IMPLEMENTATION OF MARSSIM - LESSONS LEARNED

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Enclosure 2

NRC's Experience Base

- License Termination Plans, Decommissioning Plans, and a partial site release reviewed under the License Termination Rule
  - Oyster Creek, Trojan, Saxton, Maine Yankee, Connecticut Yankee, Nuclear Fuel Services, Mallinckrodt
- NRC/ORISE in-process inspections conducted in support of decommissioning
- Staff participation on the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) Workgroup

MARSSIM Advantages

- Consistent approach to radiological surveys
- Emphasizes up-front planning and design
- Decision-based framework
- Uses Data Quality Objective (DQO) process and Data Quality Assessment (DQA)
- Iterative approach
- Statistically defensible
- Flexible methodology

MARSSIM Limitations

- Substantially more complex than NUREG-5849 guidance
- Does not apply to subsurface (>15 cm) soil contamination
- Does not address non-flat surfaces and equipment
- May be difficult to determine small areas of elevated residual radioactivity

MARSSIM Limitations (Cont'd)

- May actually result in larger sample numbers as compared to NUREG-5849
  - Statistical test may fail survey unit when derived concentration guideline level ($DCGL_W$) is near background
  - Hard-to-detect (HTD), transuranic (TRU), or multiple radionuclides may result in high scan minimum detectable concentrations (MDCs)

Historical Site Assessment (HSA)

- Identifies potential sources of contamination
- Initially determines non-impacted and impacted area classifications
- Lessons
  - Site records may be limited
  - Licensee's staff interviews directed biased sampling and measurements
  - Significant radiological events summarized

Classifications of Impacted Areas

- Area classifications determined by contamination potential
- Residual radioactivity is compared to $DCGL_W$
- Prescribed definitions, size restrictions, investigation levels, and sampling patterns
- Impacted areas are initially assumed as Class 1
- Non-impacted areas require no sampling and measurements in final status survey
- Class 2 areas require no remediation

Classifications of Impacted Areas (Cont'd)

- Lessons
  - Justification for classifying areas is required
  - HSA, scoping and characterization data facilitate staff review
  - Detailed figures and maps illustrating non-impacted and impacted areas provide valuable information

Scoping/Radiological Site Characterization

- Scoping survey
  - Performed if HSA indicates impacted areas
  - Supports Class 3 areas and provides data for final status survey
- Site Characterization
  - Determines nature and extent of contamination
- Information used to direct remedial action support surveys and develop derived concentration guideline levels ($DCGL_WS$)

Scoping/Radiological Site Characterization (Cont'd)

- Lessons
  - Information from Radiological Environmental Monitoring Program (REMP) may be inadequate
  - Site characterization data collected using former NRC guidance supplements a site's characterization program
  - Site characterization may continue into the final status survey
  - Radionuclide concentrations should be representative of site conditions

Scoping/Radiological Site Characterization (Cont'd)

- Insufficient site characterization has delayed
  - Remediation activities
  - Development of cost estimates
  - Development of $DCGL_W$s
  - Review process
- 10 CFR 50.75(g) requirements

Radiological Survey (Field) and Laboratory Instruments

- Compliance is ultimately demonstrated by sampling and measurement, and post-processing of data
- Lessons
  - Selection of radiological instruments may change
  - DQOs must be adequately addressed
  - Static MDCs within 10 to 50% of $DCGL_W$ are often readily achievable
  - Scan MDCs require evaluation and validation by inspection

Implementation of Scan MDCs

- Scanning is conducted to identify elevated areas of residual radioactivity not sampled
- Establish appropriate investigation levels (fraction of $DCGL_W$)
- Scanning coverage is dependent on Class

Implementation of Scan MDCs (Cont'd)

- Lessons
  - Instrument efficiency (ϵ_i) using a representative, conservative, or beta-weighted average energy for the radionuclide mixture at site is acceptable
  - ISO 7503-1 and 7503-3 source efficiency (ϵ_s) values for alpha/beta surface contamination detectors for design goals are acceptable
  - Appropriate ϵ_s values for scabbled concrete and embedded piping need to be determined and evaluated

Quality Assurance Program

- Ensures survey, sampling, and analysis activities are performed using approved site/contractor procedures
- Lessons
  - MDCs should be consistent with contract laboratory
  - Instrumentation requires NIST-traceable calibration using radiation sources appropriate for type and energy
  - Training and qualifications program of staff/contractor should be reviewed by inspection
  - Procedures should be referenced in plan for inspection purposes

Final Status Survey

- Conducted after successful remediation and licensee determines their site meets the release criteria
- Lessons
  - Much of information needed to properly design a final status survey may not be available
  - Information and level of detail depends on what phase in decommissioning process a plan is submitted
  - Licensee commitments to provide information

Final Status Survey (Cont'd)

- Plans have considered Scenario A in MARSSIM
- Decision errors: α (Type I) = β (Type II) = 0.05 (typically)
- Relative shift (Δ/σ) optimized between 1 and 3 by adjusting LBGR to obtain reasonable number of samples
- Staff's conceptual approval of final status survey design

Reclassification of Survey Areas/Units

- Considers existing information from HSA, scoping and characterization surveys, and professional judgement
- Lessons
  - 10 CFR 50.59 process
  - Size restrictions, investigation levels, and sampling patterns must be maintained
  - New survey design required for Class 1 and 2 areas
  - Additional measurements required for Class 3 areas
  - Controls/methods to minimize recontamination of surveyed areas when remediating adjacent areas

Implementation of $DCGL_W$s

- $DCGL_W$s are used to demonstrate compliance with the Radiological Criteria
- Screening $DCGL_W$s for building surface contamination
  - Residual radioactivity is reduced ALARA
  - Fraction of removable contamination <10%
  - No volumetric contamination
- Screening $DCGL_W$s for soils
  - Residual radioactivity is reduced ALARA
  - No subsurface soil, surface or ground water contamination
- Ref: 65 FR 37186 (June 13, 2000)

Implementation of $DCGL_W$s (Cont'd)

- Lessons
  - Surrogate ratios applied in $DCGL_{MOD}$ for soil
    - ^{137}Cs, ^{235}U, and ^{241}Am surrogate radionuclides
    - Screening and/or site-specific $DCGL_W$s
  - Relative fractions applied in $DCGL_{GA}$ or unity rule for building surfaces
    - Fission, activation, HTD, and TRU radionuclides
    - Screening $DCGL_W$s
  - Surrogate ratios and relative fractions developed by pre-remediation data must be verified post-remediation

Elevated Measurement Comparisons

- Ensures total effective dose equivalent (TEDE) in elevated areas does not exceed release criteria
- Additional measurements may be needed based on calculated scan MDC
- Lessons
  - Area factors for soils calculated by DandD or RESRAD codes
  - Area factor for building surfaces calculated by RESRAD-BUILD code

Surveys for Embedded Piping, Inaccessible, and/or Hard-to-Reach Areas

- No guidance currently available
- TEDE in survey unit containing embedded piping must not exceed release criteria
- Biased and judgmental sampling may substitute for random-start, systematic pattern measurements
- Biased measurements are inappropriate for use in statistical tests
- Inaccessible, not readily available, or hard-to-reach areas made available for surveys and sampling in Class 1 areas

Surveys for Embedded Piping, Inaccessible, and/or Hard-to-Reach Areas (Cont'd)

- Lessons
  - Separate dose criteria for penetrating radiation from embedded piping proposed
  - Grit blasting of internal surfaces of embedded piping planned to reduce surface activity levels
  - Calibration concerns for gross surface activity measurements in embedded piping
  - Radionuclide-specific measurements for relative fractions determined by pipe scraping analysis
  - Scan MDC requires evaluation and validation

Need for Continued/Improved Guidance Development

- Consolidation of guidance
- Subsurface soil contamination
- Embedded piping surveys
- Area factors for building surface contamination
- NUREG-1727, 14.0 "Facility Radiation Surveys"
- NUREG-1727, Appendix E "Implementation of MARSSIM"