

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 08-17</u>
Survey Unit:	<u>02</u>	Description:	<u>Septic Tank</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
B04-02-01-S-F-S-00	F	S	NA	NA	8.5	6.0	North Chamber Floor
B04-02-02-S-W-S-00	W	S	NA	NA	2.2	4.3	North Chamber W Wall
B04-02-03-S-W-S-00	W	S	NA	NA	6.1	0.5	North Chamber N Wall
B04-02-04-S-W-S-00	W	S	NA	NA	1.0	1.0	North Chamber S Wall
B04-02-05-S-W-S-00	W	S	NA	NA	0.1	1.1	South Chamber S Wall
B04-02-06-S-W-S-00	W	S	NA	NA	2.1	5.2	S Cross Member (N Side)
B04-02-07-S-F-S-00	R	S	NA	NA	2.9	0.4	Tank Top
B04-02-08-S-W-S-00	W	S	NA	NA	0.9	0.9	B230 E Foundation Wall
B04-02-09-S-W-S-00	W	S	NA	NA	0.9	11.9	B230 E Foundation Wall
B04-02-10-S-W-S-00	W	S	NA	NA	0.9	21.9	B230 E Foundation Wall
B04-02-11-S-W-S-00	W	S	NA	NA	0.9	32.7	B230 E Foundation Wall
B04-02-12-S-W-S-00	W	S	NA	NA	0.9	43.6	B230 E Foundation Wall
B04-02-13-S-W-B-00	W	B	NA	NA	2.0	1.0	South Chamber S Wall
B04-02-14-S-W-B-00	W	B	NA	NA	3.5	5.0	South Chamber N Wall
B04-02-15-S-W-B-00	W	B	NA	NA	2.0	0.3	South Chamber E Wall
B04-02-16-S-W-B-00	W	B	NA	NA	6.0	4.0	North Chamber N Wall
B04-02-17-S-W-B-00	W	B	NA	NA	1.0	28.5	B230 E Foundation Wall
B04-02-18-S-W-B-00	W	B	NA	NA	1.1	38.7	B230 E Foundation 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 287589	Ludlum 43-89 PR312650	Active Probe Area 100 cm ²	α HDP Efficiency 27.37%	α Cal. Efficiency N/A	β HDP Efficiency 27.01%	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	0.2737	0.25	1.00	2.682E-03	1.84E-04
Np-237	Alpha	5.0	0.2737	0.25	1.00	5.573E-05	3.81E-06
Pu-239	Alpha	5.2	0.2737	0.25	1.00	2.027E-06	1.39E-07
Tc-99	Beta	0.294	0.2701	0.25	1.00	2.829E-03	1.91E-04
Th-232	Alpha	4.1	0.2737	0.25	1.00	3.214E-03	2.20E-04
Ra-228	Beta	0.046	0.2701	0.00	1.00	3.214E-03	0.00E+00
Ac-228	Beta	2.13	0.2701	0.50	1.00	3.214E-03	4.34E-04
Th-228	Alpha	5.5	0.2737	0.25	1.00	3.214E-03	2.20E-04
Ra-224	Alpha	5.8	0.2737	0.25	1.00	3.214E-03	2.20E-04
U-234	Alpha	4.9	0.2737	0.25	1.00	8.270E-01	5.66E-02
U-235	Alpha	4.7	0.2737	0.25	1.00	3.720E-02	2.55E-03
Th-231	Beta	0.390	0.2701	0.25	1.00	3.720E-02	2.51E-03
U-238	Alpha	4.3	0.2737	0.25	1.00	1.270E-01	8.69E-03
Th-234	Beta	0.270	0.2701	0.25	1.00	1.270E-01	8.58E-03
Pa-234m	Beta	2.20	0.2701	0.50	1.00	1.270E-01	1.72E-02

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

$\Sigma =$ 9.75%

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 43-93</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 ($\alpha+\beta$)		
B04-02-01-S-F-S-00	North Chamber Floor	10/16/2015	alpha + beta TSC	327	300	27	280	280	1%
B04-02-02-S-W-S-00	North Chamber W Wall	10/16/2015	alpha + beta TSC	309	300	9.3333	96	96	1%
B04-02-03-S-W-S-00	North Chamber N Wall	10/16/2015	alpha + beta TSC	584	300	284	2916	2916	15%
B04-02-04-S-W-S-00	North Chamber S Wall	10/16/2015	alpha + beta TSC	299	300	-1	-7	0	0%
B04-02-05-S-W-S-00	South Chamber S Wall	10/16/2015	alpha + beta TSC	350	300	50	516	516	3%
B04-02-06-S-W-S-00	S Cross Member (N Side)	10/16/2015	alpha + beta TSC	458	300	158	1624	1624	9%
B04-02-07-S-F-S-00	Tank Top	10/21/2015	alpha + beta TSC	288	300	-12	-120	0	0%
B04-02-08-S-W-S-00	B230 E Foundation Wall	10/20/2015	alpha + beta TSC	326	300	26	270	270	1%
B04-02-09-S-W-S-00	B230 E Foundation Wall	10/20/2015	alpha + beta TSC	278	300	-22	-222	0	0%
B04-02-10-S-W-S-00	B230 E Foundation Wall	10/20/2015	alpha + beta TSC	299	300	-1	-7	0	0%
B04-02-11-S-W-S-00	B230 E Foundation Wall	10/20/2015	alpha + beta TSC	299	300	-1	-7	0	0%
B04-02-12-S-W-S-00	B230 E Foundation Wall	10/20/2015	alpha + beta TSC	296	300	-4	-38	0	0%
B04-02-13-S-W-B-00	South Chamber S Wall	10/13/2015	alpha + beta TSC	1366	300	1066	10937	10937	58%
B04-02-14-S-W-B-00	South Chamber N Wall	10/13/2015	alpha + beta TSC	1272	300	972	9973	9973	53%
B04-02-15-S-W-B-00	South Chamber E Wall	10/13/2015	alpha + beta TSC	1400	300	1100	11285	11285	60%
B04-02-16-S-W-B-00	North Chamber N Wall	10/13/2015	alpha + beta TSC	1515	300	1215	12465	12465	66%
B04-02-17-S-W-B-00	B230 E Foundation Wall	10/22/2015	alpha + beta TSC	1512	300	1212	12434	12434	66%
B04-02-18-S-W-B-00	B230 E Foundation Wall	10/21/2015	alpha + beta TSC	1951	300	1651	16933	16933	89%

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

Min	0	3%	Average Fraction Step 8.4.5.g
Max	2916		
Mean	475	DCGLso	mrem SU Dose Contribution Step 8.4.6
Median	48		
Stdev	897.4	0.75	
		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 2360/43-93	S/N 287589	10/13/2015	Survey # HDP-PF-101315-065
Detector Area (A) =	100 cm ²	ave. ambient bkg = 299.7 cpm ($\alpha + \beta$)	weighted eff (ϵ_w)= 0.09750
TSC (dpm/100cm ²) = (cpm-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	North Chamber Floor	10/16/2015	2	0.2	0.5	0.5	32	-0.4	-2.0
2	North Chamber W Wall	10/16/2015	0	-1.8	-4.9	0.0	28	-4.4	-22.0
3	North Chamber N Wall	10/16/2015	1	-0.8	-2.2	0.0	32	-0.4	-2.0
4	North Chamber S Wall	10/16/2015	2	0.2	0.5	0.5	31	-1.4	-7.0
5	South Chamber S Wall	10/16/2015	2	0.2	0.5	0.5	35	2.6	13.0
6	S Cross Member (N Side)	10/16/2015	0	-1.8	-4.9	0.0	34	1.6	8.0
7	Tank Top	10/21/2015	1	0.4	1.6	1.6	49	0.0	0.0
8	B230 E Foundation Wall	10/20/2015	1	0.4	1.6	1.6	50	1.0	4.2
9	B230 E Foundation Wall	10/20/2015	0	-0.6	-2.4	0.0	53	4.0	16.8
10	B230 E Foundation Wall	10/20/2015	1	0.4	1.6	1.6	46	-3.0	-12.6
11	B230 E Foundation Wall	10/20/2015	0	-0.6	-2.4	0.0	47	-2.0	-8.4
12	B230 E Foundation Wall	10/20/2015	0	-0.6	-2.4	0.0	32	-17.0	-71.3
13	South Chamber S Wall	10/13/2015	2	0.2	0.5	0.5	28	-4.4	-22.0
14	South Chamber N Wall	10/13/2015	9	7.2	19.7	19.7	33	0.6	3.0
15	South Chamber E Wall	10/13/2015	5	3.2	8.7	8.7	41	8.6	43.0
16	North Chamber N Wall	10/13/2015	4	2.2	6.0	6.0	38	5.6	28.0
17	B230 E Foundation Wall	10/22/2015	6	5.4	21.7	21.7	34	-15.0	-62.9
18	B230 E Foundation Wall	10/21/2015	4	3.4	13.7	13.7	39	-10.0	-42.0

**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	1	Y	N	N
0.0	0	N	N	N
0.0	0	N	N	N
0.0	1	Y	N	N
13.0	14	Y	N	N
8.0	8	Y	N	N
0.0	2	Y	N	N
4.2	6	Y	N	N
16.8	17	Y	N	N
0.0	2	Y	N	N
0.0	0	N	N	N
0.0	0	N	N	N
0.0	1	Y	N	N
3.0	23	Y	N	N
43.0	52	Y	N	N
28.0	34	Y	N	N
0.0	22	Y	N	N
0.0	14	Y	N	N

Min 0
 Max 52
 Mean 11
 Median 4
 StDev 14.4

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:

Ludlum 2929/43-10-1 Meter I	S/N 115578 PR098469	Cal Due 10/30/15	Survey # HDP-PF-101315-065		
		alpha bkg = 0.6 cpm beta bkg = 49 cpm	alpha efficiency = 24.9% beta efficiency = 23.83%	alpha MDA = 26.5 beta MDA = 149	
Ludlum 3030/43-10-1 Meter B (HDP HP instr.)	S/N 247399 PR263687	Cal Due 3/12/16	Survey # HDP-PF-101315-065		
		alpha bkg = 1.8 cpm beta bkg = 32.4 cpm	alpha efficiency = 36.6% beta efficiency = 20.0%	alpha MDA = 25.3 beta MDA = 147	

**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
B04-02-01-S-F-S-00	North Chamber Floor	280	0.015	0.985	0.985
B04-02-02-S-W-S-00	North Chamber W Wall	96	0.005	0.995	0.995
B04-02-03-S-W-S-00	North Chamber N Wall	2916	0.154	0.846	0.846
B04-02-04-S-W-S-00	North Chamber S Wall	0	0.000	1.000	1.000
B04-02-05-S-W-S-00	South Chamber S Wall	516	0.027	0.973	0.973
B04-02-06-S-W-S-00	S Cross Member (N Side)	1624	0.086	0.914	0.914
B04-02-07-S-F-S-00	Tank Top	0	0.000	1.000	1.000
B04-02-08-S-W-S-00	B230 E Foundation Wall	270	0.014	0.986	0.986
B04-02-09-S-W-S-00	B230 E Foundation Wall	0	0.000	1.000	1.000
B04-02-10-S-W-S-00	B230 E Foundation Wall	0	0.000	1.000	1.000
B04-02-11-S-W-S-00	B230 E Foundation Wall	0	0.000	1.000	1.000
B04-02-12-S-W-S-00	B230 E Foundation Wall	0	0.000	1.000	1.000
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**