

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>	LSA 08	<b>Description:</b>	Technetium SEA Open Land Area
<b>Survey Unit:</b>	09	<b>Description:</b>	Central Open Land Area
<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
L08-09-01-T-R-S-00	Root	S	431.6	430.6	865050	827425	Root 1-ft composite
L08-09-02-T-E-S-00	Deep	S	430.6	430.1	865050	827425	Excavation 6-inch grab
L08-09-03-T-E-S-00	Deep	S	427.8	427.3	865007	827352	Excavation 6-inch grab
L08-09-04-T-E-S-00	Deep	S	429.2	428.7	865007	827400	Excavation 6-inch grab
L08-09-05-T-E-S-00	Deep	S	430.6	430.1	865007	827449	Excavation 6-inch grab
L08-09-06-T-E-S-00	Deep	S	425.9	425.4	864965	827376	Excavation 6-inch grab
L08-09-07-T-E-S-00	Deep	S	430.1	429.6	864965	827425	Excavation 6-inch grab
L08-09-08-T-E-S-00	Deep	S	431.0	430.5	864965	827474	Excavation 6-inch grab
L08-09-09-T-E-S-00	Deep	S	430.5	430.0	864923	827449	Excavation 6-inch grab
L08-09-08-T-E-Q-00	Deep	Q	431.0	430.5	864965	827474	Excavation 6-inch grab
L08-09-10-T-E-B-00	Deep	B	428.2	428.2	864941	827423	Sidewall Sample
L08-09-11-T-E-B-00	Deep	B	430.1	429.6	865019	827448	Biased 6-inch grab
L08-09-12-T-E-B-00	Deep	B	427.9	427.4	864945	827413	Biased 6-inch grab
L08-09-13-T-E-B-00	Deep	B	428.5	428.0	864935	827437	Biased 6-inch grab
L08-09-14-T-E-B-00	Deep	B	428.2	427.7	864919	827417	Biased 6-inch grab
L08-09-15-T-E-B-00	Deep	B	430.2	429.7	864895	827440	Biased 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] (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  
 Steps 8.3 Preliminary Data Review and 8.4 Calculation of the Sum-of-Fractions (SOF)

Use corrected net results for all DE calcs 721 Sec. 8.4.2

Step 8.4.1

	DCLG <sub>w</sub> , 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

Infer U234 Step 8.3.4			
U-238/U235	U-234/U235	U-234	%
11.5	19.1	2.5	1.4
9.4	18.7	1.9	1.7
5.9	18.3	3.4	2.6
7.8	18.5	3.5	2.0
13.5	19.4	1.4	1.2
12.6	19.2	2.2	1.3
16.3	19.9	1.4	1.0
2.6	18.2	11.4	5.7
23.7	21.1	1.3	0.7
3.0	18.1	8.8	5.0
5.1	18.2	4.2	3.0
22.1	21.1	1.2	0.7
13.6	19.4	1.9	1.2
7.5	18.5	2.7	2.1
9.9	18.8	1.5	1.6
28.2	21.8	1.0	0.6
Average Enrichment (%)			1.99

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

4.06
4.12
2.71
4.58
4.58
4.40
5.40
3.40
5.65
3.79
3.18
4.57
5.70
5.19
4.48
5.35

Step 8.4.5b

Weighted SOF <sub>MEAN</sub>	0.15		
fractions	SS	RS	ES
	0	0.125	1

Step 8.4.5c SOF<sub>MEAN</sub> Re-use Backfill Material  
0

Step 8.4.5e SOF<sub>MEAN</sub> Groundwater  
0.16

Step 8.4.5g (<=1)  
SOF<sub>MEAN, SU</sub> 0.31 PASS

Step 8.4.6 Calculate the dose contribution for the SU by multiplying SOF<sub>MEAN, SU</sub> (including contribution from Re-use backfill and Groundwater) by 25  
mrem  
7.7 mrem

**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 ( $X_{i,ref}$ , $Y_{i,SU}$ ) Step 8.5.3a	ADJUSTED SOF ( $Z_i$ ) Step 8.5.3b	RANKS Step 8.5.3d	REFERENCE AREA RANKS
9574-SS-140910-01-01	Reference	1.13	2.130	33	33
9574-SS-140910-01-02	Reference	0.72	1.721	11	11
9574-SS-140910-01-03	Reference	0.97	1.970	20	20
9574-SS-140910-01-04	Reference	0.97	1.967	19	19
9574-SS-140910-01-05	Reference	0.95	1.952	17	17
9574-SS-140910-01-07	Reference	0.83	1.829	13	13
9574-SS-140910-01-08	Reference	0.99	1.987	23	23
9574-SS-140910-01-09	Reference	0.90	1.904	15	15
9574-SS-140910-01-10	Reference	1.14	2.144	34	34
9574-SS-140910-01-11	Reference	0.96	1.958	18	18
9574-SS-140910-01-12	Reference	1.16	2.160	36	36
9574-SS-140910-01-13	Reference	0.98	1.9826	22	22
9574-SS-140910-01-14	Reference	0.95	1.9513	16	16
9574-SS-140910-01-15	Reference	0.82	1.824	12	12
9574-SS-140910-01-16	Reference	1.17	2.171	37	37
9574-SS-140910-01-17	Reference	1.12	2.124	31	31
9574-SS-140910-01-18	Reference	1.24	2.241	39	39
9574-SS-140910-01-20	Reference	1.11	2.115	30	30
9574-SS-140910-01-21	Reference	1.01	2.009	25	25
9574-SS-140910-01-22	Reference	1.05	2.053	26	26
9574-SS-140910-01-23	Reference	1.23	2.234	38	38
9574-SS-140910-01-24	Reference	1.28	2.277	40	40
9574-SS-140910-01-25	Reference	1.09	2.091	28	28
9574-SS-140910-01-26	Reference	1.13	2.127	32	32
9574-SS-140910-01-27	Reference	1.16	2.160	35	35
9574-SS-140910-01-28	Reference	1.31	2.314	41	41
9574-SS-140910-01-29	Reference	1.00	1.999	24	24
9574-SS-140910-01-30	Reference	0.89	1.891	14	14
9574-SS-140910-01-31	Reference	1.06	2.064	27	27
9574-SS-140910-01-32	Reference	1.10	2.097	29	29
9574-SS-140910-01-33	Reference	0.98	1.975	21	21
9574-SS-140910-01-34	Reference	0.41	1.411	10	10
L08-09-01-T-R-S-00	Survey Unit	1.10	1.096	8	0
L08-09-02-T-E-S-00	Survey Unit	1.37	1.371	9	0
L08-09-03-T-E-S-00	Survey Unit	0.47	0.471	3	0
L08-09-04-T-E-S-00	Survey Unit	0.54	0.540	5	0
L08-09-05-T-E-S-00	Survey Unit	0.41	0.409	1	0
L08-09-06-T-E-S-00	Survey Unit	0.46	0.457	2	0
L08-09-07-T-E-S-00	Survey Unit	0.48	0.483	4	0
L08-09-08-T-E-S-00	Survey Unit	0.66	0.659	7	0
L08-09-09-T-E-S-00	Survey Unit	0.62	0.621	6	0
<b>Rank Sums</b>				<b>861</b>	<b>816</b>
<b># Reference Area Measurements</b>				<b>m</b>	<b>32</b>
<b># Survey Unit Measurements</b>				<b>n</b>	<b>9</b>
<b>Total Number of Measurements Step 8.5.3c</b>				<b>N</b>	<b>41</b>
<b><math>\alpha</math> percentile of a standard normal distribution (MARSSIM Pg. I-10)</b>				<b>z</b>	<b>1.645</b>
<b>WRS Critical Value (MARSSIM Pg. I-10, Eq. I.1)</b>				<b>CV</b>	<b>725</b>

Step 8.5.1  
Min adjusted bkg SOF: 1.41  
Stratum  
ROOT  
EXCAVATION  
EXCAVATION  
EXCAVATION  
EXCAVATION  
EXCAVATION  
EXCAVATION  
EXCAVATION  
EXCAVATION  
EXCAVATION  
EXCAVATION

**W<sub>r</sub> 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
	(pCi/g)			(pCi/g)			(pCi/g)			(pCi/g)			(pCi/g)			
	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
	(pCi/g)			(pCi/g)			(pCi/g)			(pCi/g)			(pCi/g)			
	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<sub>w</sub>, 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.	0.08
DCGL <sub>SOF</sub>	1
LBGR (Mean)	0.15
Shift	0.85
Relative Shift ( $\Delta/\sigma$ )	10.33
MARSSIM Table 5.1 ( $P_r$ )	1.000000
N	12
N + 20%	14.4
N/2	8
FSS N/2	8
Verification Check	<b>SUFFICIENT MEASUREMENTS</b>
"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										
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**FORM HDP-PR-FSS-703-1  
FIELD DUPLICATE SAMPLE ASSESSMENT**

Survey Unit No.:	LSA 08-09				Survey Unit Description:	Central Open Land Area						
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 <sub>i</sub> )	MDC	Activity (x <sub>i</sub> )	MDC						
L08-09-08-T-E-S-00	L08-09-08-T-E-Q-00	Ra-226	0.994	0.0664	1.040	0.075	1.017	5.4	0.046	0.764	1.145	N
L08-09-08-T-E-S-00	L08-09-08-T-E-Q-00	Tc-99	19.6	0.218	21.800	0.231	20.700	74	2.200	10.471	15.688	N
L08-09-08-T-E-S-00	L08-09-08-T-E-Q-00	Th-232	0.992	0.116	0.990	0.088	0.991	5.2	0.002	0.736	1.102	N
L08-09-08-T-E-S-00	L08-09-08-T-E-Q-00	U-234 <sup>1</sup>	11.420	N/A	8.805	N/A	10.112	872.4	2.614	123.445	184.949	N
L08-09-08-T-E-S-00	L08-09-08-T-E-Q-00	U-235	0.629	0.187	0.486	0.209	0.558	208.1	0.143	29.446	44.117	N
L08-09-08-T-E-S-00	L08-09-08-T-E-Q-00	U-238	1.64	0.841	1.450	0.767	1.545	551.1	0.190	77.981	116.833	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: Thomas Yardy \_\_\_\_\_

Reviewed by: Clark Evers \_\_\_\_\_

Date: \_\_\_\_\_

Date: \_\_\_\_\_

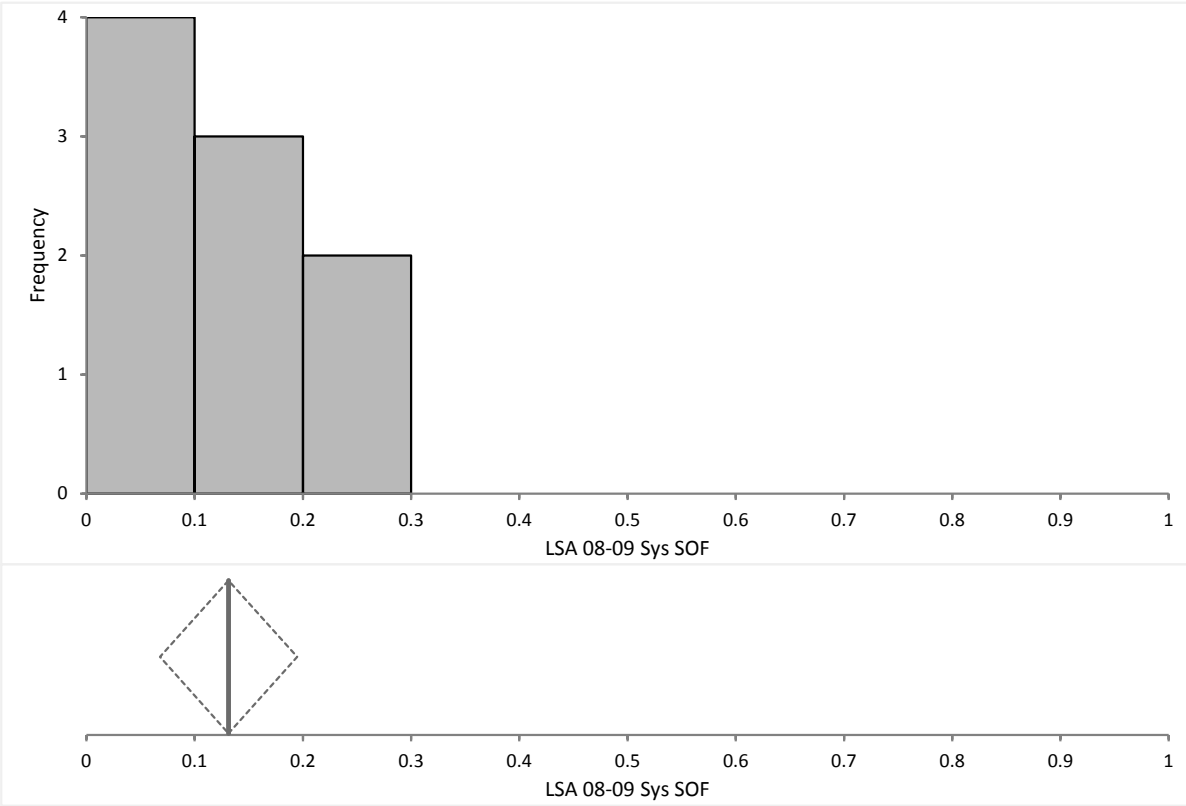
Quality Record

LSA 08-09 Sys SOF

0.1  
0.1  
0.1  
0.1  
0.0  
0.1  
0.1  
0.3  
0.2



Descriptives



N | 9

	Mean	95% CI	Mean SE	SD	Variance	Skewness	Kurtosis
LSA 08-09 Sys SOF	0.13	0.07 to 0.19	0.027	0.08	0.01	0.8	0.16
	Minimum	1st quartile	Median	96.09% CI	3rd quartile	Maximum	IQR
LSA 08-09 Sys SOF	0.02	0.08	0.12	0.07 to 0.23	0.18	0.3	0.10