MARSSIM Final Status Survey Design: Determining the Need for Additional Soil Samples Based on Scan MDC

Health Physics Society meeting in Cleveland, OH Decommissioning Section Session June 13, 2001 Eric W. Abelquist

Sign Test – Co-60 and Am-241 in Soil (Class 1)

Site contaminants: Co-60 and Am-241 Class 1 survey unit area is 1,500 m² Two strategies for determining need for additional samples based on scan MDCs RESRAD version 5.95 used to get DCGLs -3.4 pCi/g for Co-60 - 11.8 pCi/g for Am-241

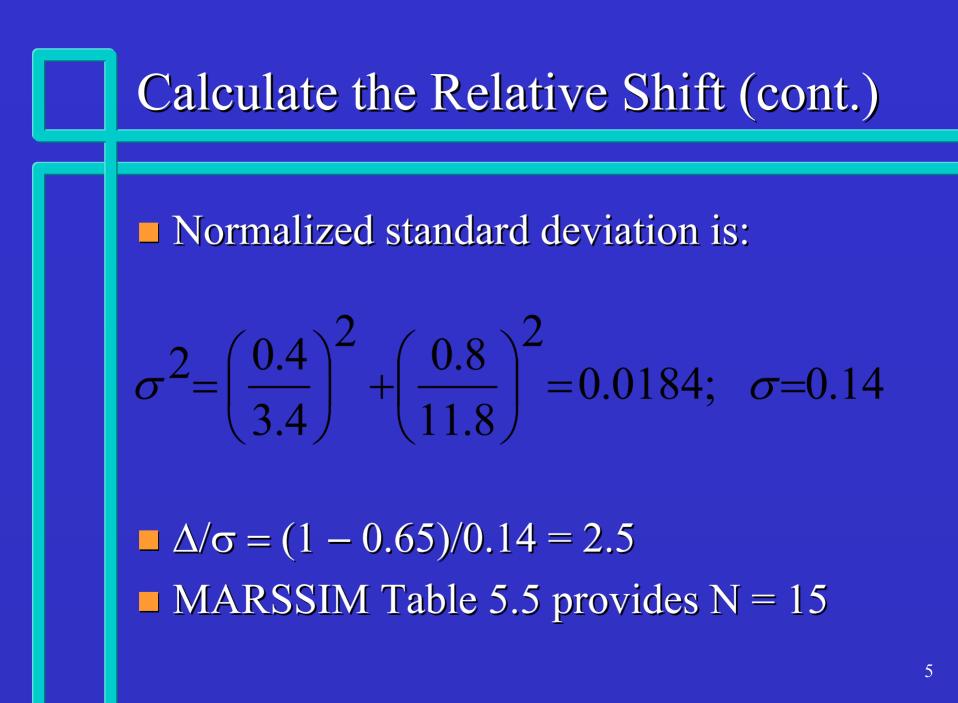
Sign Test – DQO Inputs

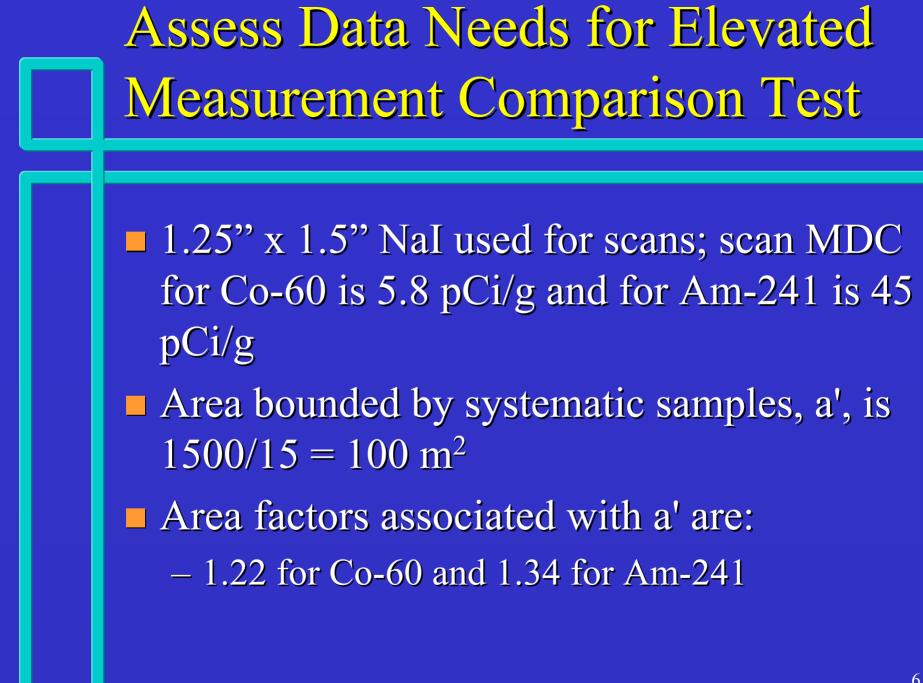
 Unity rule is used for survey design
 Characterization data used for planning: <u>Survey Unit</u>
 Co-60 1.1 ± 0.4 (1σ)
 Am-241 3.8 ± 0.8 (1σ)
 Type I and II decision errors set at 0.05

Calculate the Relative Shift

 LBGR is set at expected concentration: 1.1/3.4 + 3.8/11.8 = 0.65
 Standard deviations from survey unit are normalized according to MARSSIM eqn I-2:

$$\sigma^{2} = \left(\frac{\sigma_{Co-60}}{DCGL_{Co-60}}\right)^{2} + \left(\frac{\sigma_{Am-241}}{DCGL_{Am-241}}\right)^{2}$$





Area Factors for Co-60 and Am-241 (from RESRAD)

<u>Area (m²)</u>	<u>Co-60</u>	<u>Am-241</u>
3000	1	1
1000	1.02	1.00
300	1.10	1.06
100	1.22	1.34
30	1.58	2.46
10	2.33	4.39
3	4.95	9.50
1	11.6	159

Assess data needs for EMC

Determine required Scan MDC: (DCGL_W Area Factor) Co-60: (3.4 pCi/g)(1.22) = 4.15 pCi/gAm-241: (11.8 pCi/g)(1.34) = 15.8 pCi/gActual scan MDCs for both radionuclides are greater than the required scan MDCs – we need additional samples for EMC

Strategies for Determining Number of Additional Samples Determine which of the two radionuclides is the "driver" for the additional samples - Calculate ratio of actual-to-required scan MDC - Radionuclide with largest ratio is the driver Determine reasonable ratio (or range of ratios) between the radionuclides - Scan MDC, DCGL, and area factors are determined for specific radionuclide mixture

Determine "driver" for the additional samples Actual-to-required scan MDCs: - Co-60: 5.8/4.15 = 1.4 - Am-241: 45/15.8 = 2.8 ■ Therefore, Am-241 is the driver \blacksquare AF = actual scan MDC/DCGL, AF = 45/11.8 = 3.81Interpolate to get area that corresponds to this AF: a' is 13.1 m²; new sample size = 1500/13.1 = 115

Determine reasonable ratio (or range of ratios) between the radionuclides

Requires determination of the scan MDC for a specific mixture of Co-60 and Am-241

...and modeling to determine DCGL_W and area factors for this specific mixture (simply stated, this approach is more work!)
 Let's briefly review scan MDC calculations

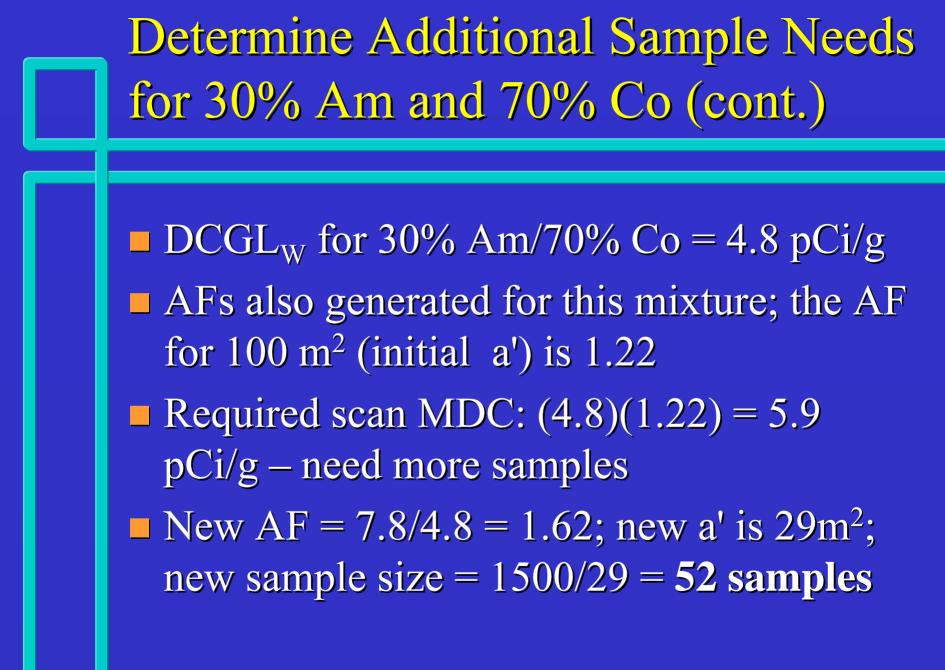
Scan MDC Determination

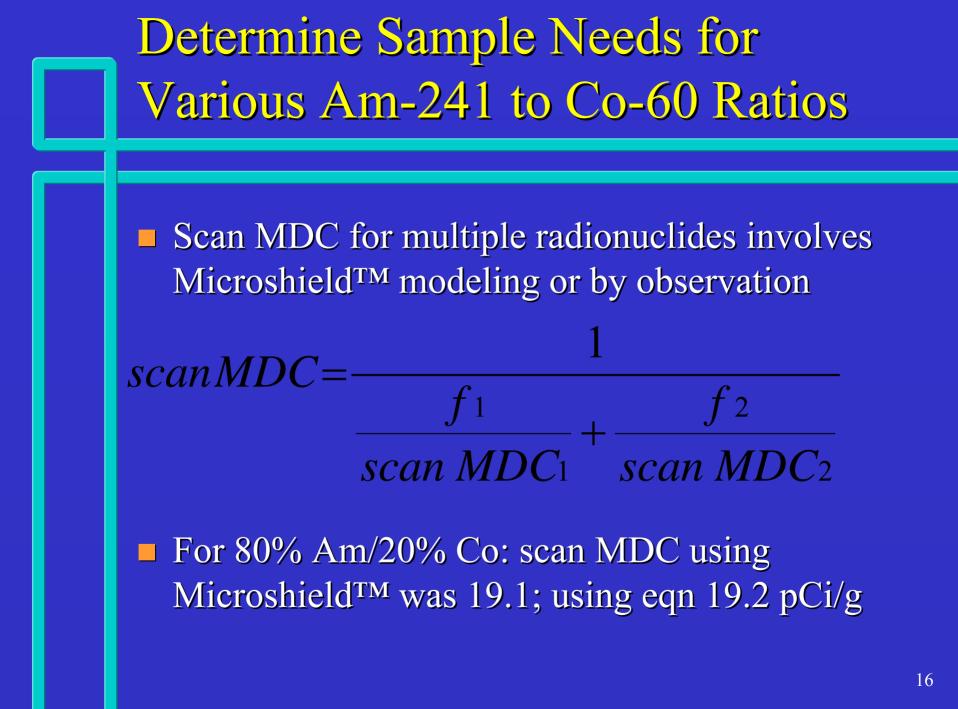
- Minimum detectable count rate based on signal detection theory & human factors(NUREG –1507)
- Relate MDCR in cpm to minimum detectable exposure rate (MDER) based on NaI characteristics
- MicroshieldTM to model specific radionuclide(s) concentration and geometry yields exposure rate
 Scan MDC = MDER/CF, where CF is the
 - exposure rate to concentration correction factor

Scan MDCs For 1.25"x1.5" Nal Detector

Radionuclide	<u>Scan MDC (pCi/g)</u>
Cs-137	10.4
Am-241	44.6
Th-232	2.8
Co-60	5.8
Processed Uranium	115
Enriched Uranium (3%)	137
Ra-226	4.5

Determine Additional Sample Needs for 30% Am-241 and 70% Co-60 Based on process knowledge and characterization, 95% confidence level on fractional amount of Am-241: 0.3 to 0.8 Determine additional sample needs for lower bound ratio: 30% Am and 70% Co Calculate scan MDC – expect it to be between 5.8 pCi/g (Co-60) and 45 pCi/g (Am-241): scan MDC = 7.8 pCi/g





Additional Sample Needs as a Function of Am/Co Mixture

Mixture]	DCGL Sc	an MDC Add	<u>'l Samples</u>
0%Am	3.4	5.8	62
30%Am	4.8	7.8	52
50%Am	6.6	10.3	42
65%Am	9.3	13.4	29
80%Am	14.7	19.2	0
90%Am	13.1	26.9	35
100%Am	n 11.8	45	115

