

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development		
	Westinghouse Non-Proprietary Class 3	Revision: 5	Appendix P-4, Page 1 of 1

**APPENDIX P-4**  
**FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES**

<b>Survey Area:</b>	LSA 10	<b>Description:</b>	Burial Pits Open Land Area
<b>Survey Unit:</b>	14	<b>Description:</b>	Southern Survey Unit in "Area 2"
<b>Survey Type:</b>	FSS	<b>Classification:</b>	Class 1

Measurement or Sample ID	Surface or CSM	Type	Start Elevation*	End Elevation*	Northing** (Y Axis)	Easting** (X Axis)	Remarks / Notes
L10-14-01-B-E-S-00	Uniform	S	428.3	427.8	865031.9	827571.0	Excavation 6-inch grab
L10-14-02-B-E-S-00	Uniform	S	420.6	420.2	864986.9	827544.9	Excavation 6-inch grab
L10-14-03-B-E-S-00	Uniform	S	423.5	423.0	864986.9	827597.1	Excavation 6-inch grab
L10-14-04-B-E-S-00	Uniform	S	426.1	425.6	864942.0	827571.0	Excavation 6-inch grab
L10-14-05-B-E-S-00	Uniform	S	415.7	415.2	864942.0	827623.2	Excavation 6-inch grab
L10-14-06-B-E-S-00	Uniform	S	416.9	416.4	864942.0	827675.3	Excavation 6-inch grab
L10-14-07-B-E-S-00	Uniform	S	423.9	423.4	864897.1	827649.2	Excavation 6-inch grab
L10-14-08-B-R-S-00	Uniform	S	429.9	429.0	864897.1	827701.4	Root 4.6-inch composite
L10-14-09-B-E-S-00	Uniform	S	429.0	428.5	864897.1	827701.4	Excavation 6-inch grab
L10-14-06-B-E-Q-00	Uniform	Q	416.9	416.4	864942.0	827675.3	Excavation 6-inch grab
L10-14-10-B-E-B-00	Uniform	B	434.6	423.4	864909.0	827633.0	Biased 6-inch grab
L10-14-11-B-E-B-00	Uniform	B	434.7	417.3	864936.0	827593.0	Biased 6-inch grab
L10-14-12-B-E-B-00	Uniform	B	434.0	419.7	864979.0	827594.0	Biased 6-inch grab
L10-14-13-B-E-B-00	Uniform	B	432.9	432.4	864982.7	827605.3	Sidewall 6-inch grab
L10-14-14-B-E-B-00	Uniform	B	433.5	433.0	864926.1	827642.9	Sidewall 6-inch grab

Green shaded samples are the samples at each sample location, for use in WRS test.

\*Elevations are in feet above mean sea level.

\*\* Missouri - East State Plane Coordinates [North American Datum (NAD) 1983]

Surface: Floor = F; Wall = W; Ceiling = C; Roof = R

CSM: Three-Layer (Surface-Root-Excavation) or Uniform DCGLs used

Type: Systematic = S, Biased = B; QC = Q; Investigation = I

Quality Record

[illegible]

U Qualifier: Result is less than the sample detection limit.

LSA 10-14 FSSDE Worksheets Uniform R1.xlsx\Ingrowth Data Eval  
12/28/2017

**HDP-PR-FSS-721 Final Status Survey Data Evaluation**  
**Preliminary Data Review and Calculation of the Sum-of-Fractions (SOF)**

Use corrected net results for all DE calcs.

DCLG<sub>W</sub>, Measure Tc-99, All SEAs

	Uniform
U-234	196.4
U-235	51.6
U-238	168.8
Tc-99	25.1
Th-232	2.0
Re-226	1.9

<b>weighted SOF<sub>MEAN</sub></b>	<b>0.13</b>		
SS	RS	ES	

fractions	0	0.1111111111	0.88889
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SOF <sub>MEAN</sub> Re-use Backfill Material	
0.10	Stockpile 1&2

SOF <sub>MEAN</sub> Groundwater	
0.16	

SOF <sub>TOT</sub> <=1		
SOF <sub>MEAN</sub> SU	0.39	PASS

Calculate the dose contribution for the SU by multiplying SOF<sub>MEAN</sub>BU (including contribution from Re-use backfill and Groundwater) by 25 mrem.

9.7 mrem

Infer U234 Step 8.3.4			
U-238/U235	U-234/U235	U-234	%
8.3	18.6	2.1	1.9
14.7	19.6	1.6	1.1
69.6	26.6	0.4	0.3
12.4	19.2	2.1	1.3
6.3	18.3	2.6	2.5
12.0	19.2	2.0	1.3
4.8	18.2	4.4	3.2
8.0	18.5	1.9	2.0
14.1	19.6	2.2	1.1
9.2	18.3	2.7	2.5
0.8	19.4	28.6	16.0
8.7	18.7	1.8	1.8
11.2	19.1	1.5	1.4
5.2	18.2	3.1	3.0
34.5	22.7	1.1	0.5
<b>Average Enrichment (%)</b>			<b>1.63</b>

Infer U-234  
MDC using U-235 MDC \* ratio of U-234 U-235 @ that sample's enrichment

4.239547486  
4.331227250  
6.765588719  
4.766100926  
5.29318659  
4.86219167  
3.4698995  
4.707242793  
5.919230376  
4.597196658  
5.6381499  
5.39248405  
4.348294676  
10.82729146  
19.86633803

Grouted pipe dose to be added if applicable.

**HDP-PR-FSS-721 Final Status Survey Data Evaluation**  
**Step 8.5 Performance of Statistical Tests**

WRS TEST					
SAMPLE ID	AREA (Reference, Survey Unit)	Gross SOF ( $X_{i,ref}$ , $Y_{i,SU,gross}$ )	ADJUSTED SOF ( $Z_i$ )	RANKS	REFERENCE AREA RANKS
9574-SS-140910-01-01	Reference	1.31	2.310	39	39
9574-SS-140910-01-02	Reference	1.18	2.179	30	30
9574-SS-140910-01-03	Reference	1.06	2.064	25	25
9574-SS-140910-01-04	Reference	1.10	2.101	26	26
9574-SS-140910-01-05	Reference	1.29	2.293	38	38
9574-SS-140910-01-07	Reference	1.34	2.339	40	40
9574-SS-140910-01-08	Reference	1.15	2.154	29	29
9574-SS-140910-01-09	Reference	1.18	2.182	31	31
9574-SS-140910-01-10	Reference	1.23	2.227	36	36
9574-SS-140910-01-11	Reference	1.38	2.380	41	41
9574-SS-140910-01-12	Reference	1.05	2.055	24	24
9574-SS-140910-01-13	Reference	0.94	1.941	14	14
9574-SS-140910-01-14	Reference	1.12	2.119	27	27
9574-SS-140910-01-15	Reference	1.15	2.152	28	28
9574-SS-140910-01-16	Reference	1.03	2.028	21	21
9574-SS-140910-01-17	Reference	0.44	1.443	10	10
9574-SS-140910-01-18	Reference	1.19	2.188	33	33
9574-SS-140910-01-20	Reference	0.76	1.757	11	11
9574-SS-140910-01-21	Reference	1.02	2.023	20	20
9574-SS-140910-01-22	Reference	1.02	2.018	19	19
9574-SS-140910-01-23	Reference	1.00	2.002	16	16
9574-SS-140910-01-24	Reference	0.87	1.873	13	13
9574-SS-140910-01-25	Reference	1.04	2.040	23	23
9574-SS-140910-01-26	Reference	0.96	1.959	15	15
9574-SS-140910-01-27	Reference	1.20	2.204	34	34
9574-SS-140910-01-28	Reference	1.01	2.007	18	18
9574-SS-140910-01-29	Reference	1.22	2.223	35	35
9574-SS-140910-01-30	Reference	1.03	2.035	22	22
9574-SS-140910-01-31	Reference	1.00	2.005	17	17
9574-SS-140910-01-32	Reference	0.86	1.865	12	12
9574-SS-140910-01-33	Reference	1.24	2.238	37	37
9574-SS-140910-01-34	Reference	1.19	2.185	32	32
L10-14-01-B-E-S-00	Survey Unit	1.03	1.026	2	0
L10-14-02-B-E-S-00	Survey Unit	1.27	1.269	9	0
L10-14-03-B-E-S-00	Survey Unit	1.26	1.262	8	0
L10-14-04-B-E-S-00	Survey Unit	1.00	1.004	1	0
L10-14-05-B-E-S-00	Survey Unit	1.07	1.072	3	0
L10-14-06-B-E-S-00	Survey Unit	1.20	1.203	6	0
L10-14-07-B-E-S-00	Survey Unit	1.23	1.235	7	0
L10-14-08-B-R-S-00	Survey Unit	1.15	1.152	5	0
L10-14-09-B-E-S-00	Survey Unit	1.12	1.119	4	0
<b>Rank Sums</b>				861	816
<b># Reference Area Measurements</b>				m	32
<b># Survey Unit Measurements</b>				n	9
<b>Total Number of Measurements</b>				N	41
<b>(1-<math>\alpha</math>) percentile of a standard normal distribution (MARSSIM Pg. I-10)</b>				z	1.645
<b>WRS Critical Value (MARSSIM Pg. I-10, Eq. I.1)</b>				CV	725

Min adjusted bkg SOF:  
1.44

No WRS test necessary  
No WRS test necessary  
No WRS test necessary  
No WRS test necessary  
No WRS test necessary  
No WRS test necessary  
No WRS test necessary  
No WRS test necessary  
No WRS test necessary

$W_r$

$\alpha = 0.05$

TEST: **PASS**

# HDP-PR-FSS-721 Final Status Survey Data Evaluation

## Retrospective Sample Size Verification

Uniform DCGL Criteria Evaluation	
N/2 Value Verification	
Isotope(s)	SOF (Ra/Tc/Th/Iso U)
St. Dev.	0.06
DCGL <sub>SOF</sub>	1
LBGR (Mean)	0.13
Shift	0.87
Relative Shift ( $\Delta/\sigma$ )	14.58
MARSSIM Table 5.1 ( $P_r$ )	1.000000
N	12
N + 20%	14.4
N/2	8
FSS N/2	8
Verification Check	SUFFICIENT MEASUREMENTS
"N/2" Corresponds to the number of survey unit measurement locations required for the WRS Test	

## MARSSIM Table 5.1

$\Delta/\sigma$	$P_r$
0.1	0.528182
0.2	0.556223
0.3	0.583985
0.4	0.611335
0.5	0.638143
0.6	0.664290
0.7	0.689665
0.8	0.714167
0.9	0.737710
1.0	0.760217
1.1	0.781627
1.2	0.801892
1.3	0.820978
1.4	0.838864
1.5	0.855541
1.6	0.871014
1.7	0.885299
1.8	0.898420
1.9	0.910413
2.0	0.921319
2.25	0.944167
2.5	0.961428
2.75	0.974067
3.0	0.983039
3.5	0.993329
4.0	0.997658
4.01	1.000000

## MARSSIM Table 5.2, $\alpha = 0.05$ , $\beta = 0.10$

$\alpha$ (or $\beta$ )	$Z_{1-\alpha}$ (or $Z_{1-\beta}$ )
0.005	2.576
0.01	2.326
0.015	2.241
0.025	1.960
0.05	1.645
0.10	1.282
0.15	1.036
0.2	0.842
0.25	0.674
0.30	0.524

$\alpha$   
 $\beta$

Hematite Decommissioning Project					Procedure: HDP-PR-FSS-703, Final Status Survey Quality Control							
					Westinghouse Non-Proprietary Class 3				Revision: 1		Page 1 of 1	
<b>FORM HDP-PR-FSS-703-1</b> <b>FIELD DUPLICATE SAMPLE ASSESSMENT</b>												
Survey Unit No.:		LSA 10-14			Survey Unit Description:		Burial Pits Open Land Area Southern Survey Unit in "Area 2"					
Sample ID	Field Duplicate Sample ID	Radionuclide	Sample (pCi/g)		Field Duplicate Sample (pCi/g)		Average Activity ( $\bar{x}$ ) (pCi/g)	Nuclide DCGL (pCi/g)	Statistic <sup>2</sup>	Warning Limit	Control Limit	Statistic Exceeds Limit? (Y/N)
			Activity ( $x_i$ )	MDC	Activity ( $x_i$ )	MDC						
L10-14-06-B-E-S-00	L10-14-06-B-E-Q-00	Ra-226	1.08	0.0762	1.1	0.067	1.090	1.9	0.02	0.269	0.403	N
L10-14-06-B-E-S-00	L10-14-06-B-E-Q-00	Tc-99	-0.0158	0.244	-0.0329	0.243	-0.024	25.1	NA	3.552	5.321	NA
L10-14-06-B-E-S-00	L10-14-06-B-E-Q-00	Th-232	1.23	0.132	1.150	0.107	1.190	2.0	0.08	0.283	0.424	N
L10-14-06-B-E-S-00	L10-14-06-B-E-Q-00	U-234 <sup>1</sup>	1.960	NA	2.747	NA	2.354	195.4	0.787	27.649	41.425	N
L10-14-06-B-E-S-00	L10-14-06-B-E-Q-00	U-235	0.102	0.253	0.15	0.251	0.126	51.6	NA	7.301	10.939	NA
L10-14-06-B-E-S-00	L10-14-06-B-E-Q-00	U-238	1.22	0.783	0.937	0.868	1.079	168.8	0.283	23.885	35.786	N
Comments: 1. U-234 is inferred, no MDC available. 2. Duplicate assessment is not necessary if the result of either sample is < MDC.												
Performed by: _____						Reviewed by: _____						
Date: _____						Date: _____						
Quality Record												

LSA 10-14 Sys SOF

0.1

0.2

0.2

0.0

0.1

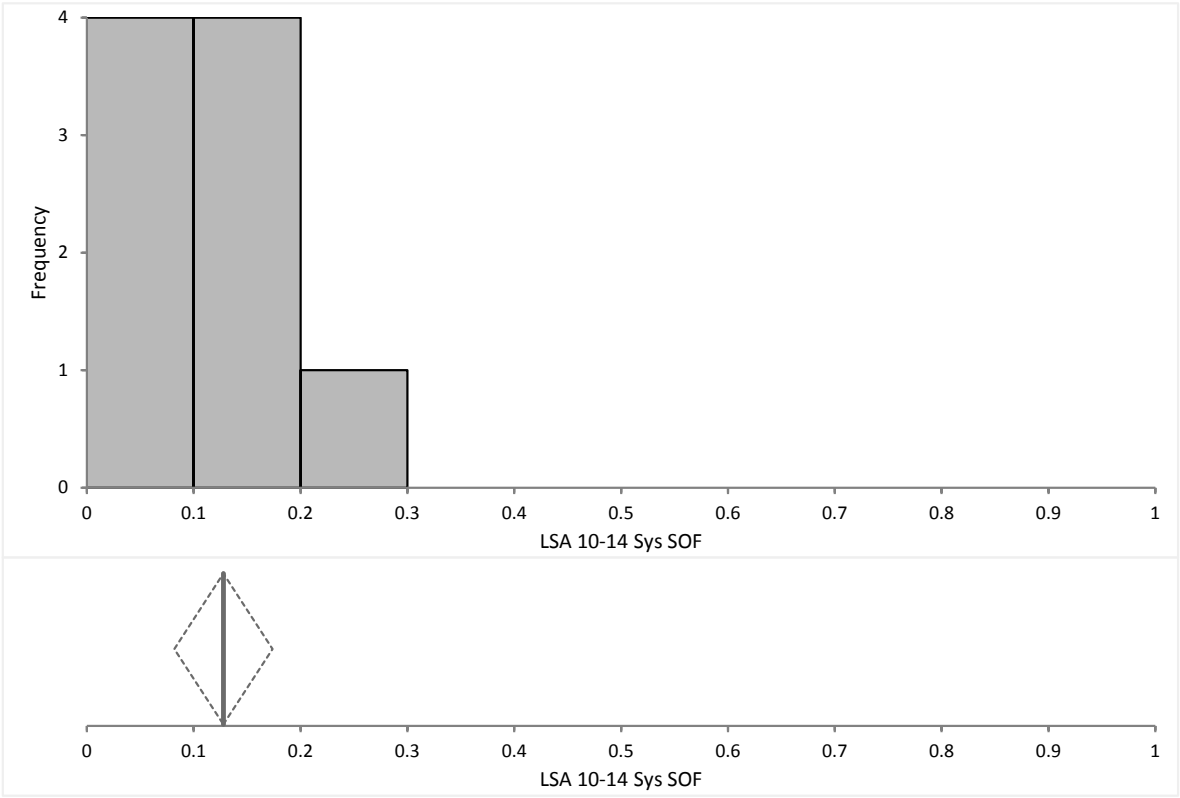
0.1

0.2

0.1

0.1

Descriptives



N   9								
	Mean	95% CI		Mean SE	SD	Variance	Skewness	Kurtosis
LSA 10-14 Sys SOF	0.13	0.08 to 0.17		0.020	0.06	0.00	0.3	-1.70
	Minimum	1st quartile	Median	96.09% CI		3rd quartile	Maximum	IQR
LSA 10-14 Sys SOF	0.05	0.08	0.10	0.08 to 0.20		0.20	0.2	0.12