

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>Building Survey Area (Misc. Structures)</u>
Survey Unit:	<u>10</u>	Description:	<u>Bld 230 Concrete Pad overlaying LSA 08-06</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
B04-10-01-S-F-S-00	F	S	NA	NA	12.5	0.6	Concrete
B04-10-02-S-F-S-00	F	S	NA	NA	12.5	9.4	Concrete
B04-10-03-S-F-S-00	F	S	NA	NA	12.5	18.3	Concrete
B04-10-04-S-F-S-00	F	S	NA	NA	12.5	27.1	Concrete
B04-10-05-S-F-S-00	F	S	NA	NA	12.5	36.0	Concrete
B04-10-06-S-F-S-00	F	S	NA	NA	12.5	44.9	Concrete
B04-10-07-S-F-S-00	F	S	NA	NA	12.5	53.7	Concrete
B04-10-08-S-F-S-00	F	S	NA	NA	12.5	62.6	Concrete
B04-10-09-S-F-S-00	F	S	NA	NA	12.5	71.4	Concrete
B04-10-10-S-F-S-00	F	S	NA	NA	5.0	67.0	Concrete
B04-10-11-S-F-S-00	F	S	NA	NA	5.0	75.9	Concrete

*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 ($\alpha+\beta$)	BKG cpm (a+b)	Net cpm (α + β)	Combined Net dpm/100 cm ² ($\alpha+\beta$)		
B04-10-01-S-F-S-00	Concrete	08/08/2016	alpha + beta TSC	204	156	48	475	475	3%
B04-10-02-S-F-S-00	Concrete	08/08/2016	alpha + beta TSC	198	156	42	415	415	2%
B04-10-03-S-F-S-00	Concrete	08/08/2016	alpha + beta TSC	219	156	63	623	623	3%
B04-10-04-S-F-S-00	Concrete	08/08/2016	alpha + beta TSC	222	156	66	653	653	3%
B04-10-05-S-F-S-00	Concrete	08/08/2016	alpha + beta TSC	157	156	1	10	10	0%
B04-10-06-S-F-S-00	Concrete	08/08/2016	alpha + beta TSC	212	156	56	554	554	3%
B04-10-07-S-F-S-00	Concrete	08/08/2016	alpha + beta TSC	210	156	54	534	534	3%
B04-10-08-S-F-S-00	Concrete	08/08/2016	alpha + beta TSC	223	156	67	663	663	4%
B04-10-09-S-F-S-00	Concrete	08/08/2016	alpha + beta TSC	197	156	41	405	405	2%
B04-10-10-S-F-S-00	Concrete	08/08/2016	alpha + beta TSC	194	156	38	376	376	2%
B04-10-11-S-F-S-00	Concrete	08/08/2016	alpha + beta TSC	207	156	51	504	504	3%

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

Min	10	3%	Average Fraction
Max	663		Step 8.4.5.g
Mean	474	DCGLso	
Median	504	0.75	mrem SU Dose Contribution
Stdev	182.7	mrem	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 278647	08/08/2016	Survey # 7739 C 160808		
Detector Area (A) =	125 cm ²	ave. ambient bkg =	156 cpm	weighted eff (ϵ_w) =	0.08090
		($\alpha + \beta$)			
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	Concrete	08/08/2016	0.0	-0.8	-3.1	0.0	7.2	3.9	15.3
2	Concrete	08/08/2016	0.0	-0.8	-3.1	0.0	3.3	0.0	0.0
3	Concrete	08/08/2016	1.0	0.2	0.8	0.8	13.8	10.5	41.2
4	Concrete	08/08/2016	2.0	1.2	4.7	4.7	3.3	0.0	0.0
5	Concrete	08/08/2016	2.0	1.2	4.7	4.7	4.5	1.2	4.7
6	Concrete	08/08/2016	1.0	0.2	0.8	0.8	3.3	0.0	0.0
7	Concrete	08/08/2016	1.0	0.2	0.8	0.8	3.3	0.0	0.0
8	Concrete	08/08/2016	0.0	-0.8	-3.1	0.0	7.2	3.9	15.3
9	Concrete	08/08/2016	0.0	-0.8	-3.1	0.0	3.3	0.0	0.0
10	Concrete	08/08/2016	1.0	0.2	0.8	0.8	9.8	6.5	25.5
11	Concrete	08/08/2016	0.0	-0.8	-3.1	0.0	3.3	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?
15.3	15	Y	N	N
0.0	0	N	N	N
41.2	42	Y	Y	N
0.0	5	Y	N	N
4.7	9	Y	N	N
0.0	1	N	N	N
0.0	1	N	N	N
15.3	15	Y	N	N
0.0	0	N	N	N
25.5	26	Y	N	N
0.0	0	N	N	N

Min 0
Max 42
Mean 10
Median 5
StDev 13.6

DCGL = 18,925 dpm/100cm²

Removable Activity (dpm/100cm²) = (gcpm-bkg) / ε

Area "swiped" = 100 cm²

Instrument used for Removable Measurements:

Tennelec Unit #1 Batch # 52728 08/08/2016

Survey # 7739 C 160808

alpha bkg = 0.8 cpm
beta bkg = 3.3 cpm

alpha efficiency = 25.50%
beta efficiency = 25.50%

alpha MDA = 14.5
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
B04-10-01-S-F-S-00	Concrete	475	0.025	0.975	0.975
B04-10-02-S-F-S-00	Concrete	415	0.022	0.978	0.978
B04-10-03-S-F-S-00	Concrete	623	0.033	0.967	0.967
B04-10-04-S-F-S-00	Concrete	653	0.034	0.966	0.966
B04-10-05-S-F-S-00	Concrete	10	0.001	0.999	0.999
B04-10-06-S-F-S-00	Concrete	554	0.029	0.971	0.971
B04-10-07-S-F-S-00	Concrete	534	0.028	0.972	0.972
B04-10-08-S-F-S-00	Concrete	663	0.035	0.965	0.965
B04-10-09-S-F-S-00	Concrete	405	0.021	0.979	0.979
B04-10-10-S-F-S-00	Concrete	376	0.020	0.980	0.980
B04-10-11-S-F-S-00	Concrete	504	0.027	0.973	0.973
Number of Positive Differences (S+)					11
Sign Test Critical Value (MARSSIM Table I-3)					8

$\alpha = 0.05$

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