

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

Survey Area:	<u>BSA 04</u>	Description:	<u>Structure Survey Unit in Area 17</u>
Survey Unit:	<u>12</u>	Description:	<u>Asphalt and Concrete in LSA 08-03</u>
Survey Type:	<u>FSS</u>	Classification:	<u>Class 1</u>

Measurement or Sample ID	Surface or CSM	Type	Start Elevation	End Elevation	Northing (feet) (Y Axis) *	Easting (feet) (X Axis) *	Remarks / Notes
B04-12-01-S-F-S-00	F	S	NA	NA	865049.1	827178.9	Asphalt
B04-12-02-S-F-S-00	F	S	NA	NA	865041.9	827174.6	Asphalt
B04-12-03-S-F-S-00	F	S	NA	NA	865041.9	827191.7	Pipe Chase
B04-12-04-S-F-S-00	F	S	NA	NA	865034.7	827153.3	Concrete
B04-12-05-S-F-S-00	F	S	NA	NA	865034.7	827161.8	Concrete
B04-12-06-S-F-S-00	F	S	NA	NA	865034.7	827170.3	Asphalt
B04-12-07-S-F-S-00	F	S	NA	NA	865034.7	827187.4	Pipe Chase
B04-12-08-S-F-S-00	F	S	NA	NA	865027.4	827157.5	Asphalt
B04-12-09-S-F-S-00	F	S	NA	NA	865020.2	827153.3	Asphalt
B04-12-10-S-F-S-00	F	S	NA	NA	865013.0	827149.0	Asphalt
B04-12-11-S-F-S-00	F	S	NA	NA	864998.6	827131.9	Asphalt
B04-12-12-S-F-S-00	F	S	NA	NA	864991.3	827127.7	Asphalt

*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 278647	Ludlum 43-89 311685	Active Probe Area 125 cm ²	α HDP Efficiency 26.5%	α Cal. Efficiency N/A	β HDP Efficiency 13.6%	β Cal. Efficiency N/A
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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

$\Sigma =$ 8.10%

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

ϵ_i = 2 Pi Instrument Efficiency for Nuclide of Concern

ϵ_s = Surface Efficiency for Nuclide of Concern

<p>Meter 43-89</p>

**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 ²	Fraction of DCGL Step 8.4.3	
				GROSS cpm (α+β)	BKG cpm (a+b)	Net cpm (α + β)	Combined Net dpm/100 cm ² (α+β)			
B04-12-01-S-F-S-00	Asphalt	04/15/2016	alpha + beta TSC	188	193	-5.333	-53	0	0%	
B04-12-02-S-F-S-00	Asphalt	04/15/2016	alpha + beta TSC	195	193	1.6667	16	16	0%	
B04-12-03-S-F-S-00	Pipe Chase	04/15/2016	alpha + beta TSC	215	193	21.667	214	214	1%	
B04-12-04-S-F-S-00	Concrete	04/15/2016	alpha + beta TSC	167	193	-26.33	-260	0	0%	
B04-12-05-S-F-S-00	Concrete	04/15/2016	alpha + beta TSC	181	193	-12.33	-122	0	0%	
B04-12-06-S-F-S-00	Asphalt	04/15/2016	alpha + beta TSC	177	193	-16.33	-162	0	0%	
B04-12-07-S-F-S-00	Pipe Chase	04/15/2016	alpha + beta TSC	170	193	-23.33	-231	0	0%	
B04-12-08-S-F-S-00	Asphalt	04/15/2016	alpha + beta TSC	195	193	1.6667	16	16	0%	
B04-12-09-S-F-S-00	Asphalt	04/15/2016	alpha + beta TSC	195	193	1.6667	16	16	0%	
B04-12-10-S-F-S-00	Asphalt	04/15/2016	alpha + beta TSC	161	193	-32.33	-320	0	0%	
B04-12-11-S-F-S-00	Asphalt	04/15/2016	alpha + beta TSC	175	193	-18.33	-181	0	0%	
B04-12-12-S-F-S-00	Asphalt	04/15/2016	alpha + beta TSC	197	193	3.6667	36	36	0%	
*NOTE: Differences from documented survey results are due to rounding in Excel								Min	0	Average Fraction Step 8.4.5.g
								Max	214	
								Mean	25	DCGLso
								Median	0	mrem SU Dose Contribution Step 8.4.6
								Stdev	60.7	
									0.1	mrem

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 278647	04/15/2016	Survey # 7341 C 160415
Detector Area (A) =	125 cm ²	ave. ambient bkg = 193.3 cpm ($\alpha + \beta$)	weighted eff (ϵ_w)= 0.08090
TSC (dpm/100cm ²) = (qcpm-bkg) / ($\epsilon_w * (A_{ref}/100 \text{ cm}^2)$)			
DCGL (structures) = 18,925 dpm/100 cm ²			

**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 ²	Corrected Alpha Net dpm/100cm ²	Beta Gross cpm	Beta Net cpm	Beta Net dpm/100cm ²
1	Asphalt	04/15/2016	2.1	1.3	5.1	5.1	7.2	3.9	15.3
2	Asphalt	04/15/2016	0.1	-0.7	-2.7	0.0	3.3	0.0	0.0
3	Pipe Chase	04/15/2016	2.1	1.3	5.1	5.1	13.8	10.5	41.2
4	Concrete	04/15/2016	0.1	-0.7	-2.7	0.0	3.3	0.0	0.0
5	Concrete	04/15/2016	1.1	0.3	1.2	1.2	4.5	1.2	4.7
6	Asphalt	04/15/2016	0.1	-0.7	-2.7	0.0	3.3	0.0	0.0
7	Pipe Chase	04/15/2016	2.1	1.3	5.1	5.1	3.3	0.0	0.0
8	Asphalt	04/15/2016	0.1	-0.7	-2.7	0.0	7.2	3.9	15.3
9	Asphalt	04/15/2016	0.1	-0.7	-2.7	0.0	3.3	0.0	0.0
10	Asphalt	04/15/2016	5.1	4.3	16.9	16.9	4.3	1.0	3.9
11	Asphalt	04/15/2016	0.1	-0.7	-2.7	0.0	5.3	2.0	7.8
12	Asphalt	04/15/2016	4.0	3.2	12.5	12.5	6.3	3.0	11.8

**HDP-PR-HP-314 Unrestricted Release of Materials and Equipment
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?
15.3	20	Y	N	N
0.0	0	N	N	N
41.2	46	Y	Y	N
0.0	0	N	N	N
4.7	6	Y	N	N
0.0	0	N	N	N
0.0	5	Y	N	N
15.3	15	Y	N	N
0.0	0	N	N	N
3.9	21	Y	Y	N
7.8	8	Y	N	N
11.8	24	Y	N	N

Min 0
Max 46
Mean 12
Median 7
StDev 14.0

DCGL = 18,925 dpm/100cm²

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

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

Instrument used for Removable Measurements:

Tennelec Unit #1 Batch # 51856 04/15/2016 Survey # 7341 C 160415

alpha bkg = 0.8 cpm alpha efficiency = 25.50% alpha MDA = 14.5
beta bkg = 3.3 cpm beta efficiency = 25.50% beta MDA = 26.5

**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
B04-12-01-S-F-S-00	Asphalt	0	0.000	1.000	1.000
B04-12-02-S-F-S-00	Asphalt	16	0.001	0.999	0.999
B04-12-03-S-F-S-00	Pipe Chase	214	0.011	0.989	0.989
B04-12-04-S-F-S-00	Concrete	0	0.000	1.000	1.000
B04-12-05-S-F-S-00	Concrete	0	0.000	1.000	1.000
B04-12-06-S-F-S-00	Asphalt	0	0.000	1.000	1.000
B04-12-07-S-F-S-00	Pipe Chase	0	0.000	1.000	1.000
B04-12-08-S-F-S-00	Asphalt	16	0.001	0.999	0.999
B04-12-09-S-F-S-00	Asphalt	16	0.001	0.999	0.999
B04-12-10-S-F-S-00	Asphalt	0	0.000	1.000	1.000
B04-12-11-S-F-S-00	Asphalt	0	0.000	1.000	1.000
B04-12-12-S-F-S-00	Asphalt	36	0.002	0.998	0.998
Number of Positive Differences (S+)					12
Sign Test Critical Value (MARSSIM Table I-3)					9

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