APPENDIX P-4

FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area: BSA 02 **Description:** Building Survey Area (Building 230)
Survey Unit: 24 **Description:** Rod Load Area - Lower Walls (South and East)
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
B02-24-01-S-W-S-00	W	S	NA	NA	4.6	108.9	South Wall
B02-24-02-S-W-S-00	W	S	NA	NA	4.6	98.4	South Wall
B02-24-03-S-W-S-00	W	S	NA	NA	4.6	87.9	South Wall
B02-24-04-S-W-S-00	W	S	NA	NA	4.6	77.5	South Wall
B02-24-05-S-W-S-00	W	S	NA	NA	4.6	67.0	South Wall
B02-24-06-S-W-S-00	W	S	NA	NA	4.6	56.5	South Wall
B02-24-07-S-W-S-00	W	S	NA	NA	4.6	46.0	South Wall
B02-24-08-S-W-S-00	W	S	NA	NA	4.6	35.5	South Wall
B02-24-09-S-W-S-00	W	S	NA	NA	4.6	25.0	South Wall
B02-24-10-S-W-S-00	W	S	NA	NA	4.6	14.5	South Wall
B02-24-11-S-W-S-00	W	S	NA	NA	4.6	4.0	South Wall
B02-24-12-S-W-S-00	W	S	NA	NA	1.3	1.6	East Wall
B02-24-13-S-W-S-00	W	S	NA	NA	6.5	10.4	East Wall
B02-24-14-S-W-S-00	W	S	NA	NA	1.3	19.3	East Wall
B02-24-15-S-W-S-00	W	S	NA	NA	1.3	37.0	East Wall
B02-24-16-S-W-B-00	F	B	NA	NA	1.0	90.0	South Wall
B02-24-17-S-W-B-00	F	B	NA	NA	1.0	80.0	South 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

Quality Record

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	**27.5%**	N/A	**28.7%**	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 cm^2 (α+β)**	**Corrected Net dpm/100cm^2**	**Fraction of DCGL Step 8.4.3**
B02-24-01-S-W-S-00	South Wall	08/12/2015	alpha + beta TSC	126	157	-30.67	-308	0	0%
B02-24-02-S-W-S-00	South Wall	08/12/2015	alpha + beta TSC	118	157	-38.67	-388	0	0%
B02-24-03-S-W-S-00	South Wall	08/12/2015	alpha + beta TSC	107	157	-49.67	-498	0	0%
B02-24-04-S-W-S-00	South Wall	08/12/2015	alpha + beta TSC	139	157	-17.67	-177	0	0%
B02-24-05-S-W-S-00	South Wall	08/12/2015	alpha + beta TSC	127	157	-29.67	-298	0	0%
B02-24-06-S-W-S-00	South Wall	08/12/2015	alpha + beta TSC	133	157	-23.67	-237	0	0%
B02-24-07-S-W-S-00	South Wall	08/12/2015	alpha + beta TSC	142	157	-14.67	-147	0	0%
B02-24-08-S-W-S-00	South Wall	08/12/2015	alpha + beta TSC	145	157	-11.67	-117	0	0%
B02-24-09-S-W-S-00	South Wall	08/12/2015	alpha + beta TSC	134	157	-22.67	-227	0	0%
B02-24-10-S-W-S-00	South Wall	08/12/2015	alpha + beta TSC	122	157	-34.67	-348	0	0%
B02-24-11-S-W-S-00	South Wall	08/12/2015	alpha + beta TSC	129	157	-27.67	-277	0	0%
B02-24-12-S-W-S-00	East Wall	08/12/2015	alpha + beta TSC	151	157	-5.667	-57	0	0%
B02-24-13-S-W-S-00	East Wall	08/12/2015	alpha + beta TSC	144	157	-12.67	-127	0	0%
B02-24-14-S-W-S-00	East Wall	08/12/2015	alpha + beta TSC	145	157	-11.67	-117	0	0%
B02-24-15-S-W-S-00	East Wall	08/12/2015	alpha + beta TSC	148	157	-8.667	-87	0	0%
B02-24-16-S-W-B-00	South Wall	08/12/2015	alpha + beta TSC	860	157	703.33	7054	7054	37%
B02-24-17-S-W-B-00	South Wall	08/12/2015	alpha + beta TSC	431	157	274.33	2752	2752	15%

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

Min	0	**0%**	Average Fraction Step 8.4.5.g
Max	0	**DCGLso**	
Mean	0	**0.00**	mrem SU Dose Contribution Step 8.4.6
Median	0	**mrem**	
Stdev	0.0		

Instrument used for FSS Static Measurements:

Ludlum 2360/43-93	S/N 275001	07/23/2015		Survey # HDP-PF-072315-039	
Detector Area (A) =	100 cm^2	ave. ambient bkg = (α + β)	156.7 cpm	weighted eff (ε_w)=	0.09970

TSC (dpm/100cm^2) = (gcpm-bkg) / (ε_w * (A_{det}/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
1	South Wall	08/12/2015	0	-1	-4	0	37	-12	-50
2	South Wall	08/12/2015	2	1	4	4	42	-7	-29
3	South Wall	08/12/2015	2	1	4	4	50	1	4
4	South Wall	08/12/2015	0	-1	-4	0	48	-1	-4
5	South Wall	08/12/2015	0	-1	-4	0	37	-12	-50
6	South Wall	08/12/2015	3	2	8	8	44	-5	-21
7	South Wall	08/12/2015	0	-1	-4	0	43	-6	-25
8	South Wall	08/12/2015	0	-1	-4	0	34	-15	-63
9	South Wall	08/12/2015	1	0	0	0	35	-14	-59
10	South Wall	08/12/2015	0	-1	-4	0	39	-10	-42
11	South Wall	08/12/2015	0	-1	-4	0	45	-4	-17
12	East Wall	08/12/2015	0	-1	-4	0	44	-5	-21
13	East Wall	08/12/2015	0	-1	-4	0	44	-5	-21
14	East Wall	08/12/2015	0	-1	-4	0	35	-14	-59
15	East Wall	08/12/2015	1	0	0	0	38	-11	-46
16	South Wall	08/12/2015	0	-1	-4	0	40	-9	-38
17	South Wall	08/12/2015	3	2	8	8	35	-14	-59

Removable Data Evaluation

Corrected Beta Net dpm/100cm^2	Combined Net dpm/100 cm^2 ($\alpha+\beta$)	Exceed 10% of Min. Sys. TSC Result?	Exceed MDA?	Exceed 10% of DCGL?
0	0	N	N	N
0	4	Y	N	N
4	8	Y	N	N
0	0	N	N	N
0	0	N	N	N
0	8	Y	N	N
0	0	N	N	N
0	0	N	N	N
0	0	N	N	N
0	0	N	N	N
0	0	N	N	N
0	0	N	N	N
0	0	N	N	N
0	0	N	N	N
0	0	N	N	N
0	0	N	N	N
0	8	Y	N	N

Min	0
Max	8
Mean	2
Median	0
StDev	3.2

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-072315-039
Meter I PR098469

alpha bkg = 0.6 cpm alpha efficiency = 24.90% alpha MDA = 26.5
beta bkg = 49 cpm beta efficiency = 23.80% 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	
B02-24-01-S-W-S-00	South Wall	0	0.000	1.000	1.000	α = 0.05
B02-24-02-S-W-S-00	South Wall	0	0.000	1.000	1.000	
B02-24-03-S-W-S-00	South Wall	0	0.000	1.000	1.000	
B02-24-04-S-W-S-00	South Wall	0	0.000	1.000	1.000	
B02-24-05-S-W-S-00	South Wall	0	0.000	1.000	1.000	
B02-24-06-S-W-S-00	South Wall	0	0.000	1.000	1.000	
B02-24-07-S-W-S-00	South Wall	0	0.000	1.000	1.000	
B02-24-08-S-W-S-00	South Wall	0	0.000	1.000	1.000	
B02-24-09-S-W-S-00	South Wall	0	0.000	1.000	1.000	
B02-24-10-S-W-S-00	South Wall	0	0.000	1.000	1.000	
B02-24-11-S-W-S-00	South Wall	0	0.000	1.000	1.000	
B02-24-12-S-W-S-00	East Wall	0	0.000	1.000	1.000	
B02-24-13-S-W-S-00	East Wall	0	0.000	1.000	1.000	
B02-24-14-S-W-S-00	East Wall	0	0.000	1.000	1.000	
B02-24-15-S-W-S-00	East Wall	0	0.000	1.000	1.000	
				Number of Positive Differences (S+)	15	
				Sign Test Critical Value (MARSSIM Table I-3)	11	

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		