

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development		
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**APPENDIX P-4**

**FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES**

<b>Survey Area:</b>	<u>BSA 04</u>	<b>Description:</b>	<u>Concrete Pad South of Bldg 230</u>
<b>Survey Unit:</b>	<u>8</u>	<b>Description:</b>	<u>Concrete Pad</u>
<b>Survey Type:</b>	<u>FSS</u>	<b>Classification:</b>	<u>Class 2</u>

Measurement or Sample ID	Surface or CSM	Type	Start Elevation	End Elevation	Northing (feet) (Y Axis) *	Easting (feet) (X Axis) *	Remarks / Notes
B04-08-01-S-F-S-00	F	S	435.5	435.5	864546.1	827072.8	Concrete Pad
B04-08-02-S-F-S-00	F	S	435.5	435.5	864506.7	827004.4	Concrete Pad
B04-08-03-S-F-S-00	F	S	435.5	435.5	864506.7	827050.0	Concrete Pad
B04-08-04-S-F-S-00	F	S	435.5	435.5	864506.7	827095.6	Concrete Pad
B04-08-05-S-F-S-00	F	S	435.5	435.5	864467.4	826981.6	Concrete Pad
B04-08-06-S-F-S-00	F	S	435.5	435.5	864467.4	827027.2	Concrete Pad
B04-08-07-S-F-S-00	F	S	435.5	435.5	864467.4	827072.8	Concrete Pad
B04-08-08-S-F-S-00	F	S	435.5	435.5	864428.0	827004.4	Concrete Pad
B04-08-09-S-F-S-00	F	S	435.5	435.5	864428.0	827050.0	Concrete Pad
B04-08-10-S-F-S-00	F	S	435.5	435.5	864428.0	827095.6	Concrete Pad
B04-08-11-S-F-S-00	F	S	435.5	435.5	864388.6	827072.8	Concrete Pad

\*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 276929	Ludlum 43-89 19204	Active Probe Area 125 cm <sup>2</sup>	$\alpha$ HDP Efficiency 24.0%	$\alpha$ Cal. Efficiency N/A	$\beta$ HDP Efficiency 14.4%	$\beta$ 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	0.2404	0.25	1.00	2.682E-03	1.61E-04
Np-237	Alpha	5.0	0.2404	0.25	1.00	5.573E-05	3.35E-06
Pu-239	Alpha	5.2	0.2404	0.25	1.00	2.027E-06	1.22E-07
Tc-99	Beta	0.294	0.1441	0.25	1.00	2.829E-03	1.02E-04
Th-232	Alpha	4.1	0.2404	0.25	1.00	3.214E-03	1.93E-04
Ra-228	Beta	0.046	0.1441	0.00	1.00	3.214E-03	0.00E+00
Ac-228	Beta	2.13	0.1441	0.50	1.00	3.214E-03	2.32E-04
Th-228	Alpha	5.5	0.2404	0.25	1.00	3.214E-03	1.93E-04
Ra-224	Alpha	5.8	0.2404	0.25	1.00	3.214E-03	1.93E-04
U-234	Alpha	4.9	0.2404	0.25	1.00	8.270E-01	4.97E-02
U-235	Alpha	4.7	0.2404	0.25	1.00	3.720E-02	2.24E-03
Th-231	Beta	0.390	0.1441	0.25	1.00	3.720E-02	1.34E-03
U-238	Alpha	4.3	0.2404	0.25	1.00	1.270E-01	7.63E-03
Th-234	Beta	0.270	0.1441	0.25	1.00	1.270E-01	4.58E-03
Pa-234m	Beta	2.20	0.1441	0.50	1.00	1.270E-01	9.15E-03

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

$\Sigma =$  7.57%

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 ( $\alpha+\beta$ )	BKG cpm (a+b)	Net cpm ( $\alpha$ + $\beta$ )	Combined Net dpm/100 cm <sup>2</sup> ( $\alpha+\beta$ )		
B04-08-01-S-F-S-00	Concrete Pad	05/29/2016	alpha + beta TSC	239	217	21.667	229	229	1%
B04-08-02-S-F-S-00	Concrete Pad	05/29/2016	alpha + beta TSC	251	217	33.667	356	356	2%
B04-08-03-S-F-S-00	Concrete Pad	05/29/2016	alpha + beta TSC	220	217	2.6667	28	28	0%
B04-08-04-S-F-S-00	Concrete Pad	05/29/2016	alpha + beta TSC	216	217	-1.333	-14	0	0%
B04-08-05-S-F-S-00	Concrete Pad	05/29/2016	alpha + beta TSC	246	217	28.667	303	303	2%
B04-08-06-S-F-S-00	Concrete Pad	05/29/2016	alpha + beta TSC	250	217	32.667	345	345	2%
B04-08-07-S-F-S-00	Concrete Pad	05/29/2016	alpha + beta TSC	236	217	18.667	197	197	1%
B04-08-08-S-F-S-00	Concrete Pad	05/29/2016	alpha + beta TSC	237	217	19.667	208	208	1%
B04-08-09-S-F-S-00	Concrete Pad	05/29/2016	alpha + beta TSC	226	217	8.6667	92	92	0%
B04-08-10-S-F-S-00	Concrete Pad	05/29/2016	alpha + beta TSC	212	217	-5.333	-56	0	0%
B04-08-11-S-F-S-00	Concrete Pad	05/29/2016	alpha + beta TSC	216	217	-1.333	-14	0	0%

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

Min	0	1%	Average Fraction
Max	356		Step 8.4.5.g
Mean	160	<b>DCGLso</b>	
Median	197	<b>0.25</b>	mrem SU Dose Contribution
Stdev	141.6	<b>mrem</b>	Step 8.4.6

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

Instrument used for FSS Static Measurements:

Ludlum 2360/43-89	S/N 276929	05/29/2016	Survey # 7582 R 160529
Detector Area (A) =	125 cm <sup>2</sup>	ave. ambient bkg = 217.3 cpm ( $\alpha + \beta$ )	weighted eff ( $\epsilon_w$ )= 0.07570
TSC (dpm/100cm <sup>2</sup> ) = (qcpm-bkg) / ( $\epsilon_w * (A_{TSC}/100 \text{ cm}^2)$ )			
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>
1	Concrete Pad	05/29/2016	1.6	0.8	3.2	3.2	6.0	3.1	12.2
2	Concrete Pad	05/29/2016	4.1	3.3	13.0	13.0	1.9	-1.0	-3.9
3	Concrete Pad	05/29/2016	1.0	0.2	0.8	0.8	5.0	2.1	8.3
4	Concrete Pad	05/29/2016	0.0	-0.8	-3.2	0.0	4.3	1.4	5.5
5	Concrete Pad	05/29/2016	0.0	-0.8	-3.2	0.0	4.3	1.4	5.5
6	Concrete Pad	05/29/2016	0.1	-0.7	-2.8	0.0	2.3	-0.6	-2.4
7	Concrete Pad	05/29/2016	1.0	0.2	0.8	0.8	4.0	1.1	4.3
8	Concrete Pad	05/29/2016	0.1	-0.7	-2.8	0.0	2.3	-0.6	-2.4
9	Concrete Pad	05/29/2016	0.0	-0.8	-3.2	0.0	3.3	0.4	1.6
10	Concrete Pad	05/29/2016	1.0	0.2	0.8	0.8	6.0	3.1	12.2
11	Concrete Pad	05/29/2016	0.0	-0.8	-3.2	0.0	3.3	0.4	1.6

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

Instrument used for Removable Measurements:

Tennelec Unit #1      Batch # 52403      05/29/2016      Survey # 7582 R 160529

alpha bkg = 0.8 cpm      alpha efficiency = 25.30%  
beta bkg = 2.9 cpm      beta efficiency = 25.40%

Corrected Beta Net dpm/100cm <sup>2</sup>	Combined Net dpm/100 cm <sup>2</sup> (α+β)	Exceed 10% of Min. Sys. TSC Result?	Exceed MDA?	Exceed 10% of DCGL?
12.2	15	Y	N	N
0.0	13	Y	N	N
8.3	9	Y	N	N
5.5	6	Y	N	N
5.5	6	Y	N	N
0.0	0	N	N	N
4.3	5	Y	N	N
0.0	0	N	N	N
1.6	2	Y	N	N
12.2	13	Y	N	N
1.6	2	Y	N	N

Min      0  
Max      15  
Mean     6  
Median   6  
StDev    5.5

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

$$\text{Removable Activity (dpm/100cm}^2\text{)} = (\text{gcpm-bkg}) / \epsilon$$

$$\text{Area "swiped"} = 100 \text{ cm}^2$$

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

alpha MDA = 14.4  
beta MDA = 25.1

**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 ( $W_s$ ) Step 8.5.4.b	Difference ( $1-W_s$ ) Step 8.5.4.d	Corrected Difference Step 8.5.4.e
B04-08-01-S-F-S-00	Concrete Pad	229	0.012	0.988	0.988
B04-08-02-S-F-S-00	Concrete Pad	356	0.019	0.981	0.981
B04-08-03-S-F-S-00	Concrete Pad	28	0.001	0.999	0.999
B04-08-04-S-F-S-00	Concrete Pad	0	0.000	1.000	1.000
B04-08-05-S-F-S-00	Concrete Pad	303	0.016	0.984	0.984
B04-08-06-S-F-S-00	Concrete Pad	345	0.018	0.982	0.982
B04-08-07-S-F-S-00	Concrete Pad	197	0.010	0.990	0.990
B04-08-08-S-F-S-00	Concrete Pad	208	0.011	0.989	0.989
B04-08-09-S-F-S-00	Concrete Pad	92	0.005	0.995	0.995
B04-08-10-S-F-S-00	Concrete Pad	0	0.000	1.000	1.000
B04-08-11-S-F-S-00	Concrete Pad	0	0.000	1.000	1.000
<b>Number of Positive Differences (S+)</b>					<b>11</b>
<b>Sign Test Critical Value (MARSSIM Table I-3)</b>					<b>8</b>

$\alpha = 0.05$

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		

If every measurement in the systematic sample population is  $\leq$  the DCGL, a statistical test is not required.

TEST: **PASS**