APPENDIX P-4

FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

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

Survey Unit: 08 **Description:** Rod Load Area - All Sections, Upper Walls and Ceiling

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
B02-08-01-S-W-S-00	W	S	NA	NA	15.5	7.1	Kardex, South Wall
B02-08-02-S-W-S-00	W	S	NA	NA	21.4	14.8	Kardex, West Wall
B02-08-03-S-W-S-00	W	S	NA	NA	16.5	3.2	Kardex, East Wall
B02-08-04-S-W-S-00	W	S	NA	NA	8.3	19.1	Rod Load, West Wall
B02-08-05-S-C-S-00	C	S	NA	NA	19.1	26.4	Rod Load, Ceiling
B02-08-06-S-C-S-00	C	S	NA	NA	19.1	62	Rod Load, Ceiling
B02-08-07-S-C-S-00	C	S	NA	NA	8.3	16	Women's Room 2, Ceiling
B02-08-08-S-W-S-00	W	S	NA	NA	6.8	1.5	Hallway 1, West Wall
B02-08-09-S-W-S-00	W	S	NA	NA	7.2	15.4	Men's Room, East Wall
B02-08-10-S-W-S-00	W	S	NA	NA	10	1.5	Hallway 3, West Wall
B02-08-11-S-C-S-00	C	S	NA	NA	2.5	16.8	Women's Room 1, Ceiling
B02-08-12-S-W-S-00	W	S	NA	NA	7.9	14.6	Women's Room 2, East Wall
B02-08-13-S-W-S-00	W	S	NA	NA	1.6	14.5	Conveyor Passage, South Wall
B02-08-14-S-F-B-00	F	B	NA	NA	2.0	20.0	Conveyor Passage, floor
B02-08-15-S-F-B-00	F	B	NA	NA	2.0	25.0	Conveyor Passage, floor
B02-08-16-S-C-B-00	F	B	NA	NA	1.0	5.0	Conveyor Passage, ceiling

*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	**25.3%**	N/A	**23.6%**	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	0.2530	0.25	1.00	2.682E-03	1.70E-04
Np-237	Alpha	5.0	0.2530	0.25	1.00	5.573E-05	3.52E-06
Pu-239	Alpha	5.2	0.2530	0.25	1.00	2.027E-06	1.28E-07
Tc-99	Beta	0.294	0.2360	0.25	1.00	2.829E-03	1.67E-04
Th-232	Alpha	4.1	0.2530	0.25	1.00	3.214E-03	2.03E-04
Ra-228	Beta	0.046	0.2360	0.00	1.00	3.214E-03	0.00E+00
Ac-228	Beta	2.13	0.2360	0.50	1.00	3.214E-03	3.79E-04
Th-228	Alpha	5.5	0.2530	0.25	1.00	3.214E-03	2.03E-04
Ra-224	Alpha	5.8	0.2530	0.25	1.00	3.214E-03	2.03E-04
U-234	Alpha	4.9	0.2530	0.25	1.00	8.270E-01	5.23E-02
U-235	Alpha	4.7	0.2530	0.25	1.00	3.720E-02	2.35E-03
Th-231	Beta	0.390	0.2360	0.25	1.00	3.720E-02	2.19E-03
U-238	Alpha	4.3	0.2530	0.25	1.00	1.270E-01	8.03E-03
Th-234	Beta	0.270	0.2360	0.25	1.00	1.270E-01	7.49E-03
Pa-234m	Beta	2.20	0.2360	0.50	1.00	1.270E-01	1.50E-02

Total Weighted Instrument Efficiency = Σ Weighted Instrument Efficiency for all Nuclides of Concern **Σ=** **8.87%**

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**
B02-08-01-S-W-S-00	Kardex, South Wall	08/22/2015	alpha + beta TSC	251	169	82	924	924	5%
B02-08-02-S-W-S-00	Kardex, West Wall	08/22/2015	alpha + beta TSC	245	169	76	857	857	5%
B02-08-03-S-W-S-00	Kardex, East Wall	08/22/2015	alpha + beta TSC	216	169	47	530	530	3%
B02-08-04-S-W-S-00	Rod Load, West Wall	08/22/2015	alpha + beta TSC	179	169	10	113	113	1%
B02-08-05-S-C-S-00	Rod Load, Ceiling	08/22/2015	alpha + beta TSC	215	169	46	519	519	3%
B02-08-06-S-C-S-00	Rod Load, Ceiling	08/22/2015	alpha + beta TSC	205	169	36	406	406	2%
B02-08-07-S-C-S-00	Women's Room 2, Ceiling	08/22/2015	alpha + beta TSC	204	169	35	395	395	2%
B02-08-08-S-W-S-00	Hallway 1, West Wall	08/22/2015	alpha + beta TSC	152	169	-17	-192	0	0%
B02-08-09-S-W-S-00	Men's Room, East Wall	08/22/2015	alpha + beta TSC	150	169	-19	-214	0	0%
B02-08-10-S-W-S-00	Hallway 3, West Wall	08/22/2015	alpha + beta TSC	234	169	65	733	733	4%
B02-08-11-S-C-S-00	Women's Room 1, Ceiling	08/22/2015	alpha + beta TSC	172	169	3	34	34	0%
B02-08-12-S-W-S-00	Women's Room 2, East Wall	08/22/2015	alpha + beta TSC	143	169	-26	-293	0	0%
B02-08-13-S-W-S-00	Conveyor Passage, South Wall	08/22/2015	alpha + beta TSC	126	169	-43	-485	0	0%
B02-08-14-S-F-B-00	Conveyor Passage, floor	08/22/2015	alpha + beta TSC	161	169	-8	-90	0	0%
B02-08-15-S-F-B-00	Conveyor Passage, floor	08/22/2015	alpha + beta TSC	515	169	346	3901	3901	21%
B02-08-16-S-C-B-00	Conveyor Passage, ceiling	08/22/2015	alpha + beta TSC	319	169	150	1691	1691	9%

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

Min	0	**2%**	Average Fraction Step 8.4.5.g
Max	924		
Mean	347	**DCGLso**	
Median	395	**0.50**	mrem SU Dose Contribution Step 8.4.6
Stdev	347.1	**mrem**	

Instrument used for FSS Static Measurements:

Ludlum 2360/43-93	S/N 215022	08/22/2015		Survey # HDP-PF-082215-052		
Detector Area (A) =	100 cm^2	ave. ambient bkg = ($\alpha + \beta$)	169 cpm	weighted eff (ε_w)=	0.08870	

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	Kardex, South Wall	08/22/2015	0	-1	-4	0	39	-10	-42
2	Kardex, West Wall	08/22/2015	0	-1	-4	0	42	-7	-29
3	Kardex, East Wall	08/22/2015	1	0	0	0	48	-1	-4
4	Rod Load, West Wall	08/22/2015	0	-1	-4	0	43	-6	-25
5	Rod Load, Ceiling	08/22/2015	0	-1	-4	0	35	-14	-59
6	Rod Load, Ceiling	08/22/2015	0	-1	-4	0	46	-3	-13
7	Women's Room 2, Ceiling	08/22/2015	0	-1	-4	0	44	-5	-21
8	Hallway 1, West Wall	08/22/2015	2	1	4	4	51	2	8
9	Men's Room, East Wall	08/22/2015	2	1	4	4	47	-2	-8
10	Hallway 3, West Wall	08/22/2015	3	2	8	8	60	11	46
11	Women's Room 1, Ceiling	08/22/2015	1	0	0	0	52	3	13
12	Women's Room 2, East Wall	08/22/2015	0	-1	-4	0	46	-3	-13
13	Conveyor Passage, South Wall	08/22/2015	3	2	8	8	48	-1	-4
14	Conveyor Passage, floor	08/22/2015	5	4	16	16	52	3	13
15	Conveyor Passage, floor	08/22/2015	12	11	44	44	59	10	42
16	Conveyor Passage, ceiling	08/22/2015	1	0	0	0	60	11	46

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	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
8	12	Y	N	N
0	4	Y	N	N
46	54	Y	N	N
13	13	Y	N	N
0	0	N	N	N
0	8	Y	N	N
13	29	Y	N	N
42	86	Y	Y	N
46	46	Y	N	N
Min	0			
Max	86			
Mean	16			
Median	2			
StDev	25.5			

DCGL = 18,925 dpm/100cm^2

Instrument used for Removable Measurements:

Ludlum 2929/43-10-1 S/N 115578 Cal Due 10/30/15 Survey # HDP-PF-082215-052
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

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
B02-08-01-S-W-S-00	Kardex, South Wall	924	0.049	0.951	0.951
B02-08-02-S-W-S-00	Kardex, West Wall	857	0.045	0.955	0.955
B02-08-03-S-W-S-00	Kardex, East Wall	530	0.028	0.972	0.972
B02-08-04-S-W-S-00	Rod Load, West Wall	113	0.006	0.994	0.994
B02-08-05-S-C-S-00	Rod Load, Ceiling	519	0.027	0.973	0.973
B02-08-06-S-C-S-00	Rod Load, Ceiling	406	0.021	0.979	0.979
B02-08-07-S-C-S-00	Women's Room 2, Ceiling	395	0.021	0.979	0.979
B02-08-08-S-W-S-00	Hallway 1, West Wall	0	0.000	1.000	1.000
B02-08-09-S-W-S-00	Men's Room, East Wall	0	0.000	1.000	1.000
B02-08-10-S-W-S-00	Hallway 3, West Wall	733	0.039	0.961	0.961
B02-08-11-S-C-S-00	Women's Room 1, Ceiling	34	0.002	0.998	0.998
B02-08-12-S-W-S-00	Women's Room 2, East Wall	0	0.000	1.000	1.000
B02-08-13-S-W-S-00	Conveyor Passage, South Wall	0	0.000	1.000	1.000
				Number of Positive Differences (S+)	13
				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

$\alpha = 0.05$

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		