APPENDIX P-4

FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area: BSA 04 **Description:** Structure Survey Unit in "Area 6"

Survey Unit: 07 **Description:** Concrete Pavement in LSA 08-10

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
B04-07-01-S-F-S-00	F	S	NA	NA	864532.0	827104.0	Concrete
B04-07-02-S-F-S-00	F	S	NA	NA	864511.0	827116.0	Concrete
B04-07-03-S-F-S-00	F	S	NA	NA	864511.0	827164.0	Concrete
B04-07-04-S-F-S-00	F	S	NA	NA	864490.0	827104.0	Concrete
B04-07-05-S-F-S-00	F	S	NA	NA	864490.0	827128.0	Concrete
B04-07-06-S-F-S-00	F	S	NA	NA	864490.0	827152.0	Concrete
B04-07-07-S-F-S-00	F	S	NA	NA	864490.0	827176.0	Concrete
B04-07-08-S-F-S-00	F	S	NA	NA	864470.0	827116.0	Concrete
B04-07-09-S-F-S-00	F	S	NA	NA	864470.0	827140.0	Concrete
B04-07-10-S-F-S-00	F	S	NA	NA	864449.0	827128.0	Concrete
B04-07-11-S-F-S-00	F	S	NA	NA	864428.0	827116.0	Concrete
B04-07-12-S-F-S-00	F	S	NA	NA	864469.0	827142.0	Concrete 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 43-89	Active Probe Area	α HDP Efficiency	α Cal. Efficiency	ß HDP Efficiency	ß Cal. Efficiency
278647	311685	125 cm^2	**26.5%**	N/A	**13.6%**	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	0.2650	0.25	1.00	2.682E-03	1.78E-04
Np-237	Alpha	5.0	0.2650	0.25	1.00	5.573E-05	3.69E-06
Pu-239	Alpha	5.2	0.2650	0.25	1.00	2.027E-06	1.34E-07
Tc-99	Beta	0.294	0.1360	0.25	1.00	2.829E-03	9.62E-05
Th-232	Alpha	4.1	0.2650	0.25	1.00	3.214E-03	2.13E-04
Ra-228	Beta	0.046	0.1360	0.00	1.00	3.214E-03	0.00E+00
Ac-228	Beta	2.13	0.1360	0.50	1.00	3.214E-03	2.19E-04
Th-228	Alpha	5.5	0.2650	0.25	1.00	3.214E-03	2.13E-04
Ra-224	Alpha	5.8	0.2650	0.25	1.00	3.214E-03	2.13E-04
U-234	Alpha	4.9	0.2650	0.25	1.00	8.270E-01	5.48E-02
U-235	Alpha	4.7	0.2650	0.25	1.00	3.720E-02	2.46E-03
Th-231	Beta	0.390	0.1360	0.25	1.00	3.720E-02	1.26E-03
U-238	Alpha	4.3	0.2650	0.25	1.00	1.270E-01	8.41E-03
Th-234	Beta	0.270	0.1360	0.25	1.00	1.270E-01	4.32E-03
Pa-234m	Beta	2.20	0.1360	0.50	1.00	1.270E-01	8.64E-03

Total Weighted Instrument Efficiency = Σ Weighted Instrument Efficiency for all Nuclides of Concern **Σ=** **8.10%**

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
43-89

Ludlum 2360	Ludlum 43-89	Active Probe Area	α HDP Efficiency	α Cal. Efficiency	ß HDP Efficiency	ß Cal. Efficiency
19206	275770	125 cm^2	**30.2%**	N/A	**18.7%**	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	0.3017	0.25	1.00	2.682E-03	2.02E-04
Np-237	Alpha	5.0	0.3017	0.25	1.00	5.573E-05	4.20E-06
Pu-239	Alpha	5.2	0.3017	0.25	1.00	2.027E-06	1.53E-07
Tc-99	Beta	0.294	0.1874	0.25	1.00	2.829E-03	1.33E-04
Th-232	Alpha	4.1	0.3017	0.25	1.00	3.214E-03	2.42E-04
Ra-228	Beta	0.046	0.1874	0.00	1.00	3.214E-03	0.00E+00
Ac-228	Beta	2.13	0.1874	0.50	1.00	3.214E-03	3.01E-04
Th-228	Alpha	5.5	0.3017	0.25	1.00	3.214E-03	2.42E-04
Ra-224	Alpha	5.8	0.3017	0.25	1.00	3.214E-03	2.42E-04
U-234	Alpha	4.9	0.3017	0.25	1.00	8.270E-01	6.24E-02
U-235	Alpha	4.7	0.3017	0.25	1.00	3.720E-02	2.81E-03
Th-231	Beta	0.390	0.1874	0.25	1.00	3.720E-02	1.74E-03
U-238	Alpha	4.3	0.3017	0.25	1.00	1.270E-01	9.58E-03
Th-234	Beta	0.270	0.1874	0.25	1.00	1.270E-01	5.95E-03
Pa-234m	Beta	2.20	0.1874	0.50	1.00	1.270E-01	1.19E-02

Total Weighted Instrument Efficiency = Σ Weighted Instrument Efficiency for all Nuclides of Concern **Σ=** **9.57%**

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
43-89

				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**
B04-07-01-S-F-S-00	Concrete	06/17/2016	alpha + beta TSC	238	221	17	142	142	1%
B04-07-02-S-F-S-00	Concrete	06/17/2016	alpha + beta TSC	253	221	32	268	268	1%
B04-07-03-S-F-S-00	Concrete	06/17/2016	alpha + beta TSC	246	221	25	209	209	1%
B04-07-04-S-F-S-00	Concrete	06/17/2016	alpha + beta TSC	229	221	8	67	67	0%
B04-07-05-S-F-S-00	Concrete	06/17/2016	alpha + beta TSC	257	221	36	301	301	2%
B04-07-06-S-F-S-00	Concrete	06/17/2016	alpha + beta TSC	260	221	39	326	326	2%
B04-07-07-S-F-S-00	Concrete	06/17/2016	alpha + beta TSC	272	221	51	426	426	2%
B04-07-08-S-F-S-00	Concrete	06/07/2016	alpha + beta TSC	218	148	70.333	696	696	4%
B04-07-09-S-F-S-00	Concrete	06/17/2016	alpha + beta TSC	228	221	7	59	59	0%
B04-07-10-S-F-S-00	Concrete	06/07/2016	alpha + beta TSC	207	148	59.333	587	587	3%
B04-07-11-S-F-S-00	Concrete	06/07/2016	alpha + beta TSC	212	148	64.333	636	636	3%
B04-07-12-S-F-S-00	Concrete Biased	06/17/2017	alpha + beta TSC	814	221	593	4957	4957	26%

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

Min	59	**2%**	Average Fraction Step 8.4.5.g
Max	696		
Mean	338	**DCGLso**	
Median	301	**0.50**	mrem SU Dose Contribution Step 8.4.6
Stdev	223.5	**mrem**	

Instrument used for FSS Static Measurements:

Ludlum 2360/43-89	S/N 278647	06/07/2016		Survey # 7641 C 160607		
Detector Area (A) =	125 cm^2	ave. ambient bkg = (α + β)	221 cpm	weighted eff (ε_w)=	0.09570	
Ludlum 2360/43-89	S/N 275770	06/17/2016		Survey # 7694 C 160617		
Detector Area (A) =	125 cm^2	ave. ambient bkg = (α + β)	147.7 cpm	weighted eff (ε_w)=	0.08090	

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
1	Concrete	06/17/2016	0.0	-0.5	-2.0	0.0	2.2	-0.3	-1.2
2	Concrete	06/17/2016	2.0	1.5	5.9	5.9	2.5	0.0	0.0
3	Concrete	06/17/2016	0.9	0.4	1.6	1.6	5.9	3.4	13.4
4	Concrete	06/17/2016	1.0	0.5	2.0	2.0	2.9	0.4	1.6
5	Concrete	06/17/2016	3.0	2.5	9.9	9.9	2.2	-0.3	-1.2
6	Concrete	06/17/2016	0.0	-0.5	-2.0	0.0	1.2	-1.3	-5.1
7	Concrete	06/17/2016	1.9	1.4	5.5	5.5	7.5	5.0	19.7
8	Concrete	06/07/2016	1.0	0.5	1.4	1.4	38.0	2.7	12.4
9	Concrete	06/17/2016	1.9	1.4	5.5	5.5	6.5	4.0	15.7
10	Concrete	06/07/2016	2.0	1.5	4.2	4.2	42.0	6.7	30.7
11	Concrete	06/07/2016	1.0	0.5	1.4	1.4	32.0	-3.3	-15.1
12	Concrete Biased	06/17/2017	0.0	-0.5	-2.0	0.0	4.2	1.7	6.7

Removable Data Evaluation

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?
0.0	0	N	N	N
0.0	6	Y	N	N
13.4	15	Y	N	N
1.6	4	N	N	N
0.0	10	Y	N	N
0.0	0	N	N	N
19.7	25	Y	N	N
12.4	14	Y	N	N
15.7	21	Y	N	N
30.7	35	Y	N	N
0.0	1	N	N	N
6.7	7	Y	N	N
Min	0			
Max	35			
Mean	11			
Median	8			
StDev	11.0			

DCGL = 18,925 dpm/100cm^2

Instrument used for Removable Measurements:

Tennelec Unit #1 Batch # 52589 06/17/2016 Survey # 7694 C 160617

alpha bkg = 0.5 cpm alpha efficiency = 25.30%
beta bkg = 2.5 cpm beta efficiency = 25.40%

Lud 3030 S/N 232152 06/07/2016 Survey # 7641 C 160607

alpha bkg = 0.5 cpm alpha efficiency = 36.00%
beta bkg = 35.3 cpm beta efficiency = 21.80%

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

Area "swiped" = 100 cm^2

alpha MDA =	12.4
beta MDA =	23.6

alpha MDA =	15.1
beta MDA =	108

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**
B04-07-01-S-F-S-00	Concrete	142	0.008	0.992	0.992
B04-07-02-S-F-S-00	Concrete	268	0.014	0.986	0.986
B04-07-03-S-F-S-00	Concrete	209	0.011	0.989	0.989
B04-07-04-S-F-S-00	Concrete	67	0.004	0.996	0.996
B04-07-05-S-F-S-00	Concrete	301	0.016	0.984	0.984
B04-07-06-S-F-S-00	Concrete	326	0.017	0.983	0.983
B04-07-07-S-F-S-00	Concrete	426	0.023	0.977	0.977
B04-07-08-S-F-S-00	Concrete	696	0.037	0.963	0.963
B04-07-09-S-F-S-00	Concrete	59	0.003	0.997	0.997
B04-07-10-S-F-S-00	Concrete	587	0.031	0.969	0.969
B04-07-11-S-F-S-00	Concrete	636	0.034	0.966	0.966
				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**

$\alpha = 0.05$

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		