

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>PSA 01</u>	Description:	<u>Piping Survey Area Bld 230 SW (STM-8)</u>
Survey Unit:	<u>08</u>	Description:	<u>Storm Water piping SW of Bld 230</u>
Survey Type:	<u>FSS</u>	Classification:	<u>Class 1</u>

Measurement or Sample ID	Surface or CSM	Type	Start * Elevation	End * Elevation	Feet South from MH-02	Feet East	Remarks / Notes
P01-08-01-S-O-S-00	O	S	NA	NA	8	N/A	STM-8 Int. Bottom
P01-08-02-S-O-S-00	O	S	NA	NA	23	N/A	STM-8 Int. Bottom
P01-08-03-S-O-S-00	O	S	NA	NA	38	N/A	STM-8 Int. Bottom
P01-08-04-S-O-S-00	O	S	NA	NA	54	N/A	STM-8 Int. Bottom
P01-08-05-S-O-S-00	O	S	NA	NA	69	N/A	STM-8 Int. Bottom
P01-08-06-S-O-S-00	O	S	NA	NA	84	N/A	STM-8 Int. Bottom
P01-08-07-S-O-S-00	O	S	NA	NA	100	N/A	STM-8 Int. Bottom
P01-08-08-S-O-S-00	O	S	NA	NA	115	N/A	STM-8 Int. Bottom
P01-08-09-S-O-S-00	O	S	NA	NA	130	N/A	STM-8 Int. Bottom
P01-08-10-S-O-S-00	O	S	NA	NA	146	N/A	STM-8 Int. Bottom
P01-08-11-S-O-S-00	O	S	NA	NA	161	N/A	STM-8 Int. Bottom
P01-08-12-S-O-S-00	O	S	NA	NA	176	N/A	STM-8 Int. Bottom
P01-08-13-S-O-S-00	O	S	NA	NA	196	N/A	STM-8 Int. Bottom
P01-08-14-S-O-S-00	O	S	NA	NA	207	N/A	STM-8 Int. Bottom
P01-08-15-S-O-S-00	O	S	NA	NA	222	N/A	STM-8 Int. Bottom
P01-08-16-S-O-B-00	O	S	NA	NA	46	N/A	Biased at pipe seam
P01-08-17-S-O-B-00	O	B	NA	NA	92	N/A	Biased at pipe seam
P01-08-18-S-O-B-00	O	B	NA	NA	138	N/A	Biased at pipe seam
P01-08-19-S-O-B-00	O	B	NA	NA	184	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 ($\alpha+\beta$)		
P01-08-01-S-O-S-00	STM-8 Int. Bottom	02/17/2016	alpha + beta TSC	98	108	-10	-85	0	0%
P01-08-02-S-O-S-00	STM-8 Int. Bottom	02/17/2016	alpha + beta TSC	116	108	8	68	68	0%
P01-08-03-S-O-S-00	STM-8 Int. Bottom	02/17/2016	alpha + beta TSC	96	108	-12	-102	0	0%
P01-08-04-S-O-S-00	STM-8 Int. Bottom	02/17/2016	alpha + beta TSC	87	108	-21	-178	0	0%
P01-08-05-S-O-S-00	STM-8 Int. Bottom	02/17/2016	alpha + beta TSC	88	108	-20	-169	0	0%
P01-08-06-S-O-S-00	STM-8 Int. Bottom	02/17/2016	alpha + beta TSC	88	108	-20	-169	0	0%
P01-08-07-S-O-S-00	STM-8 Int. Bottom	02/17/2016	alpha + beta TSC	81	108	-27	-229	0	0%
P01-08-08-S-O-S-00	STM-8 Int. Bottom	02/17/2016	alpha + beta TSC	82	108	-26	-220	0	0%
P01-08-09-S-O-S-00	STM-8 Int. Bottom	02/17/2016	alpha + beta TSC	88	108	-20	-169	0	0%
P01-08-10-S-O-S-00	STM-8 Int. Bottom	02/17/2016	alpha + beta TSC	81	108	-27	-229	0	0%
P01-08-11-S-O-S-00	STM-8 Int. Bottom	02/17/2016	alpha + beta TSC	82	108	-26	-220	0	0%
P01-08-12-S-O-S-00	STM-8 Int. Bottom	02/17/2016	alpha + beta TSC	79	108	-29	-246	0	0%
P01-08-13-S-O-S-00	STM-8 Int. Bottom	02/17/2016	alpha + beta TSC	78	108	-30	-254	0	0%
P01-08-14-S-O-S-00	STM-8 Int. Bottom	02/17/2016	alpha + beta TSC	89	108	-19	-161	0	0%
P01-08-15-S-O-S-00	STM-8 Int. Bottom	02/17/2016	alpha + beta TSC	75	108	-33	-279	0	0%
P01-08-16-S-O-B-00	Biased at pipe seam	02/17/2016	alpha + beta TSC	85	108	-23	-195	0	0%
P01-08-17-S-O-B-00	Biased at pipe seam	02/17/2016	alpha + beta TSC	73	108	-35	-296	0	0%
P01-08-18-S-O-B-00	Biased at pipe seam	02/17/2016	alpha + beta TSC	78	108	-30	-254	0	0%
P01-08-19-S-O-B-00	Biased at pipe seam	02/17/2016	alpha + beta TSC	71	108	-37	-313	0	0%

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

Min	0	Average Fraction Step 8.4.5.g
Max	68	
Mean	5	DCGL _{so}
Median	0	0.0 mrem SU Dose Contribution Step 8.4.6
Stdev	17.5	
		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 2360/43-68	S/N 248144	10/02/2016	Survey # 7053 C 160217		
Detector Area (A) =	125 cm ²	ave. ambient bkg =	108 cpm	weighted eff (ε _w)=	0.09450
		(α + β)			
TSC (dpm/100cm ²) =	(qcpm-bkg) / (ε _w * (A _{ref} /100 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	MH01 - S1	01/07/2016	2	0	0	0	31	-3	-16
2	MH01 - S2	01/07/2016	1	-1	-3	0	30	-4	-21
3	MH01 - S3	01/07/2016	0	-2	-5	0	34	0	-1
4	MH01 - S4	01/07/2016	3	1	3	3	32	-2	-11
5	MH01 - B1	01/07/2016	4	2	5	5	35	1	4
6	MH01 - B2	01/07/2016	2	0	0	0	22	-12	-61
7	MH01 - B3	01/07/2016	1	-1	-3	0	44	10	50
8	MH01 - B4	01/07/2016	2	0	0	0	31	-3	-16
9	MH02 - B1	12/09/2015	2	1	3	3	31	-3	-16
10	MH02 - B2	12/09/2015	1	0	0	0	30	-4	-21
11	MH02 - B3	12/09/2015	0	-1	-2	0	34	0	-1
12	MH02 - B4	12/09/2015	3	2	6	6	32	-2	-11
13	MH02 - S1	12/09/2015	4	3	8	8	35	1	4
14	MH02 - S2	12/09/2015	2	1	3	3	22	-12	-61
15	MH02 - S3	12/09/2015	1	0	0	0	44	10	49
16	MH02 - S4	12/09/2015	2	1	3	3	31	-3	-16

**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
0	0	N	N	N
0	0	N	N	N
0	3	Y	N	N
4	10	Y	N	N
0	0	N	N	N
50	50	Y	N	N
0	0	N	N	N
0	3	Y	N	N
0	0	Y	N	N
0	0	N	N	N
0	6	Y	N	N
4	12	Y	N	N
0	3	Y	N	N
49	49	Y	N	N
0	3	Y	N	N

Min 0
Max 49
Mean 10
Median 3
StDev 16.5

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 3030/43-10-1 S/N 247399 Cal Due 3/12/16 Survey # 6776 C 160107

alpha bkg = 2 cpm alpha efficiency = 36.60% alpha MDA = 21.5
beta bkg = 34.1 cpm beta efficiency = 20.00% beta MDA = 116

Ludlum 3030/43-10-1 S/N 247399 Cal Due 3/12/16 Survey # 6602 C 151209

alpha bkg = 0.9 cpm alpha efficiency = 36.60% alpha MDA = 17.1
beta bkg = 34.2 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
P01-08-01-S-O-S-00	STM-8 Int. Bottom	0	0.000	1.000	1.000
P01-08-02-S-O-S-00	STM-8 Int. Bottom	68	0.004	0.996	0.996
P01-08-03-S-O-S-00	STM-8 Int. Bottom	0	0.000	1.000	1.000
P01-08-04-S-O-S-00	STM-8 Int. Bottom	0	0.000	1.000	1.000
P01-08-05-S-O-S-00	STM-8 Int. Bottom	0	0.000	1.000	1.000
P01-08-06-S-O-S-00	STM-8 Int. Bottom	0	0.000	1.000	1.000
P01-08-07-S-O-S-00	STM-8 Int. Bottom	0	0.000	1.000	1.000
P01-08-08-S-O-S-00	STM-8 Int. Bottom	0	0.000	1.000	1.000
P01-08-09-S-O-S-00	STM-8 Int. Bottom	0	0.000	1.000	1.000
P01-08-10-S-O-S-00	STM-8 Int. Bottom	0	0.000	1.000	1.000
P01-08-11-S-O-S-00	STM-8 Int. Bottom	0	0.000	1.000	1.000
P01-08-12-S-O-S-00	STM-8 Int. Bottom	0	0.000	1.000	1.000
P01-08-13-S-O-S-00	STM-8 Int. Bottom	0	0.000	1.000	1.000
P01-08-14-S-O-S-00	STM-8 Int. Bottom	0	0.000	1.000	1.000
P01-08-15-S-O-S-00	STM-8 Int. Bottom	0	0.000	1.000	1.000
Number of Positive Differences (S+)					15
Sign Test Critical Value (MARSSIM Table I-3)					11

$\alpha = 0.05$

TEST: **PASS**

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

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		