APPENDIX P-4

FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area: BSA 04 **Description:** Structure Survey Unit - Bldg 230

Survey Unit: 05 **Description:** Bldg 230 Exterior Wall - Former Vault Wall (Above Grade)

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
B04-05-01-S-W-S-00	W	S	NA	NA	2.8	3.2	East B230 Exterior Wall
B04-05-02-S-W-S-00	W	S	NA	NA	8.0	0.2	East B230 Exterior Wall
B04-05-03-S-W-S-00	W	S	NA	NA	2.8	1.9	East B230 Exterior Wall
B04-05-04-S-W-S-00	W	S	NA	NA	2.8	8.2	East B230 Exterior Wall
B04-05-05-S-W-S-00	W	S	NA	NA	2.8	14.4	East B230 Exterior Wall
B04-05-06-S-W-S-00	W	S	NA	NA	2.8	20.6	East B230 Exterior Wall
B04-05-07-S-W-S-00	W	S	NA	NA	8.0	5.1	East B230 Exterior Wall
B04-05-08-S-W-S-00	W	S	NA	NA	8.0	11.3	East B230 Exterior Wall
B04-05-09-S-W-S-00	W	S	NA	NA	8.0	17.5	East B230 Exterior Wall
B04-05-10-S-W-S-00	W	S	NA	NA	8.0	23.8	East B230 Exterior Wall
B04-05-11-S-W-S-00	W	S	NA	NA	8.0	3.0	East B230 Exterior Wall
B04-05-12-S-W-B-00	W	S	NA	NA	1.0	15.0	B230 Wall Biased
B04-05-13-S-W-B-00	W	B	NA	NA	1.0	17.0	B230 Wall Biased
B04-05-14-S-W-B-00	W	B	NA	NA	1.0	19.0	B230 Wall Biased
B04-05-15-S-W-B-00	W	B	NA	NA	1.0	24.0	B230 Wall Biased
B04-05-16-S-W-B-00	W	B	NA	NA	3.0	19.0	B230 Wall Biased

*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 43-93	Active Probe Area	α HDP Efficiency	α Cal. Efficiency	ß HDP Efficiency	ß Cal. Efficiency
227415	PR289402	100 cm^2	**26.60%**	N/A	**27.80%**	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 cm^2 (α+β)**	**Corrected Net dpm/100cm^2**	**Fraction of DCGL Step 8.4.3**
B04-05-01-S-W-S-00	East B230 Exterior Wall	11/11/2015	alpha + beta TSC	219	298	-79	-816	0	0%
B04-05-02-S-W-S-00	East B230 Exterior Wall	11/11/2015	alpha + beta TSC	219	298	-78.67	-816	0	0%
B04-05-03-S-W-S-00	East B230 Exterior Wall	11/11/2015	alpha + beta TSC	242	298	-56	-577	0	0%
B04-05-04-S-W-S-00	East B230 Exterior Wall	11/11/2015	alpha + beta TSC	253	298	-45	-463	0	0%
B04-05-05-S-W-S-00	East B230 Exterior Wall	11/11/2015	alpha + beta TSC	267	298	-31	-318	0	0%
B04-05-06-S-W-S-00	East B230 Exterior Wall	11/11/2015	alpha + beta TSC	326	298	28	294	294	2%
B04-05-07-S-W-S-00	East B230 Exterior Wall	11/11/2015	alpha + beta TSC	212	298	-86	-889	0	0%
B04-05-08-S-W-S-00	East B230 Exterior Wall	11/11/2015	alpha + beta TSC	233	298	-65	-671	0	0%
B04-05-09-S-W-S-00	East B230 Exterior Wall	11/11/2015	alpha + beta TSC	229	298	-69	-712	0	0%
B04-05-10-S-W-S-00	East B230 Exterior Wall	11/11/2015	alpha + beta TSC	243	298	-55	-567	0	0%
B04-05-11-S-W-S-00	East B230 Exterior Wall	11/11/2015	alpha + beta TSC	211	298	-87	-899	0	0%
B04-05-12-S-W-B-00	B230 Wall Biased	11/11/2015	alpha + beta TSC	888	298	590	6124	6124	32%
B04-05-13-S-W-B-00	B230 Wall Biased	11/11/2015	alpha + beta TSC	1332	298	1034	10730	10730	57%
B04-05-14-S-W-B-00	B230 Wall Biased	11/11/2015	alpha + beta TSC	866	298	568	5896	5896	31%
B04-05-15-S-W-B-00	B230 Wall Biased	11/11/2015	alpha + beta TSC	684	298	386	4008	4008	21%
B04-05-16-S-W-B-00	B230 Wall Biased	11/11/2015	alpha + beta TSC	1927	298	1629	16902	16902	89%

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

	Min	0	
	Max	294	**0.1%** Average Fraction Step 8.4.5.g
	Mean	27	**DCGLso**
	Median	0	**0.1** mrem SU Dose Contribution Step 8.4.6
	Stdev	88.6	**mrem**

HDP-PR-FSS-721 *Final Status Survey Data Evaluation*
Prelimnary Data Review and Determination of Sum-of-Fractions (SOF)

Instrument used for FSS Static Measurements:

Ludlum 2360/43-93	S/N 227415	11/11/2015		Survey # HDP-PF-111115-087	
Detector Area (A) =	100 cm^2	ave. ambient bkg = (α + β)	297.7 cpm	weighted eff (ε_w)=	0.09640

TSC (dpm/100cm^2) = (gcpm-bkg) / (ε_w * (A_{det}/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	East B230 Exterior Wall	11/11/2015	2	2.0	8.2	8.2	32	6.0	28.3	28.3	36	Y	N	N
2	East B230 Exterior Wall	11/11/2015	3	0.0	0.0	0.0	33	-13.0	-61.3	0.0	0	N	N	N
3	East B230 Exterior Wall	11/11/2015	4	0.0	0.0	0.0	34	-7.0	-33.0	0.0	0	N	N	N
4	East B230 Exterior Wall	11/11/2015	5	0.0	0.0	0.0	35	-1.0	-4.7	0.0	0	N	N	N
5	East B230 Exterior Wall	11/11/2015	6	1.0	4.1	4.1	36	-2.0	-9.4	0.0	4	Y	N	N
6	East B230 Exterior Wall	11/11/2015	7	3.0	12.2	12.2	37	-7.0	-33.0	0.0	12	Y	N	N
7	East B230 Exterior Wall	11/11/2015	8	0.0	0.0	0.0	38	-14.0	-66.0	0.0	0	N	N	N
8	East B230 Exterior Wall	11/11/2015	9	0.0	0.0	0.0	39	-1.0	-4.7	0.0	0	N	N	N
9	East B230 Exterior Wall	11/11/2015	10	0.0	0.0	0.0	40	6.0	28.3	28.3	28	Y	N	N
10	East B230 Exterior Wall	11/11/2015	11	1.0	4.1	4.1	41	-1.0	-4.7	0.0	4	Y	N	N
11	East B230 Exterior Wall	11/11/2015	12	4.0	16.3	16.3	42	7.0	33.0	33.0	49	Y	N	N
12	B230 Wall Biased	11/11/2015	13	6.0	24.5	24.5	43	0.0	0.0	0.0	24	Y	Y	N
13	B230 Wall Biased	11/11/2015	14	11.0	44.9	44.9	44	0.0	0.0	0.0	45	Y	Y	N
14	B230 Wall Biased	11/11/2015	15	8.0	32.7	32.7	45	-5.0	-23.6	0.0	33	Y	Y	N
15	B230 Wall Biased	11/11/2015	16	7.0	28.6	28.6	46	9.0	42.5	42.5	71	Y	Y	N
16	B230 Wall Biased	11/11/2015	17	6.0	24.5	24.5	47	-2.0	-9.4	0.0	24	Y	Y	N
										Min	0			
										Max	71			
										Mean	21			
										Median	18			
										StDev	21.9			

DCGL = 18,925 dpm/100cm^2

Instrument used for Removable Measurements:

Ludlum 2929/43-10-1 S/N 160023 Cal Due 10/28/16 Survey # HDP-PF-111115-087

alpha bkg = 0.3 cpm alpha efficiency = 24.5% alpha MDA = 22.6
beta bkg = 42.1 cpm beta efficiency = 21.20% beta MDA = 157

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

Area "swiped" = 100 cm^2

Performance of Statistical Tests

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	
B04-05-01-S-W-S-00	East B230 Exterior Wall	0	0.000	1.000	1.000	α = 0.05
B04-05-02-S-W-S-00	East B230 Exterior Wall	0	0.000	1.000	1.000	
B04-05-03-S-W-S-00	East B230 Exterior Wall	0	0.000	1.000	1.000	
B04-05-04-S-W-S-00	East B230 Exterior Wall	0	0.000	1.000	1.000	
B04-05-05-S-W-S-00	East B230 Exterior Wall	0	0.000	1.000	1.000	
B04-05-06-S-W-S-00	East B230 Exterior Wall	294	0.016	0.984	0.984	
B04-05-07-S-W-S-00	East B230 Exterior Wall	0	0.000	1.000	1.000	
B04-05-08-S-W-S-00	East B230 Exterior Wall	0	0.000	1.000	1.000	
B04-05-09-S-W-S-00	East B230 Exterior Wall	0	0.000	1.000	1.000	
B04-05-10-S-W-S-00	East B230 Exterior Wall	0	0.000	1.000	1.000	
B04-05-11-S-W-S-00	East B230 Exterior Wall	0	0.000	1.000	1.000	
				Number of Positive Differences (S+)	11	
				Sign Test Critical Value (MARSSIM Table I-3)	8	

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		