APPENDIX P-4

FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

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

Survey Unit: 11 **Description:** Gadolinium Room Floor and Lower Walls (North)

Survey Type: FSS **Classification:** Class 1

Measurement or Sample ID	Surface or CSM	Type	Start Elevation	End Elevation	Northing (feet) (Y Axis) *	Easting (feet) (X Axis) *	Remarks / Notes
B02-11-01-S-F-S-00	F	S	NA	NA	22.5	2.1	Floor
B02-11-02-S-F-S-00	F	S	NA	NA	22.5	10.7	Floor
B02-11-03-S-F-S-00	F	S	NA	NA	22.5	19.2	Floor
B02-11-04-S-F-S-00	F	S	NA	NA	22.5	27.7	Floor
B02-11-05-S-F-S-00	F	S	NA	NA	14.9	6.4	Floor
B02-11-06-S-F-S-00	F	S	NA	NA	14.9	14.9	Floor
B02-11-07-S-F-S-00	F	S	NA	NA	14.9	23.5	Floor
B02-11-08-S-W-S-00	W	S	NA	NA	2.1	14.9	West Wall
B02-11-09-S-W-S-00	W	S	NA	NA	4.3	6.4	North Wall
B02-11-10-S-W-S-00	W	S	NA	NA	4.3	14.9	North Wall
B02-11-11-S-W-S-00	W	S	NA	NA	4.3	23.5	North Wall
B02-11-12-S-W-S-00	W	S	NA	NA	3.5	10.8	East Wall
B02-11-13-S-F-B-00	F	B	NA	NA	22.0	2.0	Biased Floor
B02-11-14-S-F-B-00	F	B	NA	NA	22.0	12.0	Biased Floor
B02-11-15-S-F-B-00	F	B	NA	NA	22.0	20.0	Biased Floor
B02-11-16-S-F-B-00	F	B	NA	NA	15.0	20.0	Biased Floor
B02-11-17-S-F-B-00	F	B	NA	NA	23.0	20.0	Biased Floor

*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

Quality Record

Ludlum 2360 275001	Ludlum 43-93 293948	Active Probe Area 100	α HDP Efficiency **27.5%**	α Cal. Efficiency N/A	ß HDP Efficiency **28.7%**	ß Cal. Efficiency 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	0.2750	0.25	1.00	2.682E-03	1.84E-04
Np-237	Alpha	5.0	0.2750	0.25	1.00	5.573E-05	3.83E-06
Pu-239	Alpha	5.2	0.2750	0.25	1.00	2.027E-06	1.39E-07
Tc-99	Beta	0.294	0.2870	0.25	1.00	2.829E-03	2.03E-04
Th-232	Alpha	4.1	0.2750	0.25	1.00	3.214E-03	2.21E-04
Ra-228	Beta	0.046	0.2870	0.00	1.00	3.214E-03	0.00E+00
Ac-228	Beta	2.13	0.2870	0.50	1.00	3.214E-03	4.61E-04
Th-228	Alpha	5.5	0.2750	0.25	1.00	3.214E-03	2.21E-04
Ra-224	Alpha	5.8	0.2750	0.25	1.00	3.214E-03	2.21E-04
U-234	Alpha	4.9	0.2750	0.25	1.00	8.270E-01	5.69E-02
U-235	Alpha	4.7	0.2750	0.25	1.00	3.720E-02	2.56E-03
Th-231	Beta	0.390	0.2870	0.25	1.00	3.720E-02	2.67E-03
U-238	Alpha	4.3	0.2750	0.25	1.00	1.270E-01	8.73E-03
Th-234	Beta	0.270	0.2870	0.25	1.00	1.270E-01	9.11E-03
Pa-234m	Beta	2.20	0.2870	0.50	1.00	1.270E-01	1.82E-02

Total Weighted Instrument Efficiency = Σ Weighted Instrument Efficiency for all Nuclides of Concern **Σ=** **9.97%**

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
B02-11-01-S-F-S-00	Floor	06/29/2015	alpha + beta TSC	232	172	60	598	598	3%
B02-11-02-S-F-S-00	Floor	06/29/2015	alpha + beta TSC	219	172	47	468	468	2%
B02-11-03-S-F-S-00	Floor	06/29/2015	alpha + beta TSC	208	172	36	358	358	2%
B02-11-04-S-F-S-00	Floor	06/29/2015	alpha + beta TSC	234	172	62	619	619	3%
B02-11-05-S-F-S-00	Floor	06/29/2015	alpha + beta TSC	257	172	85	849	849	4%
B02-11-06-S-F-S-00	Floor	06/29/2015	alpha + beta TSC	274	172	102	1020	1020	5%
B02-11-07-S-F-S-00	Floor	06/29/2015	alpha + beta TSC	300	172	128	1281	1281	7%
B02-11-08-S-W-S-00	West Wall	06/29/2015	alpha + beta TSC	135	172	-37	-374	0	0%
B02-11-09-S-W-S-00	North Wall	06/29/2015	alpha + beta TSC	119	172	-53	-535	0	0%
B02-11-10-S-W-S-00	North Wall	06/29/2015	alpha + beta TSC	128	172	-44	-445	0	0%
B02-11-11-S-W-S-00	North Wall	06/29/2015	alpha + beta TSC	124	172	-48	-485	0	0%
B02-11-12-S-W-S-00	East Wall	06/29/2015	alpha + beta TSC	140	172	-32	-324	0	0%
B02-11-13-S-F-B-00	Biased Floor	06/29/2015	alpha + beta TSC	550	172	378	3788	3788	20%
B02-11-14-S-F-B-00	Biased Floor	06/29/2015	alpha + beta TSC	717	172	545	5463	5463	29%
B02-11-15-S-F-B-00	Biased Floor	06/29/2015	alpha + beta TSC	917	172	745	7469	7469	39%
B02-11-16-S-F-B-00	Biased Floor	06/29/2015	alpha + beta TSC	523	172	351	3517	3517	19%
B02-11-17-S-F-B-00	Biased Floor	06/29/2015	alpha + beta TSC	604	172	432	4330	4330	23%

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

Min	0	2% Average Fraction Step 8.4.5.g
Max	1281	
Mean	433	DCGLso
Median	413	0.50 mrem SU Dose Contribution Step 8.4.6
Stdev	451.5	mrem

Instrument used for FSS Static Measurements:

Ludlum 2360/43-93 S/N 275001 06/29/2015 Survey # HDP-PF-062915-033

Detector Area (A) = 100 cm^2 ave. ambient bkg = 172 cpm ($\alpha + \beta$) weighted eff (ε_w)= 0.09970

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

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

Removable Data Evaluation

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	Floor	06/29/2015	1	0	0	0	55	6	25	25	25	Y	N	N
2	Floor	06/29/2015	0	-1	-4	0	52	3	13	13	13	Y	N	N
3	Floor	06/29/2015	4	3	12	12	56	7	29	29	41	Y	N	N
4	Floor	06/29/2015	1	0	0	0	39	-10	-42	0	0	N	N	N
5	Floor	06/29/2015	0	-1	-4	0	49	0	0	0	0	N	N	N
6	Floor	06/29/2015	0	-1	-4	0	37	-12	-50	0	0	N	N	N
7	Floor	06/29/2015	1	0	0	0	40	-9	-38	0	0	N	N	N
8	West Wall	06/29/2015	1	0	0	0	30	-19	-80	0	0	N	N	N
9	North Wall	06/29/2015	0	-1	-4	0	41	-8	-34	0	0	N	N	N
10	North Wall	06/29/2015	0	-1	-4	0	40	-9	-38	0	0	N	N	N
11	North Wall	06/29/2015	0	-1	-4	0	48	-1	-4	0	0	N	N	N
12	East Wall	06/29/2015	1	0	0	0	41	-8	-34	0	0	N	N	N
13	Biased Floor	06/29/2015	0	-1	-4	0	57	8	34	34	34	Y	N	N
14	Biased Floor	06/29/2015	0	-1	-4	0	43	-6	-25	0	0	N	N	N
15	Biased Floor	06/29/2015	0	-1	-4	0	57	8	34	34	34	Y	N	N
16	Biased Floor	06/29/2015	0	-1	-4	0	45	-4	-17	0	0	N	N	N
17	Biased Floor	06/29/2015	0	-1	-4	0	45	-4	-17	0	0	N	N	N
										Min	0			
										Max	41			
										Mean	9			
										Median	0			
										StDev	14.8			

Instrument used for Removable Measurements:

Ludlum 2929/43-10-1 S/N 115578 Cal Due 10/30/15 Survey # HDP-PF-062915-033

alpha bkg = 0.6 cpm alpha efficiency = 24.90% alpha MDA = 26.5
beta bkg = 49 cpm beta efficiency = 23.80% beta MDA = 149

DCGL = 18,925 dpm/100cm^2

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

Area "swiped" = 100 cm^2

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	
B02-11-01-S-F-S-00	Floor	598	0.032	0.968	0.968	$\alpha = 0.05$
B02-11-02-S-F-S-00	Floor	468	0.025	0.975	0.975	
B02-11-03-S-F-S-00	Floor	358	0.019	0.981	0.981	
B02-11-04-S-F-S-00	Floor	619	0.033	0.967	0.967	
B02-11-05-S-F-S-00	Floor	849	0.045	0.955	0.955	
B02-11-06-S-F-S-00	Floor	1020	0.054	0.946	0.946	
B02-11-07-S-F-S-00	Floor	1281	0.068	0.932	0.932	
B02-11-08-S-W-S-00	West Wall	0	0.000	1.000	1.000	
B02-11-09-S-W-S-00	North Wall	0	0.000	1.000	1.000	
B02-11-10-S-W-S-00	North Wall	0	0.000	1.000	1.000	
B02-11-11-S-W-S-00	North Wall	0	0.000	1.000	1.000	
B02-11-12-S-W-S-00	East Wall	0	0.000	1.000	1.000	
				Number of Positive Differences (S+)	12	
				Sign Test Critical Value (MARSSIM Table I-3)	9	

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		