APPENDIX P-4

FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area: BSA 02 **Description:** Building Survey Area (Building 230)

Survey Unit: 14 **Description:** U-Shaped Area (Southeast) – Lower Walls, Floor and Stairs

Survey Type: FSS **Classification:** Class 2

Measurement or Sample ID	Surface or CSM	Type	Start Elevation	End Elevation	Northing (feet) (Y Axis) *	Easting (feet) (X Axis) *	Remarks / Notes
B02-14-01-S-W-S-00	W	S	NA	NA	6.1	16.3	Instrument Lab North Wall
B02-14-02-S-W-S-00	W	S	NA	NA	2.1	4.3	Instrument Lab West Wall
B02-14-03-S-W-S-00	F	S	NA	NA	48.3	14.2	U-Shaped Area Floor
B02-14-04-S-W-S-00	F	S	NA	NA	48.3	48.7	U-Shaped Area Floor
B02-14-05-S-W-S-00	F	S	NA	NA	48.3	83.1	U-Shaped Area Floor
B02-14-06-S-W-S-00	W	S	NA	NA	4.7	11.7	Gad Room North Wall
B02-14-07-S-W-S-00	W	S	NA	NA	3.5	90.4	U-Shaped Area South Wall
B02-14-08-S-W-S-00	F	S	NA	NA	18.4	65.9	U-Shaped Area Floor
B02-14-09-S-W-S-00	F	S	NA	NA	18.4	100.3	U-Shaped Area Floor
B02-14-10-S-W-S-00	W	S	NA	NA	4.1	7.5	HP Area North Wall
B02-14-11-S-W-S-00	W	S	NA	NA	4.1	42.0	HP Area North Wall
B02-14-12-S-W-S-00	W	S	NA	NA	4.1	76.6	HP Area North Wall
B02-14-13-S-W-S-00	W	S	NA	NA	4.3	55.8	HP Area South Wall
B02-14-14-S-W-S-00	W	S	NA	NA	4.3	21.3	HP Area South Wall
B02-14-15-S-F-B-00	F	B	NA	NA	17.8	13.4	Instrument Lab Floor
B02-14-16-S-F-B-00	F	B	NA	NA	111	7.3	HP Area North Floor
B02-14-17-S-F-B-00	F	B	NA	NA	72.4	10.1	HP Area North Floor
B02-14-18-S-F-B-00	F	B	NA	NA	73.4	32.2	U-Shaped Area Floor
B02-14-19-S-F-B-00	F	B	NA	NA	22.7	33.8	U-Shaped Area Floor
B02-14-20-S-W-B-00	W	B	NA	NA	11.7	4.3	U-Shaped Area North Wall

*X and Y coordinates are provided using Missouri - East State Plane Coordinates [North American Datum (NAD) 1983] (Open Land Area)
Surface: Floor = F; Wall = W; Ceiling = C; Roof = R
CSM: Three-Layer (Surface-Root-Deep) or Uniform
Type: Systematic = S, Biased = B; QC =Q; Investigation = I

Ludlum 2360	Ludlum 43-89	Active Probe Area	α HDP Efficiency	α Cal. Efficiency	ß HDP Efficiency	ß Cal. Efficiency
278647	311685	125 cm^2	**26.6%**	N/A	**27.8%**	N/A

TOTAL WEIGHTED INSTRUMENT EFFICIENCY CALCULATION

Radionuclide	Radiation	Maximum Energy (MeV)	Instrument Efficiency (ε_i)	Surface Efficiency (ε_s)	Yield 100%	Activity Fraction	Weighted Efficiency
Am-241	Alpha	5.6	0.2660	0.25	1.00	2.682E-03	1.78E-04
Np-237	Alpha	5.0	0.2660	0.25	1.00	5.573E-05	3.71E-06
Pu-239	Alpha	5.2	0.2660	0.25	1.00	2.027E-06	1.35E-07
Tc-99	Beta	0.294	0.2780	0.25	1.00	2.829E-03	1.97E-04
Th-232	Alpha	4.1	0.2660	0.25	1.00	3.214E-03	2.14E-04
Ra-228	Beta	0.046	0.2780	0.00	1.00	3.214E-03	0.00E+00
Ac-228	Beta	2.13	0.2780	0.50	1.00	3.214E-03	4.47E-04
Th-228	Alpha	5.5	0.2660	0.25	1.00	3.214E-03	2.14E-04
Ra-224	Alpha	5.8	0.2660	0.25	1.00	3.214E-03	2.14E-04
U-234	Alpha	4.9	0.2660	0.25	1.00	8.270E-01	5.50E-02
U-235	Alpha	4.7	0.2660	0.25	1.00	3.720E-02	2.47E-03
Th-231	Beta	0.390	0.2780	0.25	1.00	3.720E-02	2.59E-03
U-238	Alpha	4.3	0.2660	0.25	1.00	1.270E-01	8.45E-03
Th-234	Beta	0.270	0.2780	0.25	1.00	1.270E-01	8.83E-03
Pa-234m	Beta	2.20	0.2780	0.50	1.00	1.270E-01	1.77E-02

Total Weighted Instrument Efficiency = Σ Weighted Instrument Efficiency for all Nuclides of Concern **Σ=** **9.64%**

Weighted Instrument Efficiency = ε_i * ε_s * Yield * Activity Fraction

ε_i = 2 Pi Instrument Efficiency for Nuclide of Concern

ε_s = Surface Efficiency for Nuclide of Concern

Meter
43-93

				Step 8.3.2					
MEASUREMENT ID	**MEASUREMENT LOCATION**	**DATE MEAS**	**MEASUREMENT**	**GROSS cpm (α+β)**	**BKG cpm (a+b)**	**Net cpm (α + β)**	**Combined Net dpm/100 cm² (α+β)**	**Corrected Net dpm/100cm²**	**Fraction of DCGL Step 8.4.3**
B02-14-01-S-W-S-00	Instrument Lab North Wall	11/04/2015	alpha + beta TSC	275	182	93	964	964	5%
B02-14-02-S-W-S-00	Instrument Lab West Wall	11/04/2015	alpha + beta TSC	276	182	94	975	975	5%
B02-14-03-S-W-S-00	U-Shaped Area Floor	11/04/2015	alpha + beta TSC	218	182	36	373	373	2%
B02-14-04-S-W-S-00	U-Shaped Area Floor	11/04/2015	alpha + beta TSC	191	182	9	93	93	0%
B02-14-05-S-W-S-00	U-Shaped Area Floor	11/04/2015	alpha + beta TSC	255	182	73	757	757	4%
B02-14-06-S-W-S-00	Gad Room North Wall	11/04/2015	alpha + beta TSC	154	182	-28	-290	0	0%
B02-14-07-S-W-S-00	U-Shaped Area South Wall	11/04/2015	alpha + beta TSC	141	182	-41	-425	0	0%
B02-14-08-S-W-S-00	U-Shaped Area Floor	11/04/2015	alpha + beta TSC	237	182	55	570	570	3%
B02-14-09-S-W-S-00	U-Shaped Area Floor	11/04/2015	alpha + beta TSC	245	182	63	653	653	3%
B02-14-10-S-W-S-00	HP Area North Wall	11/04/2015	alpha + beta TSC	171	182	-11	-114	0	0%
B02-14-11-S-W-S-00	HP Area North Wall	11/04/2015	alpha + beta TSC	152	182	-30	-311	0	0%
B02-14-12-S-W-S-00	HP Area North Wall	11/04/2015	alpha + beta TSC	193	182	11	114	114	1%
B02-14-13-S-W-S-00	HP Area South Wall	11/04/2015	alpha + beta TSC	168	182	-14	-145	0	0%
B02-14-14-S-W-S-00	HP Area South Wall	11/04/2015	alpha + beta TSC	162	182	-20	-207	0	0%
B02-14-15-S-F-B-00	Instrument Lab Floor	11/04/2015	alpha + beta TSC	272	182	90	933	933	5%
B02-14-16-S-F-B-00	HP Area North Floor	11/04/2015	alpha + beta TSC	264	182	82	850	850	4%
B02-14-17-S-F-B-00	HP Area North Floor	11/04/2015	alpha + beta TSC	237	182	55	570	570	3%
B02-14-18-S-F-B-00	U-Shaped Area Floor	11/04/2015	alpha + beta TSC	239	182	57	591	591	3%
B02-14-19-S-F-B-00	U-Shaped Area Floor	11/04/2015	alpha + beta TSC	242	182	60	622	622	3%
B02-14-20-S-W-B-00	U-Shaped Area North Wall	11/04/2015	alpha + beta TSC	306	182	124	1286	1286	7%

*NOTE: Differences from documented survey results are due to rounding in Excel

	Min	0	
	Max	975	
	Mean	321	
	Median	104	
	Stdev	384.2	

2% Average Fraction Step 8.4.5.g

DCGLso

0.50 mrem SU Dose Contribution Step 8.4.6

mrem

Instrument used for FSS Static Measurements:

Ludlum 2360/43-93 S/N 227415 11/04/2015 Survey # HDP-PF-102515-071

Detector Area (A) = 100 cm^2 ave. ambient bkg = 182 cpm ($\alpha + \beta$) weighted eff (ε_w)= 0.09645

TSC ($dpm/100cm^2$) = (gcpm-bkg) / (ε_w * (A_{wipe}/100 cm^2))

DCGL (structures) = 18,925 dpm/100 cm^2

MEASUREMENT ID	MEASUREMENT LOCATION	DATE MEAS	Alpha Gross cpm	Alpha Net cpm	Alpha Net dpm/100cm^2	Corrected Alpha Net dpm/100cm^2	Beta Gross cpm	Beta Net cpm	Beta Net dpm/100cm^2	Corrected Beta Net dpm/100cm^2	Combined Net dpm/100 cm^2 (α+β)	Exceed 10% of Min. Sys. TSC Result?	Exceed MDA?	Exceed 10% of DCGL?
1	Instrument Lab North Wall	11/04/2015	2	1	6	6	47	-2	-8	0	6	Y	N	N
2	Instrument Lab West Wall	11/04/2015	0	-1	-2	0	49	0	0	0	0	N	N	N
3	U-Shaped Area Floor	11/04/2015	1	0	2	2	55	6	25	25	27	Y	N	N
4	U-Shaped Area Floor	11/04/2015	0	-1	-2	0	44	-5	-21	0	0	N	N	N
5	U-Shaped Area Floor	11/04/2015	0	-1	-2	0	54	5	21	21	21	Y	N	N
6	Gad Room North Wall	11/04/2015	0	-1	-2	0	79	30	126	126	126	Y	N	N
7	U-Shaped Area South Wall	11/04/2015	0	-1	-2	0	58	9	38	38	38	Y	N	N
8	U-Shaped Area Floor	11/04/2015	0	-1	-2	0	47	-2	-8	0	0	N	N	N
9	U-Shaped Area Floor	11/04/2015	0	-1	-2	0	56	7	29	29	29	Y	N	N
10	HP Area North Wall	11/04/2015	1	0	2	2	60	11	46	46	48	Y	N	N
11	HP Area North Wall	11/04/2015	1	0	2	2	59	10	42	42	44	Y	N	N
12	HP Area North Wall	11/04/2015	0	-1	-2	0	62	13	55	55	55	Y	N	N
13	HP Area South Wall	11/04/2015	1	0	2	2	57	8	34	34	35	Y	N	N
14	HP Area South Wall	11/04/2015	2	1	6	6	57	8	34	34	39	Y	N	N
15	Instrument Lab Floor	11/04/2015	0	-1	-2	0	59	10	42	42	42	Y	N	N
16	HP Area North Floor	11/04/2015	1	0	2	2	65	16	67	67	69	Y	N	N
17	HP Area North Floor	11/04/2015	0	-1	-2	0	42	-7	-29	0	0	N	N	N
18	U-Shaped Area Floor	11/04/2015	0	-1	-2	0	50	1	4	4	4	Y	N	N
19	U-Shaped Area Floor	11/04/2015	0	-1	-2	0	59	10	42	42	42	Y	N	N
20	U-Shaped Area North Wall	11/04/2015	1	0	2	2	53	4	17	17	18	Y	N	N

Min	0
Max	126
Mean	32
Median	32
StDev	30.1

DCGL = 18,925 dpm/100cm^2

Removable Activity (dpm/100cm^2) = (gcpm-bkg) / ε

Area "swiped" = 100 cm^2

Instrument used for Removable Measurements:

Ludlum 2929/43-10-1 S/N 115578 Cal Due 10/30/15 Survey # HDP-PF-102515-071

alpha bkg = 0.6 cpm alpha efficiency = 24.90% alpha MDA = 26.5
beta bkg = 49 cpm beta efficiency = 23.83% beta MDA = 149

Sign Test						
SAMPLE ID	SAMPLE ID	Gross TSC Step 8.5.4.a	Gross TSC / Adj. Gross DCGL (W_s) Step 8.5.4.b	Difference ($1-W_s$) Step 8.5.4.d	Corrected Difference Step 8.5.4.e	
B02-14-01-S-W-S-00	Instrument Lab North Wall	964	0.051	0.949	0.949	$\alpha = 0.05$
B02-14-02-S-W-S-00	Instrument Lab West Wall	975	0.051	0.949	0.949	
B02-14-03-S-W-S-00	U-Shaped Area Floor	373	0.020	0.980	0.980	
B02-14-04-S-W-S-00	U-Shaped Area Floor	93	0.005	0.995	0.995	
B02-14-05-S-W-S-00	U-Shaped Area Floor	757	0.040	0.960	0.960	
B02-14-06-S-W-S-00	Gad Room North Wall	0	0.000	1.000	1.000	
B02-14-07-S-W-S-00	U-Shaped Area South Wall	0	0.000	1.000	1.000	
B02-14-08-S-W-S-00	U-Shaped Area Floor	570	0.030	0.970	0.970	
B02-14-09-S-W-S-00	U-Shaped Area Floor	653	0.035	0.965	0.965	
B02-14-10-S-W-S-00	HP Area North Wall	0	0.000	1.000	1.000	
B02-14-11-S-W-S-00	HP Area North Wall	0	0.000	1.000	1.000	
B02-14-12-S-W-S-00	HP Area North Wall	114	0.006	0.994	0.994	
B02-14-13-S-W-S-00	HP Area South Wall	0	0.000	1.000	1.000	
B02-14-14-S-W-S-00	HP Area South Wall	0	0.000	1.000	1.000	
				Number of Positive Differences (S+)	14	
				Sign Test Critical Value (MARSSIM Table I-3)	**10**	

If every measurement in the systematic sample population is <= the DCGL, a statistical test is not required.

TEST: **PASS**

MARSSIM Table I-3 Critical Values for the Sign Test Statistic S+		MARSSIM Table I-3 Critical Values for the Sign Test Statistic S+	
N	Alpha = 0.05	N	0.05
4	4	28	18
5	4	29	19
6	5	30	19
7	6	31	20
8	6	32	21
9	7	33	21
10	8	34	22
11	8	35	22
12	9	36	23
13	9	37	23
14	10	38	24
15	11	39	25
16	11	40	25
17	12	41	26
18	12	42	26
19	13	43	27
20	14	44	27
21	14	45	28
22	15	46	29
23	15	47	29
24	16	48	30
25	17	49	30
26	17	50	31
27	18		