

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

Survey Area:	<u>BSA 04</u>	Description:	<u>Structure Survey Unit in LSA 04-01</u>
Survey Unit:	<u>09</u>	Description:	<u>Asphalt Pavement</u>
Survey Type:	<u>FSS</u>	Classification:	<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
B04-09-01-S-F-S-00	F	S	NA	NA	864618	826833	Asphalt
B04-09-02-S-F-S-00	F	S	NA	NA	864588	826808	Asphalt
B04-09-03-S-F-S-00	F	S	NA	NA	864577	826867	Asphalt
B04-09-04-S-F-S-00	F	S	NA	NA	864562	826853	Asphalt
B04-09-05-S-F-S-00	F	S	NA	NA	864542	826869	Asphalt
B04-09-06-S-F-S-00	F	S	NA	NA	864532	826869	Asphalt
B04-09-07-S-F-S-00	F	S	NA	NA	864552	826901	Asphalt
B04-09-08-S-F-S-00	F	S	NA	NA	864531	826905	Asphalt
B04-09-09-S-F-S-00	F	S	NA	NA	864515	826915	Asphalt
B04-09-10-S-F-S-00	F	S	NA	NA	864520	826927	Asphalt
B04-09-11-S-F-S-00	F	S	NA	NA	864494	826954	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 237312	Ludlum 43-89 19207	Active Probe Area 125 cm ²	α HDP Efficiency 24.1%	α Cal. Efficiency N/A	β HDP Efficiency 8.5%	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	0.2410	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	0.0853	0.25	1.00	2.829E-03	6.03E-05
Th-232	Alpha	4.1	0.2410	0.25	1.00	3.214E-03	1.94E-04
Ra-228	Beta	0.046	0.0853	0.00	1.00	3.214E-03	0.00E+00
Ac-228	Beta	2.13	0.0853	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	0.0853	0.25	1.00	3.720E-02	7.93E-04
U-238	Alpha	4.3	0.2410	0.25	1.00	1.270E-01	7.65E-03
Th-234	Beta	0.270	0.0853	0.25	1.00	1.270E-01	2.71E-03
Pa-234m	Beta	2.20	0.0853	0.50	1.00	1.270E-01	5.42E-03

Total Weighted Instrument Efficiency = Σ Weighted Instrument Efficiency for all Nuclides of Concern

$\Sigma =$

6.96%

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 ($\alpha+\beta$)	BKG cpm (a+b)	Net cpm (α + β)	Combined Net dpm/100 cm ² ($\alpha+\beta$)		
B04-09-01-S-F-S-00	Asphalt	02/26/2016	alpha + beta TSC	205	137	67.667	778	778	4%
B04-09-02-S-F-S-00	Asphalt	02/26/2016	alpha + beta TSC	179	137	41.667	479	479	3%
B04-09-03-S-F-S-00	Asphalt	02/26/2016	alpha + beta TSC	177	137	39.667	456	456	2%
B04-09-04-S-F-S-00	Asphalt	02/26/2016	alpha + beta TSC	209	137	71.667	824	824	4%
B04-09-05-S-F-S-00	Asphalt	02/26/2016	alpha + beta TSC	177	137	39.667	456	456	2%
B04-09-06-S-F-S-00	Asphalt	02/26/2016	alpha + beta TSC	191	137	53.667	617	617	3%
B04-09-07-S-F-S-00	Asphalt	02/26/2016	alpha + beta TSC	168	137	30.667	352	352	2%
B04-09-08-S-F-S-00	Asphalt	02/26/2016	alpha + beta TSC	173	137	35.667	410	410	2%
B04-09-09-S-F-S-00	Asphalt	02/26/2016	alpha + beta TSC	180	137	42.667	490	490	3%
B04-09-10-S-F-S-00	Asphalt	02/26/2016	alpha + beta TSC	163	137	25.667	295	295	2%
B04-09-11-S-F-S-00	Asphalt	02/26/2016	alpha + beta TSC	175	137	37.667	433	433	2%

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

Min	295	3%	Average Fraction Step 8.4.5.g
Max	824		
Mean	508	DCGL _{so}	
Median	456	0.75	mrem SU Dose Contribution Step 8.4.6
Stdev	166.0		
		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 237312	02/26/2016	Survey # 7112 C 160226
Detector Area (A) =	125 cm ²	ave. ambient bkg = 137.3 cpm ($\alpha + \beta$)	weighted eff (ϵ_w)= 0.06960
TSC (dpm/100cm ²) = (qcpm-bkg) / ($\epsilon_w * (A_{\text{ref}}/100 \text{ cm}^2)$)			
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	Alpha Net	Alpha Net	Corrected	Beta Gross	Beta Net	Beta Net
			cpm	cpm	dpm/100cm ²	Alpha Net dpm/100cm ²	cpm	cpm	dpm/100cm ²
1	Asphalt	02/26/2016	2.3	1.0	2.8	2.8	39.7	0.0	0.0
2	Asphalt	02/26/2016	3.3	2.0	5.6	5.6	39.7	0.0	0.0
3	Asphalt	02/26/2016	2.3	1.0	2.8	2.8	39.7	0.0	0.0
4	Asphalt	02/26/2016	4.3	3.0	8.3	8.3	42.7	3.0	13.8
5	Asphalt	02/26/2016	2.3	1.0	2.8	2.8	39.7	0.0	0.0
6	Asphalt	02/26/2016	2.3	1.0	2.8	2.8	39.7	0.0	0.0
7	Asphalt	02/26/2016	1.3	0.0	0.0	0.0	39.7	0.0	0.0
8	Asphalt	02/26/2016	2.3	1.0	2.8	2.8	39.7	0.0	0.0
9	Asphalt	02/26/2016	3.3	2.0	5.6	5.6	39.7	0.0	0.0
10	Asphalt	02/26/2016	1.3	0.0	0.0	0.0	39.7	0.0	0.0
11	Asphalt	02/26/2016	3.3	2.0	5.6	5.6	39.7	0.0	0.0

**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?
0.0	3	N	N	N
0.0	6	N	N	N
0.0	3	N	N	N
13.8	22	N	N	N
0.0	3	N	N	N
0.0	3	N	N	N
0.0	0	N	N	N
0.0	3	N	N	N
0.0	6	N	N	N
0.0	0	N	N	N
0.0	6	N	N	N

Min 0
 Max 22
 Mean 5
 Median 3
 StDev 6.1

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:

Lud 3030 A S/N 232152 02/26/2016 Survey # 7112 C 160226

alpha bkg = 1.3 cpm alpha efficiency = 36.00% alpha MDA = 20.5
 beta bkg = 39.7 cpm beta efficiency = 21.80% beta MDA = 114

**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
B04-09-01-S-F-S-00	Asphalt	778	0.041	0.959	0.959
B04-09-02-S-F-S-00	Asphalt	479	0.025	0.975	0.975
B04-09-03-S-F-S-00	Asphalt	456	0.024	0.976	0.976
B04-09-04-S-F-S-00	Asphalt	824	0.044	0.956	0.956
B04-09-05-S-F-S-00	Asphalt	456	0.024	0.976	0.976
B04-09-06-S-F-S-00	Asphalt	617	0.033	0.967	0.967
B04-09-07-S-F-S-00	Asphalt	352	0.019	0.981	0.981
B04-09-08-S-F-S-00	Asphalt	410	0.022	0.978	0.978
B04-09-09-S-F-S-00	Asphalt	490	0.026	0.974	0.974
B04-09-10-S-F-S-00	Asphalt	295	0.016	0.984	0.984
B04-09-11-S-F-S-00	Asphalt	433	0.023	0.977	0.977
Number of Positive Differences (S+)					11
Sign Test Critical Value (MARSSIM Table I-3)					8

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**