- FSS Report is key element for release
- Time spent in planning and managing can reduce overall timeline
- Documentation, documentation, documentation
- Success will be measured more by meeting deadlines than meeting release limits

Questions and Experiences???



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