Environmental TLD Quality Assurance Testing Program Comparison to ANSI/HPS N13.37-2014

RETS/REMP Workshop 2016

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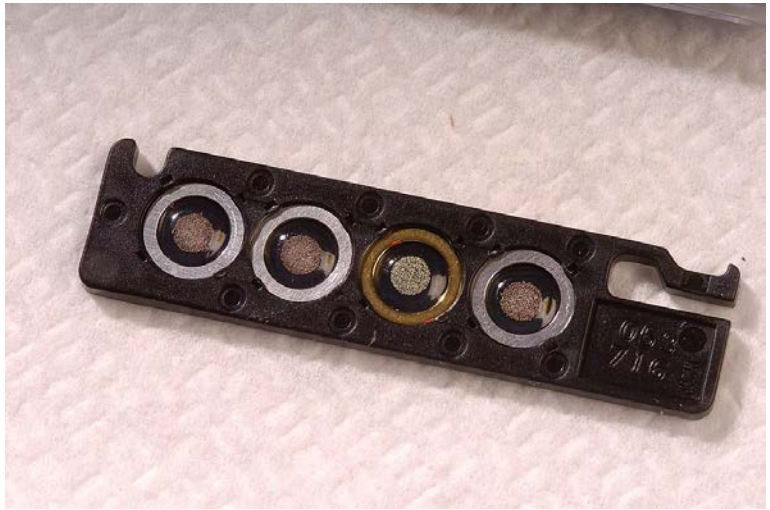
Presentation Outline

- **Seabrook Station Environmental TLD Program**
  - Environmental Dosimetry Company (EDC) Panasonic TLDs
  - REMP and Site Area TLD Monitoring Programs
- **Seabrook Station Environmental TLD QA Test Program**
  - Blind Spike and Blind Duplicate TLD testing
- **Comparisons to ANSI/HPS N13.37-2014 QA Test Program**
- **Seabrook Station Environmental TLD QA Test Results**

EDC Panasonic TLDs

- **Two 814 Badges with Calcium Sulfate Elements**
  - Six calcium sulfate elements averaged together
  - One sigma coefficient of variance typically less than 6%
  - Minor signal fade over quarterly monitoring period (~5%)



EDC Panasonic TLDs (Continued)

- **Quarterly Monitoring Methods**
  - Transit Control TLDs monitor extraneous signal during TLD shipment and field deployment.
  - Fade TLDs evaluate signal fade during quarter
  - Normalization to standard 91 day quarter “FCYCLE” (Example: 86 day deployment is multiplied by FCYCLE of 1.058)

Seabrook Station Environmental TLD Program

- **REMP TLD Program Monitors 77 locations (ODCM)**
  - Protected Area fences
  - Inner ring 16-sector radial grid (e.g. site boundary)
  - Outer ring in applicable 16-sector radial grids (coastal site)
  - Control locations > 20 km (regional/seasonal impact)
  - Neutron TLDs at 19 locations to monitor ISFSI

Seabrook Station Environmental TLD Program (Continued)

- **Site Area TLD Program Monitors 31 locations (10CFR20.1302)**
  - Occupied buildings and work areas adjacent to Radiological Control Areas
  - Monitor on-site members of public, visitors and workers while not wearing personal dosimeters
  - Neutron TLDs at 12 locations to monitor ISFSI

Seabrook Station Environmental TLD QA Program

- **12 QA TLDs and 4 QA Control TLDs, quarterly**

- **Blind Spike TLD Test Program**
  - 12 TLDs spiked annually (6 in 2nd and 4th quarters)
  - NIST-traceable ^{137}Cs beam
  - Irradiate "free-in-air"
  - Spike range 20 - 100 mR (0.21 - 1.05 mSv)
  - Store TLDs with QA controls in lead shield during quarter
  - Acceptance criteria:
    - Average bias (B) of 6 TLDs within $\pm$15% of known
    - Performance criteria $(B^2+S^2)^{1/2}$ less than 0.30 (where S is standard deviation of B)

Seabrook Station Environmental TLD QA Program (Continued)

- **Blind Duplicate TLD Test Program**
  - 36 Blind Duplicate TLD tests annually
    - 12 in 1st and 3rd quarters, 6 in 2nd and 4th quarters
  - Duplicate TLD co-located with a field monitoring TLD for entire quarter
  - Duplicate TLD response compared to field monitoring TLD
  - Acceptance criteria:
    - Comparison to within ±20% of field monitoring TLD

Seabrook Station Environmental TLD QA Program (Continued)

– Holder for Field Monitoring TLD and Blind Duplicate TLD

ANSI/HPS N13.37-2014 QA Performance Testing

- Blind spike test a minimum of 15 TLDs annually (or ≥ 5% of field dosimeter inventory)
- Dose range between 50 - 200 mrem (0.50 - 2.0 mSv)
- Reference ^{137}Cs source
- Expose free-in-air
- Acceptance criteria: average bias (B) within ±15%

Comparison of Seabrook Station and ANSI/HPS N13.37-2014 QA Test Programs

	Seabrook Station	ANSI/HPS N13.37-2014
Annual Blind Spikes	12	22 (15 minimum)
Annual Blind Duplicates	36	-
Annual Total QA Tests	48	22 (15 minimum)
Percentage of Annual Field TLDs	11%	5% (3.5%)
Source	Cs-137	Cs-137
Test Range	20 - 100 mR	50 - 200 mrem
Testing Units	Exposure (mR)	Dose Equivalent (mrem)
Bias Tolerence Level	0.15	0.15
Performance Tolerence	0.30	-

Example Quarterly QA Result Spreadsheet

QA TYPE	LOCATION	FCYCLE	LOCATION OR SPIKE DOSE (mR)	EXPECTED DOSE (mR)	QA FCYCLE	QA DOSE (mR)	OBSERVED BIAS (Bi)	AVERAGE BIAS (B)	SIGMA (S)
DUPLICATE	TL-10	0.919	16.8	16.8	0.919	15.7	-0.060		
DUPLICATE	TL-12	0.919	18.4	18.4	0.919	17.5	-0.050		
DUPLICATE	TL-69	0.919	14.8	14.8	0.919	14.4	-0.023		
DUPLICATE	SB-32	0.938	12.9	12.6	0.919	13.5	0.067		
DUPLICATE	SB-39	0.938	13.3	13.1	0.919	12.7	-0.027		
DUPLICATE	SB-40	0.938	19.1	18.7	0.919	18.3	-0.024		
SPIKE	SHIELD		36.0	44.2	0.919	44.2	0.001		
SPIKE	SHIELD		36.0	44.2	0.919	44.0	-0.003		
SPIKE	SHIELD		36.0	44.2	0.919	43.3	-0.020		
SPIKE	SHIELD		36.0	44.2	0.919	44.0	-0.003	-0.009	0.009
SPIKE	SHIELD		36.0	44.2	0.919	43.7	-0.010		
SPIKE	SHIELD		36.0	44.2	0.919	43.3	-0.019		
CONTROL	SHIELD				0.919	11.0			
CONTROL	SHIELD				0.919	10.9			
CONTROL	SHIELD				0.919	11.2			
CONTROL	SHIELD				0.919	11.2			
				Average of Controls:		11.1	± 0.2 (± 1.6% CV)		

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Example Quarterly Blind Duplicate Analysis

QA TYPE	LOCATION	FCYCLE	LOCATION OR SPIKE DOSE (mR)	EXPECTED DOSE (mR)	QA FCYCLE	QA DOSE (mR)	OBSERVED BIAS (Bi)
DUPLICATE	TL-10	0.919	16.8	16.8	0.919	15.7	-0.060
DUPLICATE	TL-12	0.919	18.4	18.4	0.919	17.5	-0.050
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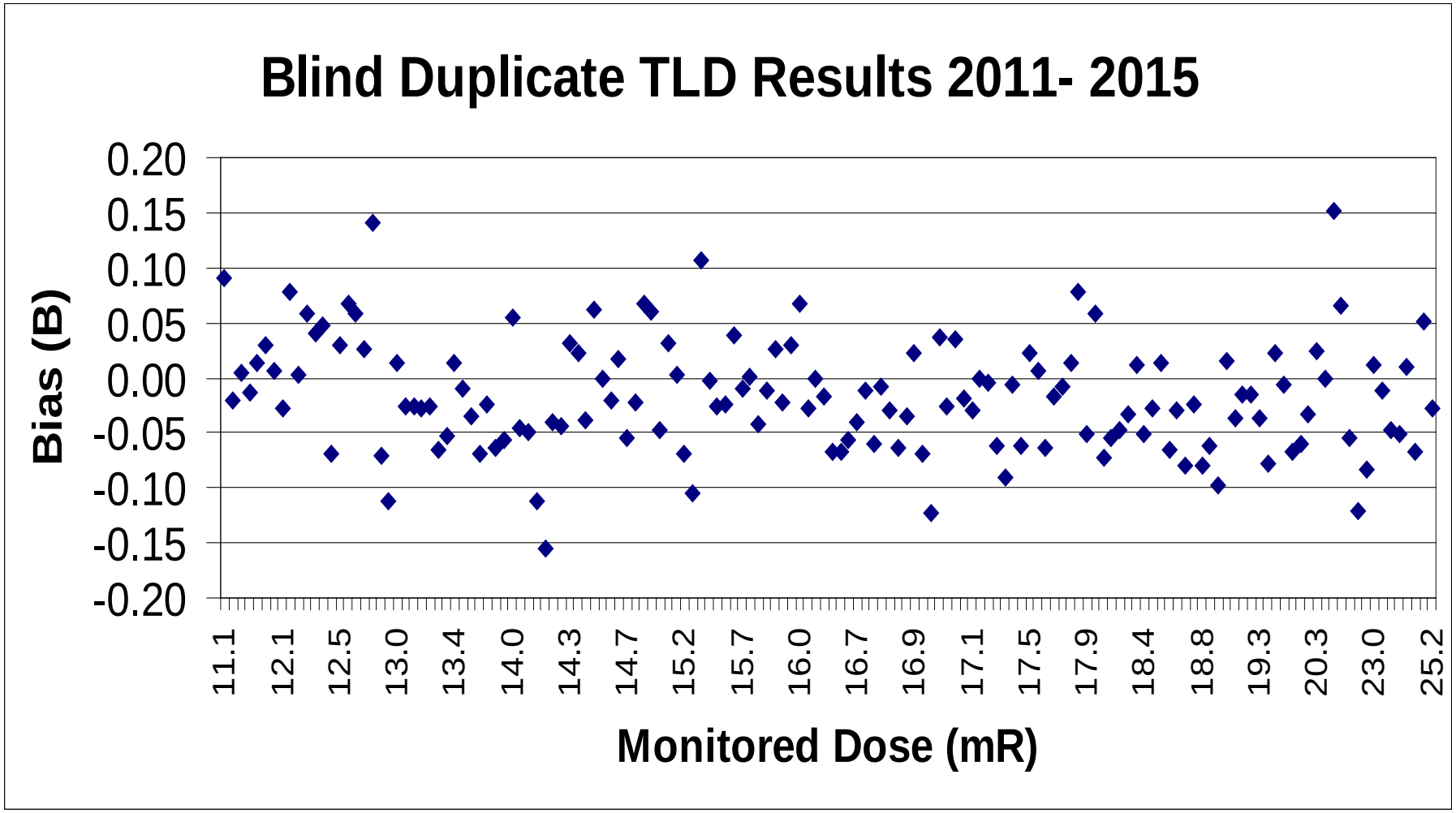
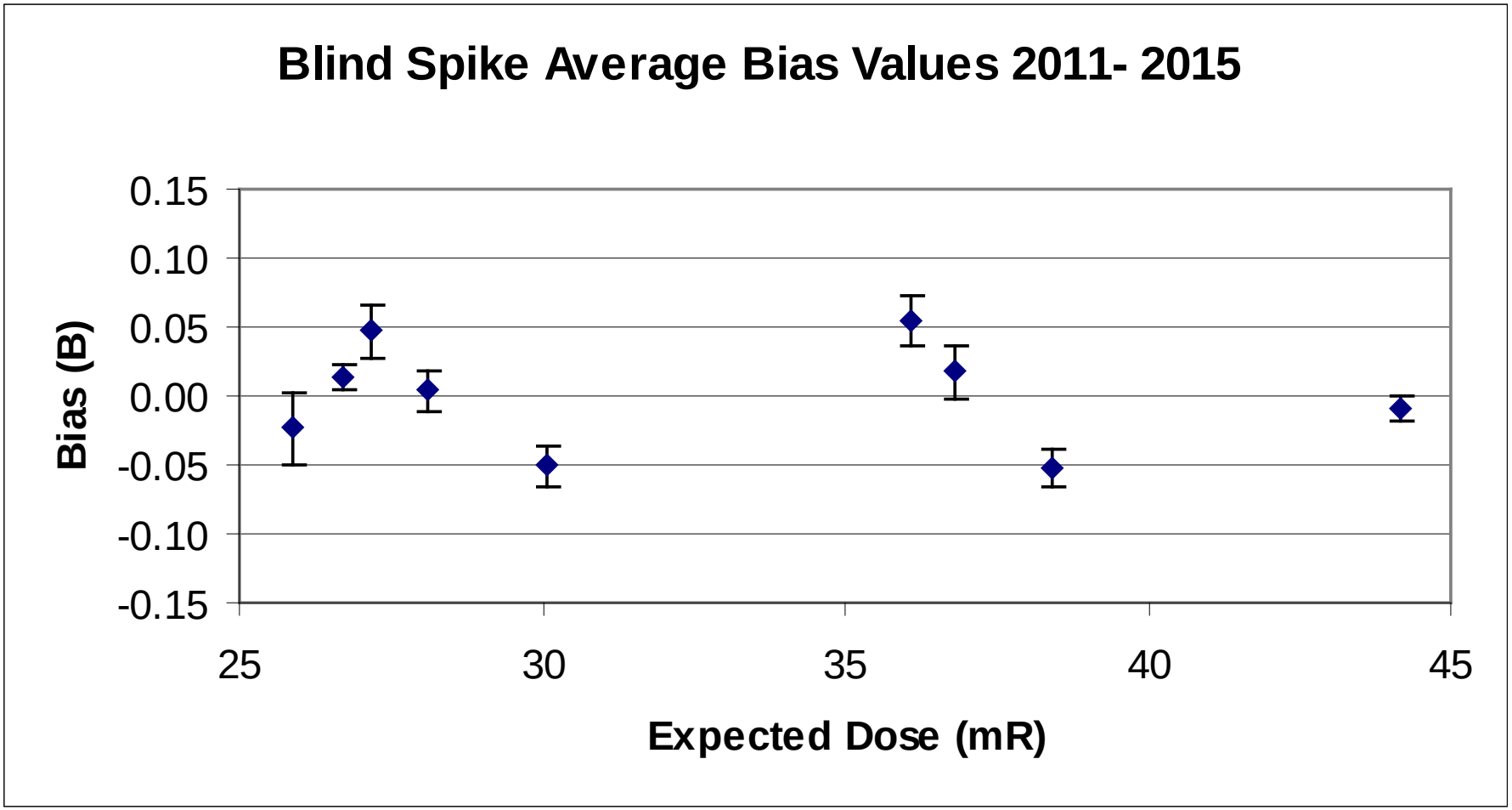
Environmental TLD QA Testing Program and ANSI/HPS N13.37-2014



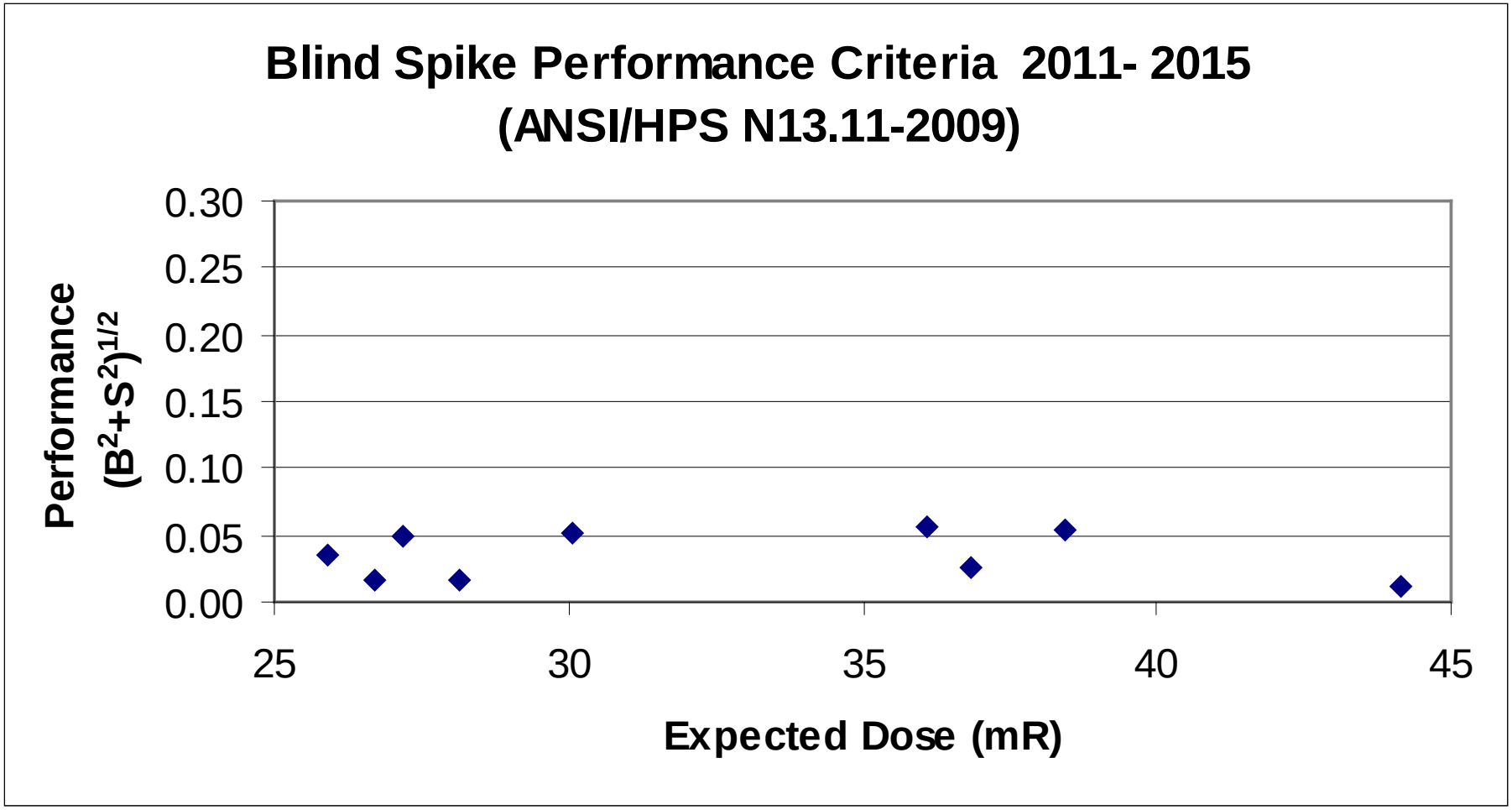
Example Quarterly Blind Spike Analysis

QA TYPE	LOCATION	LOCATION OR SPIKE DOSE (mR)	EXPECTED DOSE (mR)	QA FCYCLE	QA DOSE (mR)	OBSERVED BIAS (Bi)	AVERAGE BIAS (B)	SIGMA (S)
SPIKE	SHIELD	36.0	44.2	0.919	44.2	0.001		
SPIKE	SHIELD	36.0	44.2	0.919	44.0	-0.003		
SPIKE	SHIELD	36.0	44.2	0.919	43.3	-0.020		
SPIKE	SHIELD	36.0	44.2	0.919	44.0	-0.003	-0.009	0.009
SPIKE	SHIELD	36.0	44.2	0.919	43.7	-0.010		
SPIKE	SHIELD	36.0	44.2	0.919	43.3	-0.019		
CONTROL	SHIELD			0.919	11.0			
CONTROL	SHIELD			0.919	10.9			
CONTROL	SHIELD			0.919	11.2			
CONTROL	SHIELD			0.919	11.2			
				Average of Controls:	11.1	± 0.2 (± 1.6% CV)		

Environmental TLD QA Testing Program and ANSI/HPS N13.37-2014



Environmental TLD QA Testing Program and ANSI/HPS N13.37-2014



Presentation Conclusions

- **Seabrook Station QA TLD testing program documents the accurate, reproducible performance of EDC TLD system**
  - Blind Spikes test accuracy to NIST traceable ^{137}Cs source
    - No observable systematic bias
    - Bias within ± 15%
    - Performance $(B^2+S^2)^{1/2}$ well within 0.30
  - Blind Duplicates test reproducibility of field monitoring data
    - Comparisons within ± 20%

Presentation Conclusions (Continued)

- **Overall Seabrook Station QA TLD Program exceeds ANSI/HPS N13.37-2014 requirements**
  - 48 total QA tests (12 spikes and 36 duplicates) exceeds 22 minimum annual requirement (n $\geq$ 5%) of ANSI/HPS N13.37-2014
- **Continue spiking in 20 - 100 mR range (0.21 - 1.05 mSv)**
  - EDC system performs well
  - Range is consistent with typical field monitoring results.
- **Implement dose equivalent (mrem) units**
  - Expose TLDs “free-in-air”
  - Convert exposure to dose equivalent at 1.05 rem/R

Questions ?