

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**

<b>Survey Area:</b>	<u>BSA 04</u>	<b>Description:</b>	<u>Rail Line in 09-02</u>
<b>Survey Unit:</b>	<u>16</u>	<b>Description:</b>	<u>Rail Line (Tracks and Ties)</u>
<b>Survey Type:</b>	<u>FSS</u>	<b>Classification:</b>	<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
B04-16-01-S-F-S-00	F	S	434.8	434.8	864726.6	827501.2	Rail Line
B04-16-02-S-F-S-00	F	S	434.8	434.8	864741.4	827509.8	Rail Line
B04-16-03-S-F-S-00	F	S	434.8	434.8	864756.1	827535.3	Rail Line
B04-16-04-S-F-S-00	F	S	434.8	434.8	864770.9	827560.9	Rail Line
B04-16-05-S-F-S-00	F	S	434.8	434.8	864785.7	827586.5	Rail Line
B04-16-06-S-F-S-00	F	S	434.8	434.8	864800.4	827612.1	Rail Line
B04-16-07-S-F-S-00	F	S	434.8	434.8	864815.2	827637.7	Rail Line
B04-16-08-S-F-S-00	F	S	434.8	434.8	864829.9	827663.3	Rail Line
B04-16-09-S-F-S-00	F	S	434.8	434.8	864844.7	827688.9	Rail Line
B04-16-10-S-F-S-00	F	S	434.8	434.8	864859.5	827714.5	Rail Line
B04-16-11-S-F-S-00	F	S	434.8	434.8	864874.2	827740.1	Rail Line

\*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 275770	Ludlum 43-89 19206	Active Probe Area 125 cm <sup>2</sup>	$\alpha$ HDP Efficiency 30.2%	$\alpha$ Cal. Efficiency N/A	$\beta$ HDP Efficiency 18.7%	$\beta$ 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	0.3017	0.25	1.00	2.682E-03	2.02E-04
Np-237	Alpha	5.0	0.3017	0.25	1.00	5.573E-05	4.20E-06
Pu-239	Alpha	5.2	0.3017	0.25	1.00	2.027E-06	1.53E-07
Tc-99	Beta	0.294	0.1874	0.25	1.00	2.829E-03	1.33E-04
Th-232	Alpha	4.1	0.3017	0.25	1.00	3.214E-03	2.42E-04
Ra-228	Beta	0.046	0.1874	0.00	1.00	3.214E-03	0.00E+00
Ac-228	Beta	2.13	0.1874	0.50	1.00	3.214E-03	3.01E-04
Th-228	Alpha	5.5	0.3017	0.25	1.00	3.214E-03	2.42E-04
Ra-224	Alpha	5.8	0.3017	0.25	1.00	3.214E-03	2.42E-04
U-234	Alpha	4.9	0.3017	0.25	1.00	8.270E-01	6.24E-02
U-235	Alpha	4.7	0.3017	0.25	1.00	3.720E-02	2.81E-03
Th-231	Beta	0.390	0.1874	0.25	1.00	3.720E-02	1.74E-03
U-238	Alpha	4.3	0.3017	0.25	1.00	1.270E-01	9.58E-03
Th-234	Beta	0.270	0.1874	0.25	1.00	1.270E-01	5.95E-03
Pa-234m	Beta	2.20	0.1874	0.50	1.00	1.270E-01	1.19E-02

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

$\Sigma =$  9.57%

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 (α+β)	BKG cpm (a+b)	Net cpm (α + β)	Combined Net dpm/100 cm <sup>2</sup> (α+β)		
B04-16-01-S-F-S-00	Rail Line	05/13/2016	alpha + beta TSC	275	285	-10	-84	0	0%
B04-16-02-S-F-S-00	Rail Line	05/13/2016	alpha + beta TSC	304	285	19	159	159	1%
B04-16-03-S-F-S-00	Rail Line	05/13/2016	alpha + beta TSC	286	285	1	8	8	0%
B04-16-04-S-F-S-00	Rail Line	05/13/2016	alpha + beta TSC	362	285	77	644	644	3%
B04-16-05-S-F-S-00	Rail Line	05/13/2016	alpha + beta TSC	229	285	-56	-468	0	0%
B04-16-06-S-F-S-00	Rail Line	05/13/2016	alpha + beta TSC	288	285	3	25	25	0%
B04-16-07-S-F-S-00	Rail Line	05/13/2016	alpha + beta TSC	393	285	108	903	903	5%
B04-16-08-S-F-S-00	Rail Line	05/13/2016	alpha + beta TSC	277	285	-8	-67	0	0%
B04-16-09-S-F-S-00	Rail Line	05/13/2016	alpha + beta TSC	193	285	-92	-769	0	0%
B04-16-10-S-F-S-00	Rail Line	05/13/2016	alpha + beta TSC	237	285	-48	-401	0	0%
B04-16-11-S-F-S-00	Rail Line	05/13/2016	alpha + beta TSC	230	285	-55	-460	0	0%

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

Min	0	1%	Average Fraction
Max	903	DCGL <sub>so</sub>	Step 8.4.5.g
Mean	158	0.2	mrem SU Dose Contribution
Median	0	mrem	Step 8.4.6
Stdev	313.1		

Instrument used for FSS Static Measurements:

Ludlum 2360/43-89	S/N 275770	05/13/2016	Survey # 7484 R160514
Detector Area (A) =	125 cm <sup>2</sup>	ave. ambient bkg =	285 cpm    weighted eff (ε <sub>w</sub> ) = 0.09570
		(α + β)	
TSC (dpm/100cm <sup>2</sup> ) =	(acpm-bkg) / (ε <sub>w</sub> * (A <sub>cm</sub> /100 cm <sup>2</sup> ))		
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>	Corrected Beta Net dpm/100cm <sup>2</sup>	Combined Net dpm/100 cm <sup>2</sup> ( $\alpha+\beta$ )	Exceed 10% of Min. Sys. TSC Result?	Exceed MDA?	Exceed 10% of DCGL?
1	Rail Line	05/13/2016	2.1	1.6	6.3	6.3	9.5	-2.3	-9.1	0.0	6	Y	N	N
2	Rail Line	05/13/2016	1.0	0.5	2.0	2.0	3.9	1.1	4.3	4.3	6	Y	N	N
3	Rail Line	05/13/2016	2.1	1.6	6.3	6.3	1.5	-1.3	-5.1	0.0	6	Y	N	N
4	Rail Line	05/13/2016	2.0	1.5	5.9	5.9	2.5	-0.3	-1.2	0.0	6	Y	N	N
5	Rail Line	05/13/2016	0.0	-0.5	-2.0	0.0	5.2	2.4	9.6	9.4	9	Y	N	N
6	Rail Line	05/13/2016	2.0	1.5	5.9	5.9	2.5	-0.3	-1.2	0.0	6	Y	N	N
7	Rail Line	05/13/2016	0.0	-0.5	-2.0	0.0	6.2	3.4	13.4	13.4	13	Y	N	N
8	Rail Line	05/13/2016	0.0	-0.5	-2.0	0.0	5.2	2.4	9.4	9.4	9	Y	N	N
9	Rail Line	05/13/2016	3.0	2.5	9.9	9.9	2.2	-0.6	-2.4	0.0	10	Y	N	N
10	Rail Line	05/13/2016	1.0	0.5	2.0	2.0	2.9	0.1	0.4	0.4	2	Y	N	N
11	Rail Line	05/13/2016	0.1	-0.4	-1.6	0.0	1.2	-1.6	-6.3	0.0	0	N	N	N

Instrument used for Removable Measurements:

Tennelec Unit #1    Batch # 52189    #####    Survey # 7484 R 160514  
 alpha bkg = 0.5 cpm    alpha efficiency = 25.30%    alpha MDA = 12  
 beta bkg = 2.8 cpm    beta efficiency = 25.40%    beta MDA = 24.7

Min 0  
 Max 13  
 Mean 7  
 Median 6  
 StDev 3.7

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

Removable Activity (dpm/100cm<sup>2</sup>) = (cpm-bkg) / ε

Area "swiped" = 100 cm<sup>2</sup>

**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
B04-16-01-S-F-S-00	Rail Line	0	0.000	1.000	1.000
B04-16-02-S-F-S-00	Rail Line	159	0.008	0.992	0.992
B04-16-03-S-F-S-00	Rail Line	8	0.000	1.000	1.000
B04-16-04-S-F-S-00	Rail Line	644	0.034	0.966	0.966
B04-16-05-S-F-S-00	Rail Line	0	0.000	1.000	1.000
B04-16-06-S-F-S-00	Rail Line	25	0.001	0.999	0.999
B04-16-07-S-F-S-00	Rail Line	903	0.048	0.952	0.952
B04-16-08-S-F-S-00	Rail Line	0	0.000	1.000	1.000
B04-16-09-S-F-S-00	Rail Line	0	0.000	1.000	1.000
B04-16-10-S-F-S-00	Rail Line	0	0.000	1.000	1.000
B04-16-11-S-F-S-00	Rail Line	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>

$\alpha = 0.05$

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

**TEST: PASS**

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		