Gamma Spectroscopy of Concrete Pucks

Introduction:

Lacrosse decommissioning staff analyzed characterization and FSS concrete pucks (3 in dia X 0.5 in thick) using the in-house gamma spectroscopy system. For each puck, an analysis was performed on each facing surface in close proximity to the detector. A summary of the data is shown in Table 1.

Table 1: Summary of Puck Onsite Analysis

Sample ID	Orientation	Cs-137 Results, (pCi/g)	Ratio top/bottom
B1-010-04A-CJFC-009-CV 0-0.5"	Top	5.95	2.20
	Bottom	2.70	
B1-010-04A-CJFC-010-CV 0-0.5"	Top	10.5	1.72
	Bottom	6.11	
B1-010-04A-CJFC-011-CV 0-0.5"	Top	4.63	2.91
	Bottom	1.59	
B1-010-04A-CJFC-012-CV 0-0.5"	Top	3.16	3.58
	Bottom	0.882	
B1-010-04A-CJFC-013-CV 0-0.5"	Top	148	2.92
	Bottom	50.7	
B1-010-04A-CJFC-014-CV 0-0.5"	Top	74.2	3.27
	Bottom	22.7	
B1-010-04A-CJFC-016-CV 0-0.5"	Top	5.48	2.67
	Bottom	2.05	
		average	2.75

In order to assess the distribution of the activity, a simulation was done using Microshield for several geometrical representations of activity distribution for a comparison to the ratios in Table 1.

Analysis:

Two Microshield models were created for this simulation as presented below.

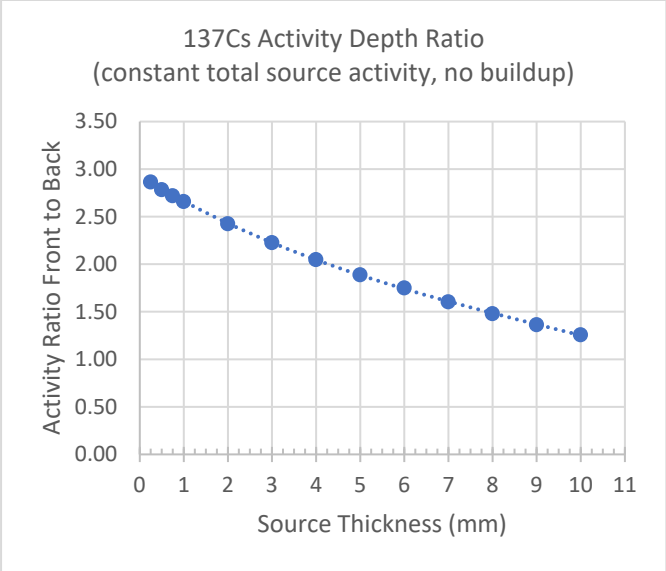
Model 1:

This model varied the thickness of the activity distributed within the puck from a thickness of 0.25 mm to 10 mm and for each thickness, the activity remained at 320 µCi (1 Bq/g for 1 mm thick source). For each case, the dose point was at the puck center with an offset of 1 cm. This data is shown in Table 2.

Table 2: Dose Point at Center of 3 inch diameter source at an offset distance of 1 cm from the source. Disk activity at 320 µCi Cs-137, variable source thickness

Case	Source Thickness (mm)	Back Side Dose Rate (mR/h)	Front Side Dose Rate (mR/h)	Ratio: Front to Back
0.25 mm Source	0.25	6.26E-05	1.79E-04	2.86
0.50 mm Source	0.50	6.30E-05	1.75E-04	2.78
0.75 mm Source	0.75	6.37E-05	1.73E-04	2.72
1 mm Source	1	6.44E-05	1.71E-04	2.66
2 mm Source	2	6.66E-05	1.61E-04	2.43
3 mm Source	3	6.89E-05	1.53E-04	2.23
4 mm Source	4	7.17E-05	1.47E-04	2.05
5 mm Source	5	7.44E-05	1.41E-04	1.89
6 mm Source	6	7.69E-05	1.35E-04	1.75
7 mm Source	7	8.10E-05	1.30E-04	1.60
8 mm Source	8	8.42E-05	1.25E-04	1.48
9 mm Source	9	8.79E-05	1.20E-04	1.36
10 mm Source	10	9.23E-05	1.16E-04	1.26

Figure 1



This data strongly suggests that the observed ratio from Table 1 of 2.75 suggests a very thin source distribution of approximately 1 mm or less.

Model 2:

This model assumed that the source was distributed in a 1 mm layer in two configurations, the source facing the detector and the source facing away from the detector (gamma rays attenuated through the

0.5 inch concrete puck). In this case, a 1 Ci Cs-137 source was used for all runs and the gap between the concrete and the dose points was 0.3 mm air and the location varied radially from the center to the edge in four increments. The data from these analyses are shown in Table 3 and support the hypothesis that the source is thin since the ratios shown below are close to the vale of 2.75 from Table 1

Table 3

1 mm Disk Source Thickness, offset distance of 0.3 mm			
Radial Distance, cm	DR Source Away from Detector (back), R/h per Ci	DR Source Towards from Detector (front), R/hr per Ci	Ratio: Front to Back
0	478	1489	3.12
1.27	459	1439	3.14
2.54	390	1309	3.36
3.81	253	681.4	2.69

Conclusions

The Microshield models strongly suggests that the distribution of Cs-137 is substantially smaller than the value of 0.5 inch used in the WGTV ISOCS modeling.