

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:	LSA 09	Description:	Open Land Area, Tc-99 SEA
Survey Unit:	03	Description:	Central Open Land Area Survey Unit in "Area 12"
Survey Type:	FSS	Classification:	Class 1

Measurement or Sample ID	Surface or CSM	Type	Start Elevation	End Elevation	Northing (Y Axis) *	Easting (X Axis) *	Remarks / Notes
L09-03-01-P-S-S-00	Uniform	S	432.4	431.9	864499	827239	Surface 6-inch grab
L09-03-02-P-R-S-00	Uniform	S	431.9	427.5	864499	827239	Root 4.4-ft composite
L09-03-04-P-S-S-00	Uniform	S	432.2	431.7	864537	827261	Surface 6-inch grab
L09-03-05-P-R-S-00	Uniform	S	431.7	427.3	864537	827261	Root 4.4-ft composite
L09-03-07-P-R-S-00	Uniform	S	432.6	432.1	864576	827328	Surface 6-inch grab
L09-03-08-P-R-S-00	Uniform	S	432.1	427.7	864576	827328	Root 4.4-ft composite
L09-03-10-P-S-S-00	Uniform	S	432.2	431.7	864614	827350	Surface 6-inch grab
L09-03-11-P-R-S-00	Uniform	S	431.7	427.3	864614	827350	Root 4.4-ft composite
L09-03-13-P-S-S-00	Uniform	S	433.0	432.5	864652	827373	Surface 6-inch grab
L09-03-14-P-R-S-00	Uniform	S	432.5	428.1	864652	827373	Root 4.4-ft composite
L09-03-16-P-S-S-00	Uniform	S	433.6	433.1	864652	827417	Surface 6-inch grab
L09-03-17-P-R-S-00	Uniform	S	433.1	428.7	864652	827417	Root 4.4-ft composite
L09-03-19-P-S-S-00	Uniform	S	433.3	432.8	864691	827440	Surface 6-inch grab
L09-03-20-P-R-S-00	Uniform	S	432.8	428.4	864691	827440	Root 4.4-ft composite
L09-03-22-P-S-S-00	Uniform	S	432.9	432.4	864691	827484	Surface 6-inch grab
L09-03-23-P-R-S-00	Uniform	S	432.4	428.0	864691	827484	Root 4.4-ft composite
L09-03-08-P-R-Q-00	Uniform	Q	432.1	427.7	864576	827328	Root 4.4-ft composite
L09-03-14-P-R-Q-00	Uniform	Q	432.5	428.1	864652	827373	Root 4.4-ft composite
L09-03-25-P-E-B-00	Uniform	B	430.0	430.0	864652	827439	Sidewall sample

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] (Open Land Area) OR
 Distance in feet from lower left corner of the surface (Structures); each surface has it's own (X,Y) = (0,0); OR
 For piping the distance from the beginning of the survey unit.
 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

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 ($X_{i,ref}$, $Y_{i,SU}$)		ADJUSTED SOF (Z_i) Step 8.5.3b	RANKS Step 8.5.3d	REFERENCE AREA RANKS
		Step 8.5.3a				
9574-SS-140910-01-01	Reference	1.13		2.130	40	40
9574-SS-140910-01-02	Reference	0.72		1.721	18	18
9574-SS-140910-01-03	Reference	0.97		1.970	27	27
9574-SS-140910-01-04	Reference	0.97		1.967	26	26
9574-SS-140910-01-05	Reference	0.95		1.952	24	24
9574-SS-140910-01-07	Reference	0.83		1.829	20	20
9574-SS-140910-01-08	Reference	0.99		1.987	30	30
9574-SS-140910-01-09	Reference	0.90		1.904	22	22
9574-SS-140910-01-10	Reference	1.14		2.144	41	41
9574-SS-140910-01-11	Reference	0.96		1.958	25	25
9574-SS-140910-01-12	Reference	1.16		2.160	43	43
9574-SS-140910-01-13	Reference	0.98		1.9826	29	29
9574-SS-140910-01-14	Reference	0.95		1.9513	23	23
9574-SS-140910-01-15	Reference	0.82		1.824	19	19
9574-SS-140910-01-16	Reference	1.17		2.171	44	44
9574-SS-140910-01-17	Reference	1.12		2.124	38	38
9574-SS-140910-01-18	Reference	1.24		2.241	46	46
9574-SS-140910-01-20	Reference	1.11		2.115	37	37
9574-SS-140910-01-21	Reference	1.01		2.009	32	32
9574-SS-140910-01-22	Reference	1.05		2.053	33	33
9574-SS-140910-01-23	Reference	1.23		2.234	45	45
9574-SS-140910-01-24	Reference	1.28		2.277	47	47
9574-SS-140910-01-25	Reference	1.09		2.091	35	35
9574-SS-140910-01-26	Reference	1.13		2.127	39	39
9574-SS-140910-01-27	Reference	1.16		2.160	42	42
9574-SS-140910-01-28	Reference	1.31		2.314	48	48
9574-SS-140910-01-29	Reference	1.00		1.999	31	31
9574-SS-140910-01-30	Reference	0.89		1.891	21	21
9574-SS-140910-01-31	Reference	1.06		2.064	34	34
9574-SS-140910-01-32	Reference	1.10		2.097	36	36
9574-SS-140910-01-33	Reference	0.98		1.975	28	28
9574-SS-140910-01-34	Reference	0.41		1.411	15	15
L09-03-01-P-S-S-00	Survey Unit	1.52		1.524	17	0
L09-03-02-P-R-S-00	Survey Unit	1.24		1.237	14	0
L09-03-04-P-S-S-00	Survey Unit	0.29		0.289	4	0
L09-03-05-P-R-S-00	Survey Unit	1.46		1.462	16	0
L09-03-07-P-S-S-00	Survey Unit	0.61		0.613	6	0
L09-03-08-P-R-S-00	Survey Unit	1.05		1.051	10	0
L09-03-10-P-S-S-00	Survey Unit	0.24		0.237	3	0
L09-03-11-P-R-S-00	Survey Unit	1.06		1.057	11	0
L09-03-13-P-S-S-00	Survey Unit	0.10		0.104	2	0
L09-03-14-P-R-S-00	Survey Unit	1.08		1.080	12	0
L09-03-16-P-S-S-00	Survey Unit	0.66		0.664	7	0
L09-03-17-P-R-S-00	Survey Unit	0.97		0.969	9	0
L09-03-19-P-S-S-00	Survey Unit	0.05		0.052	1	0
L09-03-20-P-R-S-00	Survey Unit	1.08		1.080	13	0
L09-03-22-P-S-S-00	Survey Unit	0.95		0.953	8	0
L09-03-23-P-R-S-00	Survey Unit	0.56		0.561	5	0
Rank Sums					1176	1038
# Reference Area Measurements					m	32
# Survey Unit Measurements					n	16
Total Number of Measurements Step 8.5.3c					N	48
α percentile of a standard normal distribution (MARSSIM Pg. I-10)					z	1.645
WRS Critical Value (MARSSIM Pg. I-10, Eq. I.1)					CV	860

Step 8.5.1
 Min adjusted bkg SOF:
 1.41

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W_r Step 8.5.3e

$\alpha = 0.05$

TEST: **PASS**

Step 8.5.3f

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

Background Soil Locations - Surface and Sub-Surface Soil - Statistical and Analytical Sample Results
Surface and Sub-Surface - Background Soil - Analytical Results

Sample ID	Ra-226 w/ 21-Day Ingrowth			Th-232			U-234*			U-235*			U-238*			SOF
	Conc.	Error	MDC	Conc.	Error	MDC	Conc.	Error	MDC	Conc.	Error	MDC	Conc.	Error	MDC	
9574-SS-140910-01-01	1.150	0.164	0.068	1.150	0.178	0.133	0.671	0.181	0.050	0.022	0.040	0.071	0.724	0.189	0.050	1.13
9574-SS-140910-01-02	0.719	0.103	0.045	0.749	0.120	0.090	0.353	0.129	0.051	0.011	0.028	0.063	0.379	0.135	0.068	0.72
9574-SS-140910-01-03	1.040	0.166	0.077	0.936	0.183	0.145	0.518	0.164	0.062	0.015	0.030	0.044	0.723	0.195	0.036	0.97
9574-SS-140910-01-04	1.010	0.138	0.051	0.962	0.171	0.090	0.390	0.138	0.034	0.014	0.029	0.043	0.591	0.172	0.060	0.97
9574-SS-140910-01-05	0.995	0.160	0.085	0.948	0.178	0.091	0.345	0.163	0.083	0.000	0.009	0.068	0.421	0.179	0.055	0.95
9574-SS-140910-01-07	0.858	0.133	0.064	0.831	0.150	0.110	0.512	0.160	0.035	0.038	0.051	0.075	0.453	0.150	0.035	0.83
9574-SS-140910-01-08	1.030	0.143	0.064	0.979	0.139	0.087	0.832	0.210	0.075	0.000	0.005	0.043	0.632	0.179	0.053	0.99
9574-SS-140910-01-09	1.080	0.169	0.070	0.768	0.188	0.184	0.484	0.159	0.055	0.043	0.053	0.069	0.493	0.161	0.063	0.90
9574-SS-140910-01-10	1.170	0.174	0.077	1.160	0.191	0.143	0.571	0.169	0.064	0.034	0.050	0.080	0.757	0.196	0.034	1.14
9574-SS-140910-01-11	0.972	0.136	0.084	0.977	0.142	0.079	0.606	0.174	0.059	0.028	0.040	0.042	0.575	0.168	0.034	0.96
9574-SS-140910-01-12	1.220	0.184	0.086	1.140	0.210	0.139	0.747	0.199	0.054	0.056	0.060	0.067	0.997	0.233	0.036	1.16
9574-SS-140910-01-13	1.020	0.140	0.076	0.978	0.157	0.096	0.724	0.198	0.037	0.046	0.053	0.046	0.744	0.201	0.056	0.98
9574-SS-140910-01-14	1.050	0.146	0.061	0.889	0.156	0.080	0.705	0.193	0.061	0.029	0.042	0.044	0.607	0.178	0.067	0.95
9574-SS-140910-01-15	0.805	0.121	0.058	0.871	0.140	0.110	0.434	0.145	0.058	-0.003	0.005	0.064	0.594	0.171	0.034	0.82
9574-SS-140910-01-16	1.320	0.201	0.090	1.070	0.189	0.153	0.513	0.152	0.054	0.049	0.052	0.059	0.835	0.198	0.031	1.17
9574-SS-140910-01-17	1.190	0.165	0.070	1.100	0.179	0.129	0.639	0.183	0.062	0.024	0.043	0.077	0.844	0.213	0.036	1.12
Min	0.72			0.75			0.35			0.00			0.38			0.72
Max	1.32			1.16			0.83			0.06			1.00			
Mean	1.04			0.97			0.57			0.03			0.65			
Stdev	0.16			0.13			0.15			0.02			0.17			

Use Root DCGLs.

Sub-Surface

Sample ID	Ra-226 w/ 21-Day Ingrowth			Th-232			U-234*			U-235*			U-238*			SOF
	Conc.	Error	MDC	Conc.	Error	MDC	Conc.	Error	MDC	Conc.	Error	MDC	Conc.	Error	MDC	
9574-SS-140910-01-18	1.340	0.193	0.085	1.190	0.200	0.117	0.808	0.200	0.062	0.038	0.047	0.062	0.745	0.191	0.049	1.24
9574-SS-140910-01-20	1.260	0.206	0.109	1.010	0.197	0.176	1.120	0.241	0.057	0.068	0.061	0.041	0.710	0.187	0.050	1.11
9574-SS-140910-01-21	1.070	0.156	0.074	0.982	0.153	0.124	1.040	0.232	0.050	0.028	0.039	0.041	0.705	0.187	0.050	1.01
9574-SS-140910-01-22	0.922	0.131	0.057	1.210	0.170	0.106	0.829	0.215	0.065	0.013	0.032	0.071	0.981	0.236	0.037	1.05
9574-SS-140910-01-23	1.130	0.170	0.084	1.370	0.229	0.115	1.140	0.254	0.055	0.073	0.068	0.069	0.994	0.235	0.036	1.23
9574-SS-140910-01-24	1.200	0.165	0.065	1.390	0.221	0.131	1.090	0.247	0.055	0.024	0.043	0.078	0.992	0.234	0.055	1.28
9574-SS-140910-01-25	1.230	0.164	0.065	0.990	0.156	0.126	0.887	0.216	0.053	0.069	0.065	0.065	0.959	0.226	0.070	1.09
9574-SS-140910-01-26	1.080	0.159	0.079	1.210	0.179	0.106	0.730	0.219	0.078	0.019	0.037	0.056	0.764	0.223	0.045	1.13
9574-SS-140910-01-27	1.310	0.185	0.082	1.050	0.163	0.110	1.160	0.255	0.036	0.059	0.059	0.044	0.956	0.228	0.062	1.16
9574-SS-140910-01-28	1.280	0.188	0.089	1.390	0.201	0.131	0.871	0.217	0.055	0.060	0.060	0.045	0.895	0.220	0.036	1.31
9574-SS-140910-01-29	1.080	0.154	0.081	0.955	0.160	0.146	0.842	0.208	0.059	0.011	0.029	0.064	0.708	0.189	0.051	1.00
9574-SS-140910-01-30	0.960	0.161	0.086	0.851	0.166	0.156	0.744	0.196	0.035	0.072	0.065	0.043	0.787	0.203	0.053	0.89
9574-SS-140910-01-31	1.060	0.146	0.050	1.100	0.159	0.089	0.572	0.170	0.070	0.099	0.075	0.043	0.986	0.228	0.052	1.06
9574-SS-140910-01-32	1.060	0.157	0.071	1.170	0.177	0.078	0.598	0.174	0.060	0.058	0.058	0.043	0.758	0.198	0.060	1.10
9574-SS-140910-01-33	1.030	0.147	0.069	0.954	0.153	0.119	0.772	0.196	0.050	0.014	0.028	0.041	0.828	0.203	0.033	0.98
9574-SS-140910-01-34	0.618	0.099	0.040	0.225	0.085	0.099	0.389	0.138	0.052	0.014	0.029	0.043	0.494	0.156	0.035	0.41
Min	0.62			0.23			0.39			0.01			0.49			0.41
Max	1.34			1.39			1.16			0.0992			0.994			
Mean	1.10			1.07			0.85			0.04			0.83			
Stdev	0.18			0.28			0.22			0.03			0.14			

Use Root DCGLs.

DCLG_w, Measure Tc-99, All SEAs

	Surface	Root	Excavation
U-234	508.5	235.6	872.4
U-235	102.3	64.1	208.1
U-238	297.6	183.3	551.1
Tc-99	151	30.1	74
Th-232	4.7	2	5.2
Ra-226	5	2.1	5.4

No Tc-99 expected in background area.

* alpha spectroscopy results.

Dataset Min = 0.618 0.225 0.345 -0.00262 0.379

HDP-PR-FSS-701 Final Status Survey Plan Development
Appendix P-1 Step 8. Calculate the Number of Samples in the Statistical Survey Population

DCGL Criteria Evaluation	
N/2 Value Verification	
Isotope(s)	SOF (Ra/Tc/Th/Iso U)
St. Dev.	0.13
DCGL _{SOF}	1
LBGR (Mean)	0.11
Shift	0.89
Relative Shift (Δ/σ)	6.81
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

Δ/σ	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, $\alpha = 0.05$, $\beta = 0.10$

α (OR β)	$Z_{1-\alpha}$ (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

α
 β

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-703, Final Status Survey Quality Control										
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**FORM HDP-PR-FSS-703-1
FIELD DUPLICATE SAMPLE ASSESSMENT**

Survey Unit No.:		LSA 09-03			Survey Unit Description:		Central Open Land Area Survey Unit in "Area 12"					
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 ²	Warning Limit	Control Limit	Statistic Exceeds Limit? (Y/N)
			Activity (x _i)	MDC	Activity (x _i)	MDC						
L09-03-08-P-R-S-00	L09-03-08-P-R-Q-00	Ra-226	0.871	0.0616	0.975	0.058	0.923	5.4	0.104	0.764	1.145	N
L09-03-08-P-R-S-00	L09-03-08-P-R-Q-00	Tc-99	3.37	0.194	3.030	0.206	3.200	74	0.340	10.471	15.688	N
L09-03-08-P-R-S-00	L09-03-08-P-R-Q-00	Th-232	0.997	0.076	0.926	0.098	0.962	5.2	0.071	0.736	1.102	N
L09-03-08-P-R-S-00	L09-03-08-P-R-Q-00	U-234 ¹	3.921	N/A	4.383	N/A	4.152	872.4	0.462	123.445	184.949	N
L09-03-08-P-R-S-00	L09-03-08-P-R-Q-00	U-235	0.216	0.173	0.242	0.161	0.229	208.1	0.026	29.446	44.117	N
L09-03-08-P-R-S-00	L09-03-08-P-R-Q-00	U-238	0.988	0.638	0.931	0.691	0.960	551.1	0.057	77.981	116.833	N

Comments:

- U-234 is inferred, no MDC available.
- Duplicate assessment is not necessary if the result of either sample is < MDC.

Performed by: Thomas Yardy _____

Reviewed by: Clark Evers _____

Date: _____

Date: _____

Quality Record

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**FORM HDP-PR-FSS-703-1
FIELD DUPLICATE SAMPLE ASSESSMENT**

Survey Unit No.:		LSA 09-03			Survey Unit Description:		Central Open Land Area Survey Unit in "Area 12"					
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 ²	Warning Limit	Control Limit	Statistic Exceeds Limit? (Y/N)
			Activity (x_i)	MDC	Activity (x_i)	MDC						
L09-03-14-P-R-S-00	L09-03-14-P-R-Q-00	Ra-226	0.826	0.0638	0.966	0.070	0.896	5.4	0.140	0.764	1.145	N
L09-03-14-P-R-S-00	L09-03-14-P-R-Q-00	Tc-99	3.92	0.204	8.780	0.237	6.350	74	4.860	10.471	15.688	N
L09-03-14-P-R-S-00	L09-03-14-P-R-Q-00	Th-232	1.020	0.085	0.972	0.104	0.996	5.2	0.048	0.736	1.102	N
L09-03-14-P-R-S-00	L09-03-14-P-R-Q-00	U-234 ¹	7.717	N/A	7.411	N/A	7.564	872.4	0.305	123.445	184.949	N
L09-03-14-P-R-S-00	L09-03-14-P-R-Q-00	U-235	0.426	0.173	0.409	0.185	0.418	208.1	0.017	29.446	44.117	N
L09-03-14-P-R-S-00	L09-03-14-P-R-Q-00	U-238	1.31	0.847	1.680	0.854	1.495	551.1	0.370	77.981	116.833	N

Comments:

- U-234 is inferred, no MDC available.
- Duplicate assessment is not necessary if the result of either sample is < MDC.

Performed by: Thomas Yardy _____

Reviewed by: Clark Evers _____

Date: _____

Date: _____

Quality Record

LSA 09-03 Sys SOF

0.2

0.3

0.0

0.5

0.1

0.1

0.0

0.2

0.0

0.2

0.0

0.0

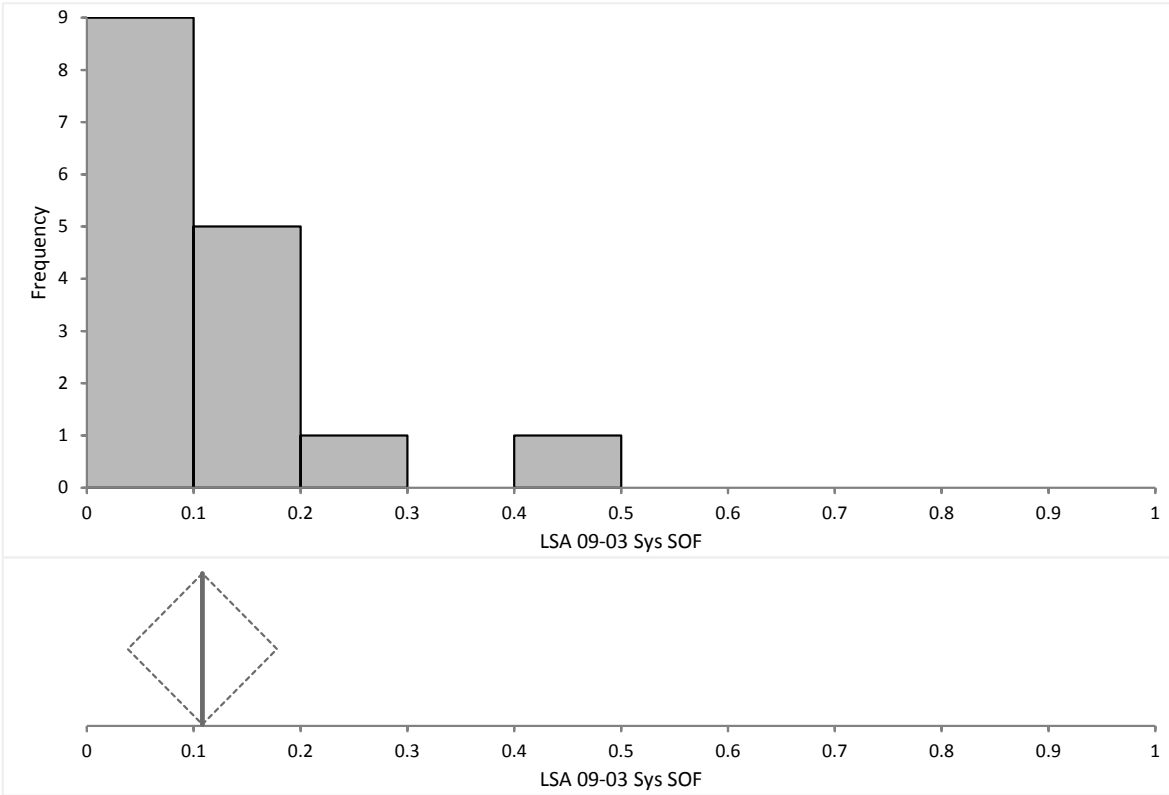
0.0

0.2

0.0

0.0

Descriptives



N | 16

	Mean	95% CI	Mean SE	SD	Variance	Skewness	Kurtosis
LSA 09-03 Sys SOF	0.11	0.04 to 0.18	0.033	0.13	0.02	1.7	3.35
	Minimum	1st quartile	Median	97.87% CI	3rd quartile	Maximum	IQR
LSA 09-03 Sys SOF	0.0	0.01	0.05	0.01 to 0.18	0.17	0.5	0.16