

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: PSA 01 **Description:** Piping Survey Area Bld 110 NW (STM-1)
Survey Unit: 01 **Description:** Storm Water piping NW of Bld 110
Survey Type: FSS **Classification:** Class 1

Measurement or Sample ID	Surface or CSM	Type	Start Elevation	End Elevation	Dist. from NE of Pipe Elbow	Dist. from SE of Pipe Elbow	Remarks / Notes
P01-01-01-S-O-S-00	O	S	NA	NA	2	N/A	STM-1 Int. Bottom
P01-01-02-S-O-S-00	O	S	NA	NA	17	N/A	STM-1 Int. Bottom
P01-01-03-S-O-S-00	O	S	NA	NA	31	N/A	STM-1 Int. Bottom
P01-01-04-S-O-S-00	O	S	NA	NA	45	N/A	STM-1 Int. Bottom
P01-01-05-S-O-S-00	O	S	NA	NA	59	N/A	STM-1 Int. Bottom
P01-01-06-S-O-S-00	O	S	NA	NA	73	N/A	STM-1 Int. Bottom
P01-01-07-S-O-S-00	O	S	NA	NA	88	N/A	STM-1 Int. Bottom
P01-01-08-S-O-S-00	O	S	NA	NA	102	N/A	STM-1 Int. Bottom
P01-01-09-S-O-S-00	O	S	NA	NA	116	N/A	STM-1 Int. Bottom
P01-01-10-S-O-S-00	O	S	NA	NA	130	N/A	STM-1 Int. Bottom
P01-01-11-S-O-S-00	O	S	NA	NA	N/A	14	STM-1 Int. Bottom
P01-01-12-S-O-S-00	O	S	NA	NA	N/A	28	STM-1 Int. Bottom
P01-01-13-S-O-S-00	O	S	NA	NA	N/A	43	STM-1 Int. Bottom
P01-01-14-S-O-S-00	O	S	NA	NA	N/A	57	STM-1 Int. Bottom
P01-01-15-S-O-S-00	O	S	NA	NA	N/A	71	STM-1 Int. Bottom
P01-01-16-S-O-B-00	O	B	NA	NA	N/A	18	Biased at pipe seam
P01-01-17-S-O-B-00	O	B	NA	NA	N/A	35	Biased at pipe seam
P01-01-18-S-O-B-00	O	B	NA	NA	N/A	46	Biased at pipe seam
P01-01-19-S-O-B-00	O	B	NA	NA	15	N/A	Biased at pipe seam
P01-01-20-S-O-B-00	O	B	NA	NA	21	N/A	Biased at pipe seam
P01-01-21-S-O-B-00	O	B	NA	NA	38	N/A	Biased at pipe seam
P01-01-22-S-O-B-00	O	B	NA	NA	61	N/A	Biased at pipe seam

*X and Y coordinates originate from lower left or southwest corner of structural surface. Each structural surface has it's own origin (0,0) point.

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 248144	Ludlum 43-68 216857	Active Probe Area 125 cm ²	α HDP Efficiency 29.2%	α Cal. Efficiency N/A	β HDP Efficiency 19.9%	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	0.2920	0.25	1.00	2.682E-03	1.96E-04
Np-237	Alpha	5.0	0.2920	0.25	1.00	5.573E-05	4.07E-06
Pu-239	Alpha	5.2	0.2920	0.25	1.00	2.027E-06	1.48E-07
Tc-99	Beta	0.294	0.1990	0.25	1.00	2.829E-03	1.41E-04
Th-232	Alpha	4.1	0.2920	0.25	1.00	3.214E-03	2.35E-04
Ra-228	Beta	0.046	0.1990	0.00	1.00	3.214E-03	0.00E+00
Ac-228	Beta	2.13	0.1990	0.50	1.00	3.214E-03	3.20E-04
Th-228	Alpha	5.5	0.2920	0.25	1.00	3.214E-03	2.35E-04
Ra-224	Alpha	5.8	0.2920	0.25	1.00	3.214E-03	2.35E-04
U-234	Alpha	4.9	0.2920	0.25	1.00	8.270E-01	6.04E-02
U-235	Alpha	4.7	0.2920	0.25	1.00	3.720E-02	2.72E-03
Th-231	Beta	0.390	0.1990	0.25	1.00	3.720E-02	1.85E-03
U-238	Alpha	4.3	0.2920	0.25	1.00	1.270E-01	9.27E-03
Th-234	Beta	0.270	0.1990	0.25	1.00	1.270E-01	6.32E-03
Pa-234m	Beta	2.20	0.1990	0.50	1.00	1.270E-01	1.26E-02

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

$\Sigma =$ 9.45%

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 43-68</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 ($\alpha+\beta$)		
P01-01-01-S-O-S-00	STM-1 Int. Bottom	11/24/2015	alpha + beta TSC	71	163	-92	-779	0	0%
P01-01-02-S-O-S-00	STM-1 Int. Bottom	11/24/2015	alpha + beta TSC	92	163	-71	-601	0	0%
P01-01-03-S-O-S-00	STM-1 Int. Bottom	11/24/2015	alpha + beta TSC	73	163	-90	-762	0	0%
P01-01-04-S-O-S-00	STM-1 Int. Bottom	11/24/2015	alpha + beta TSC	60	163	-103	-872	0	0%
P01-01-05-S-O-S-00	STM-1 Int. Bottom	11/24/2015	alpha + beta TSC	68	163	-95	-804	0	0%
P01-01-06-S-O-S-00	STM-1 Int. Bottom	11/24/2015	alpha + beta TSC	63	163	-100	-847	0	0%
P01-01-07-S-O-S-00	STM-1 Int. Bottom	11/24/2015	alpha + beta TSC	49	163	-114	-965	0	0%
P01-01-08-S-O-S-00	STM-1 Int. Bottom	11/24/2015	alpha + beta TSC	78	163	-85	-720	0	0%
P01-01-09-S-O-S-00	STM-1 Int. Bottom	11/24/2015	alpha + beta TSC	63	163	-100	-847	0	0%
P01-01-10-S-O-S-00	STM-1 Int. Bottom	11/24/2015	alpha + beta TSC	93	163	-70	-593	0	0%
P01-01-11-S-O-S-00	STM-1 Int. Bottom	11/24/2015	alpha + beta TSC	115	163	-48	-406	0	0%
P01-01-12-S-O-S-00	STM-1 Int. Bottom	11/24/2015	alpha + beta TSC	87	163	-76	-643	0	0%
P01-01-13-S-O-S-00	STM-1 Int. Bottom	11/24/2015	alpha + beta TSC	88	163	-75	-635	0	0%
P01-01-14-S-O-S-00	STM-1 Int. Bottom	11/24/2015	alpha + beta TSC	78	163	-85	-720	0	0%
P01-01-15-S-O-S-00	STM-1 Int. Bottom	11/24/2015	alpha + beta TSC	77	163	-86	-728	0	0%
P01-01-16-S-O-B-00	Biased at pipe seam	11/24/2015	alpha + beta TSC	258	163	95	804	804	4%
P01-01-17-S-O-B-00	Biased at pipe seam	11/24/2015	alpha + beta TSC	215	163	52	440	440	2%
P01-01-18-S-O-B-00	Biased at pipe seam	11/24/2015	alpha + beta TSC	191	163	28	237	237	1%
P01-01-19-S-O-B-00	Biased at pipe seam	11/24/2015	alpha + beta TSC	126	163	-37	-313	0	0%
P01-01-20-S-O-B-00	Biased at pipe seam	11/24/2015	alpha + beta TSC	130	163	-33	-279	0	0%
P01-01-21-S-O-B-00	Biased at pipe seam	11/24/2015	alpha + beta TSC	115	163	-48	-406	0	0%
P01-01-22-S-O-B-00	Biased at pipe seam	11/24/2015	alpha + beta TSC	125	163	-38	-322	0	0%

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

Min	0	Average Fraction Step 8.4.5.g
Max	0	
Mean	0	DCGLso
Median	0	
Stdev	0.0	mrem SU Dose Contribution 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 2360/43-68	S/N 248144	10/02/2016	Survey # 7134 C 160303		
Detector Area (A) =	125 cm ²	ave. ambient bkg = ($\alpha + \beta$)	163 cpm	weighted eff (ϵ_w)=	0.09450
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	Biased - 1B	11/24/2015	0	-2	-5	0	25	-9	-45
2	Biased - 2B	11/24/2015	2	0	1	1	42	8	40
3	Biased - 3B	11/24/2015	1	-1	-2	0	32	-2	-10
4	Biased - 4B	11/24/2015	0	-2	-5	0	38	4	20
5	Systematic - 1S	11/24/2015	0	-2	-5	0	32	-2	-10
6	Systematic - 2S	11/24/2015	0	-2	-5	0	36	2	10
7	Systematic - 3S	11/24/2015	1	-1	-2	0	34	0	0
8	Systematic - 4S	11/24/2015	2	0	1	1	23	-11	-55
1	Biased - 1B	11/24/2015	2	0	1	1	29	-5	-25
2	Biased - 2B	11/24/2015	0	-2	-5	0	38	4	20
3	Biased - 3B	11/24/2015	2	0	1	1	31	-3	-15
4	Biased - 4B	11/24/2015	1	-1	-2	0	34	0	0
5	Systematic - 1S	11/24/2015	1	1	3	3	25	-9	-45
6	Systematic - 2S	11/24/2015	0	0	0	0	32	-2	-10
7	Systematic - 3S	11/24/2015	0	0	0	0	29	-5	-25
8	Systematic - 4S	11/24/2015	2	2	5	5	37	3	15

**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	N	N	N
40	41	Y	N	N
0	0	N	N	N
20	20	Y	N	N
0	0	N	N	N
10	10	Y	N	N
0	0	N	N	N
0	1	Y	N	N
0	1	Y	N	N
20	20	Y	N	N
0	1	Y	N	N
0	0	N	N	N
0	3	Y	N	N
0	0	N	N	N
0	0	N	N	N
15	20	Y	N	N

Min 0
Max 41
Mean 8
Median 1
StDev 12.9

DCGL = 18,925 dpm/100cm²

Removable Activity (dpm/100cm²) =

Area "swiped" =

(gcpm-bkg) / ε

100 cm²

Instrument used for Removable Measurements:

Ludlum 3030/43-10-1 S/N 247399 Cal Due 3/12/16 Survey # 6054 C 151124

alpha bkg = 1.8 cpm alpha efficiency = 36.60% alpha MDA = 20.9
beta bkg = 34 cpm beta efficiency = 20.00% beta MDA = 116

Ludlum 3030/43-10-1 S/N 247399 Cal Due 3/12/16 Survey # 6055 C 151124

alpha bkg = 1.8 cpm alpha efficiency = 36.60% alpha MDA = 20.9
beta bkg = 34 cpm beta efficiency = 20.00% beta MDA = 116

**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
P01-01-01-S-O-S-00	STM-1 Int. Bottom	0	0.000	1.000	1.000
P01-01-02-S-O-S-00	STM-1 Int. Bottom	0	0.000	1.000	1.000
P01-01-03-S-O-S-00	STM-1 Int. Bottom	0	0.000	1.000	1.000
P01-01-04-S-O-S-00	STM-1 Int. Bottom	0	0.000	1.000	1.000
P01-01-05-S-O-S-00	STM-1 Int. Bottom	0	0.000	1.000	1.000
P01-01-06-S-O-S-00	STM-1 Int. Bottom	0	0.000	1.000	1.000
P01-01-07-S-O-S-00	STM-1 Int. Bottom	0	0.000	1.000	1.000
P01-01-08-S-O-S-00	STM-1 Int. Bottom	0	0.000	1.000	1.000
P01-01-09-S-O-S-00	STM-1 Int. Bottom	0	0.000	1.000	1.000
P01-01-10-S-O-S-00	STM-1 Int. Bottom	0	0.000	1.000	1.000
P01-01-11-S-O-S-00	STM-1 Int. Bottom	0	0.000	1.000	1.000
P01-01-12-S-O-S-00	STM-1 Int. Bottom	0	0.000	1.000	1.000
P01-01-13-S-O-S-00	STM-1 Int. Bottom	0	0.000	1.000	1.000
P01-01-14-S-O-S-00	STM-1 Int. Bottom	0	0.000	1.000	1.000
P01-01-15-S-O-S-00	STM-1 Int. Bottom	0	0.000	1.000	1.000
Number of Positive Differences (S+)					15
Sign Test Critical Value (MARSSIM Table I-3)					11

$\alpha = 0.05$

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