

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development		
		Revision: 10	Appendix P-4, Page 1 of 1

**APPENDIX P-4**

**FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES**

<b>Survey Area:</b>	<u>BSA 02</u>	<b>Description:</b>	<u>Building Survey Area (Building 230)</u>
<b>Survey Unit:</b>	<u>17</u>	<b>Description:</b>	<u>All Sections and Warehouse, Upper Walls, Ceiling and Duct Exteriors</u>
<b>Survey Type:</b>	<u>FSS</u>	<b>Classification:</b>	<u>Class 3</u>

Measurement or Sample ID	Surface or CSM	Type	Start Elevation	End Elevation	Northing (feet) (Y Axis) *	Easting (feet) (X Axis) *	Remarks / Notes
B02-17-01-S-C-S-00	C	S	NA	NA	26.0	110.0	Warehouse Ceiling
B02-17-02-S-C-S-00	C	S	NA	NA	47.0	131.0	Warehouse Ceiling
B02-17-03-S-C-S-00	C	S	NA	NA	74.8	62.8	U-Shaped Area Ceiling
B02-17-04-S-W-S-00	W	S	NA	NA	10.2	19.3	U-Shaped Area West Wall
B02-17-05-S-W-S-00	W	S	NA	NA	18.8	57.8	U-Shaped Area North Wall
B02-17-06-S-W-S-00	W	S	NA	NA	8.0	128.8	U-Shaped Area North Wall
B02-17-07-S-W-S-00	W	S	NA	NA	10.2	13.9	Gad Room West Ext. Wall
B02-17-08-S-W-S-00	W	S	NA	NA	26.1	42.3	U-Shaped Area East Wall
B02-17-09-S-W-S-00	W	S	NA	NA	72.2	452.7	U-Shaped Area South Wall
B02-17-10-S-W-S-00	W	S	NA	NA	17.3	49.0	Warehouse North Wall
B02-17-11-S-W-S-00	W	S	NA	NA	19.8	144.1	Warehouse South Wall
B02-17-12-S-W-S-00	W	S	NA	NA	7.4	14.5	Rod Load West Ext. 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 237312	Ludlum 43-89 19027	Active Probe Area 125 cm <sup>2</sup>	$\alpha$ HDP Efficiency 24.1%	$\alpha$ Cal. Efficiency N/A	$\beta$ HDP Efficiency 8.5%	$\beta$ Cal. Efficiency N/A
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**TOTAL WEIGHTED INSTRUMENT EFFICIENCY CALCULATION**

Radionuclide	Radiation	Maximum Energy (MeV)	Instrument Efficiency ( $\epsilon_i$ )	Surface Efficiency ( $\epsilon_s$ )	Yield 100%	Activity Fraction	Weighted Efficiency
Am-241	Alpha	5.6	0.2410	0.25	1.00	2.682E-03	1.62E-04
Np-237	Alpha	5.0	0.2410	0.25	1.00	5.573E-05	3.36E-06
Pu-239	Alpha	5.2	0.2410	0.25	1.00	2.027E-06	1.22E-07
Tc-99	Beta	0.294	0.0851	0.25	1.00	2.829E-03	6.02E-05
Th-232	Alpha	4.1	0.2410	0.25	1.00	3.214E-03	1.94E-04
Ra-228	Beta	0.046	0.0851	0.00	1.00	3.214E-03	0.00E+00
Ac-228	Beta	2.13	0.0851	0.50	1.00	3.214E-03	1.37E-04
Th-228	Alpha	5.5	0.2410	0.25	1.00	3.214E-03	1.94E-04
Ra-224	Alpha	5.8	0.2410	0.25	1.00	3.214E-03	1.94E-04
U-234	Alpha	4.9	0.2410	0.25	1.00	8.270E-01	4.98E-02
U-235	Alpha	4.7	0.2410	0.25	1.00	3.720E-02	2.24E-03
Th-231	Beta	0.390	0.0851	0.25	1.00	3.720E-02	7.91E-04
U-238	Alpha	4.3	0.2410	0.25	1.00	1.270E-01	7.65E-03
Th-234	Beta	0.270	0.0851	0.25	1.00	1.270E-01	2.70E-03
Pa-234m	Beta	2.20	0.0851	0.50	1.00	1.270E-01	5.40E-03

Total Weighted Instrument Efficiency =  $\Sigma$  Weighted Instrument Efficiency for all Nuclides of Concern

$\Sigma =$  6.96%

Weighted Instrument Efficiency =  $\epsilon_i * \epsilon_s * \text{Yield} * \text{Activity Fraction}$

$\epsilon_i$  = 2 Pi Instrument Efficiency for Nuclide of Concern

$\epsilon_s$  = Surface Efficiency for Nuclide of Concern

<p>Meter <b>43-89</b></p>
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**HDP-PR-FSS-721 Final Status Survey Data Evaluation**  
**Preliminary Data Review and Determination of Sum-of-Fractions (SOF)**

MEASUREMENT ID	MEASUREMENT LOCATION	DATE MEAS	MEASUREMENT	Step 8.3.2				Corrected Net dpm/100cm <sup>2</sup>	Fraction of DCGL Step 8.4.3
				GROSS cpm (α+β)	BKG cpm (a+b)	Net cpm (α + β)	Combined Net dpm/100 cm <sup>2</sup> (α+β)		
B02-17-01-S-C-S-00	Warehouse Ceiling	06/16/2016	alpha + beta TSC	175	153	22	253	253	1%
B02-17-02-S-C-S-00	Warehouse Ceiling	06/16/2016	alpha + beta TSC	173	153	20	230	230	1%
B02-17-03-S-C-S-00	U-Shaped Area Ceiling	06/16/2016	alpha + beta TSC	154	153	1	11	11	0%
B02-17-04-S-W-S-00	U-Shaped Area West Wall	06/16/2016	alpha + beta TSC	178	153	25	287	287	2%
B02-17-05-S-W-S-00	U-Shaped Area North Wall	06/16/2016	alpha + beta TSC	158	153	5	57	57	0%
B02-17-06-S-W-S-00	U-Shaped Area North Wall	06/16/2016	alpha + beta TSC	166	153	13	149	149	1%
B02-17-07-S-W-S-00	Gad Room West Ext. Wall	06/16/2016	alpha + beta TSC	128	153	-25	-287	0	0%
B02-17-08-S-W-S-00	U-Shaped Area East Wall	06/16/2016	alpha + beta TSC	136	153	-17	-195	0	0%
B02-17-09-S-W-S-00	U-Shaped Area South Wall	06/16/2016	alpha + beta TSC	130	153	-23	-264	0	0%
B02-17-10-S-W-S-00	Warehouse North Wall	06/16/2016	alpha + beta TSC	129	153	-24	-276	0	0%
B02-17-11-S-W-S-00	Warehouse South Wall	06/16/2016	alpha + beta TSC	143	153	-10	-115	0	0%
B02-17-12-S-W-S-00	Rod Load West Ext. Wall	06/16/2016	alpha + beta TSC	136	153	-17	-195	0	0%

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

Min	0
Max	287
Mean	82
Median	6
Stdev	114.3

Average Fraction  
Step 8.4.5.g

**0.4%**

**DCGL<sub>so</sub>**

**0.10**

mrem SU Dose Contribution  
Step 8.4.6

**mrem**

Instrument used for FSS Static Measurements:

Ludlum 2360/43-89	S/N 237312	06/16/2016	Survey # 7728 C 160616
Detector Area (A) =	125 cm <sup>2</sup>	ave. ambient bkg =	153 cpm weighted eff (ε <sub>w</sub> ) = 0.06960 (α + β)
TSC (dpm/100cm <sup>2</sup> ) = (acpm-bka) / (ε <sub>w</sub> * (A <sub>net</sub> /100 cm <sup>2</sup> ))			
DCGL (structures) = 18.925 dpm/100 cm <sup>2</sup>			

HDP-PR-HP-314 Unrestricted Release of Materials and Equipment  
Removable Data Evaluation

MEASUREMENT ID	MEASUREMENT LOCATION	DATE MEAS	Alpha Gross cpm	Alpha Net cpm	Alpha Net dpm/100cm <sup>2</sup>	Corrected Alpha Net dpm/100cm <sup>2</sup>	Beta Gross cpm	Beta Net cpm	Beta Net dpm/100cm <sup>2</sup>	Corrected Beta Net dpm/100cm <sup>2</sup>	Combined Net dpm/100 cm <sup>2</sup> ( $\alpha+\beta$ )	Exceed 10% of Min. Sys. TSC Result?	Exceed MDA?	Exceed 10% of DCGL?
1	Warehouse Ceiling	06/16/2016	0	-1	-2	0	4	2	7	7	7	Y	N	N
2	Warehouse Ceiling	06/16/2016	2	-1	-2	0	1	-1	-5	0	0	N	N	N
3	U-Shaped Area Ceiling	06/16/2016	-1	-1	-2	0	6	4	15	15	7	Y	N	N
4	U-Shaped Area West Wall	06/16/2016	-1	-1	-2	0	4	2	7	7	7	Y	N	N
5	U-Shaped Area North Wall	06/16/2016	2	2	6	6	5	2	8	8	14	Y	N	N
6	U-Shaped Area North Wall	06/16/2016	4	4	14	14	2	-1	-3	0	14	Y	Y	N
7	Gad Room West Ext. Wall	06/16/2016	0	0	2	2	7	4	17	17	19	Y	N	N
8	U-Shaped Area East Wall	06/16/2016	-1	-1	-2	0	3	1	3	3	3	Y	N	N
9	U-Shaped Area South Wall	06/16/2016	-1	-1	-2	0	5	3	11	11	11	Y	N	N
10	Warehouse North Wall	06/16/2016	1	1	2	2	5	2	9	9	11	Y	N	N
11	Warehouse South Wall	06/16/2016	-1	-1	-2	0	4	2	7	7	7	Y	N	N
12	Rod Load West Ext. Wall	06/16/2016	1	1	2	2	3	0	2	2	4	Y	N	N

Instrument used for Removable Measurements:

Tennelec Unit # 1

Cal Due 9/11/16

Survey # 7728 C 160816

alpha bkg = 0.5 cpm      alpha efficiency = 25.30%      alpha MDA = 12.4  
beta bkg = 2.5 cpm      beta efficiency = 25.40%      beta MDA = 23.6

Min 0  
Max 19  
Mean 9  
Median 9  
StDev 5.6

DCGL = 18,925 dpm/100cm<sup>2</sup>

Removable Activity (dpm/100cm<sup>2</sup>) = (gcpm-bkg) / ε

Area "swiped" = 100 cm<sup>2</sup>

**HDP-PR-FSS-721 Final Status Survey Data Evaluation  
Performance of Statistical Tests**

Sign Test					
SAMPLE ID	SAMPLE ID	Gross TSC Step 8.5.4.a	Gross TSC / Adj. Gross DCGL (W <sub>s</sub> ) Step 8.5.4.b	Difference (1-W <sub>s</sub> ) Step 8.5.4.d	Corrected Difference Step 8.5.4.e
B02-17-01-S-C-S-00	Warehouse Ceiling	253	0.013	0.987	0.987
B02-17-02-S-C-S-00	Warehouse Ceiling	230	0.012	0.988	0.988
B02-17-03-S-C-S-00	U-Shaped Area Ceiling	11	0.001	0.999	0.999
B02-17-04-S-W-S-00	U-Shaped Area West Wall	287	0.015	0.985	0.985
B02-17-05-S-W-S-00	U-Shaped Area North Wall	57	0.003	0.997	0.997
B02-17-06-S-W-S-00	U-Shaped Area North Wall	149	0.008	0.992	0.992
B02-17-07-S-W-S-00	Gad Room West Ext. Wall	0	0.000	1.000	1.000
B02-17-08-S-W-S-00	U-Shaped Area East Wall	0	0.000	1.000	1.000
B02-17-09-S-W-S-00	U-Shaped Area South Wall	0	0.000	1.000	1.000
B02-17-10-S-W-S-00	Warehouse North Wall	0	0.000	1.000	1.000
B02-17-11-S-W-S-00	Warehouse South Wall	0	0.000	1.000	1.000
B02-17-12-S-W-S-00	Rod Load West Ext. Wall	0	0.000	1.000	1.000
<b>Number of Positive Differences (S+)</b>					<b>12</b>
<b>Sign Test Critical Value (MARSSIM Table I-3)</b>					<b>9</b>

α = 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		

If every measurement in the systematic sample population is <= the DCGL, a statistical test is not required.

**TEST: PASS**