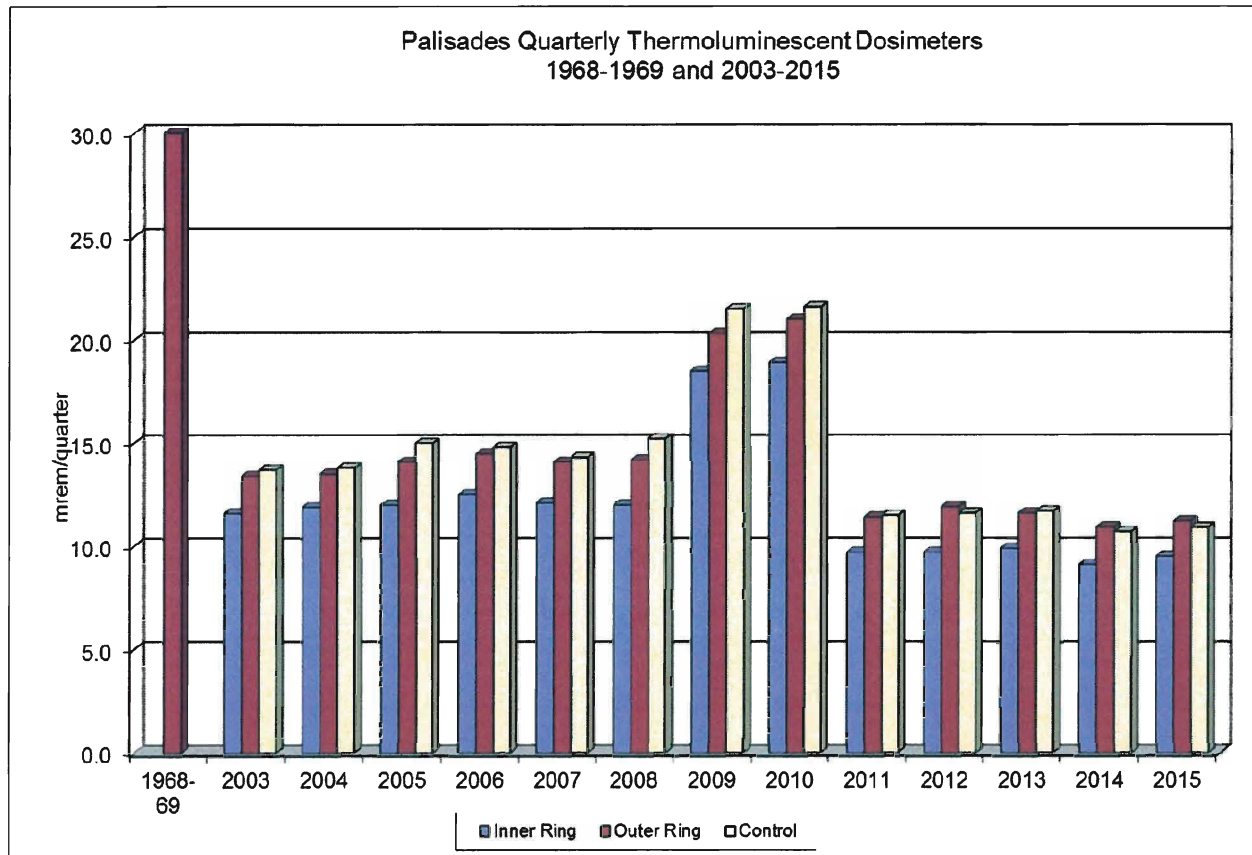


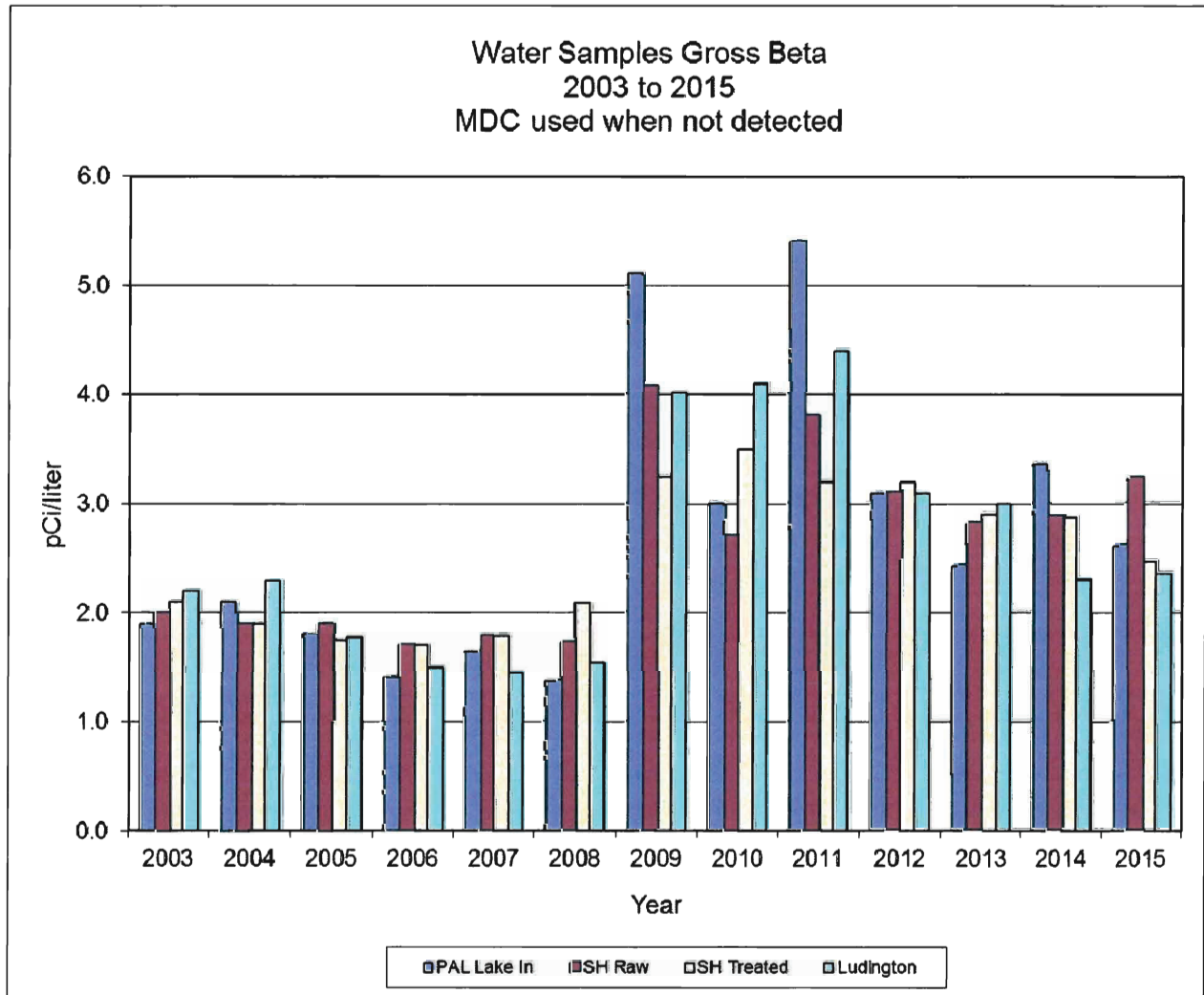
ATTACHMENT F DATA GRAPHS

1. Palisades TLD Quarterly Palisades Operational Comparison Graph, 1968-1969 and 2003-2015.



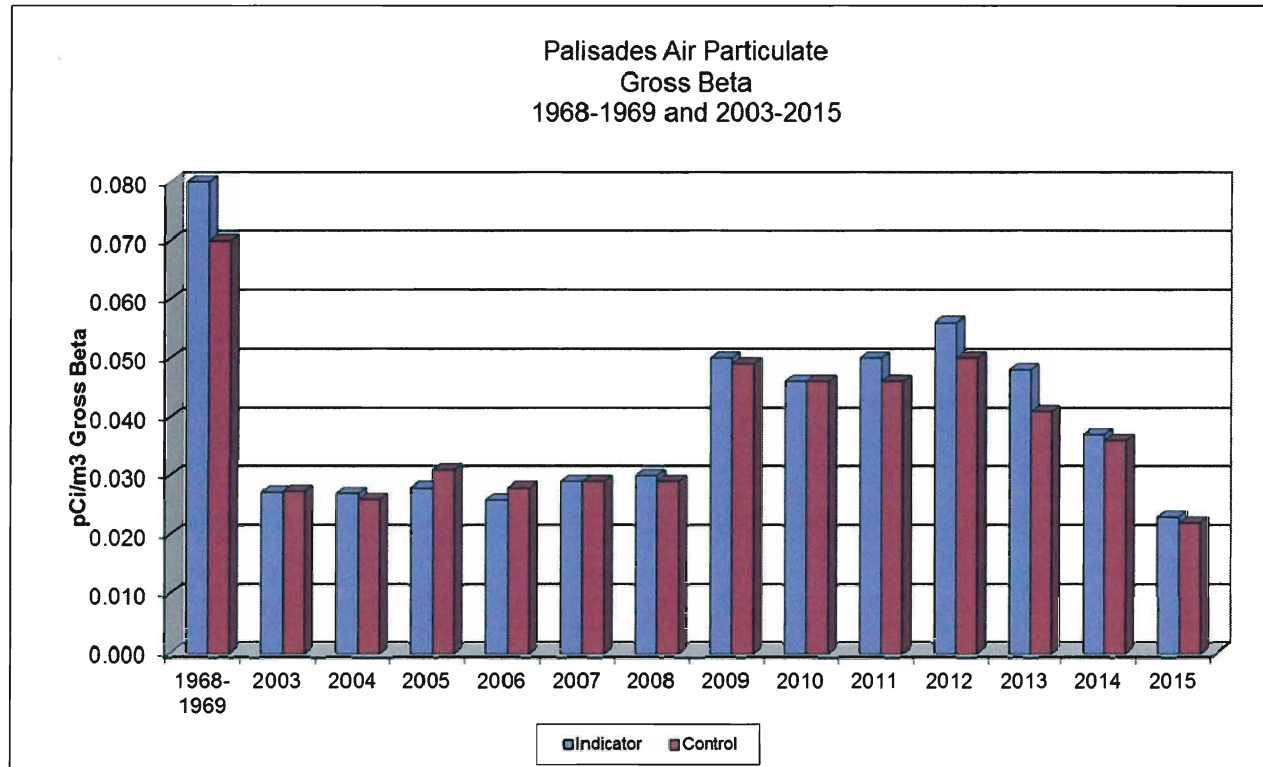
ATTACHMENT F DATA GRAPHS

2. Palisades Lake Water (Ludington Control vs. Intake, South Haven Treated and Raw), 2003-2015 in gross beta trending.



ATTACHMENT F DATA GRAPHS

3. Palisades Air Particulate (gross beta), Operational Comparison Graphs, 1968-1969 (pre-op) and 2003-2015.



ATTACHMENT G

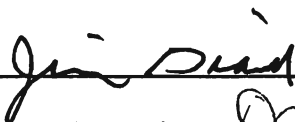
**Environmental Dosimetry Company
Annual Quality Assurance Status Report
January – December 2015**

ENVIRONMENTAL DOSIMETRY COMPANY

ANNUAL QUALITY ASSURANCE STATUS REPORT

January - December 2015

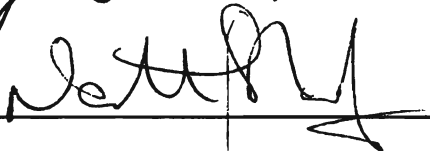
Prepared By:



Date:

2/29/16

Approved By:



Date:

2/29/16

**Environmental Dosimetry Company
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Sterling, MA 01564**

TABLE OF CONTENTS

	<u>Page</u>
LIST OF TABLES	iii
EXECUTIVE SUMMARY	iv
I. INTRODUCTION	1
A. QC Program	1
B. QA Program	1
II. PERFORMANCE EVALUATION CRITERIA	1
A. Acceptance Criteria for Internal Evaluations	1
B. QC Investigation Criteria and Result Reporting	3
C. Reporting of Environmental Dosimetry Results to EDC Customers	3
III. DATA SUMMARY FOR ISSUANCE PERIOD JANUARY-DECEMBER 2015	3
A. General Discussion	3
B. Result Trending	4
IV. STATUS OF EDC CONDITION REPORTS (CR)	4
V. STATUS OF AUDITS/ASSESSMENTS	4
A. Internal	4
B. External	4
VI. PROCEDURES AND MANUALS REVISED DURING JANUARY - DECEMBER 2015 ...	4
VII. CONCLUSION AND RECOMMENDATIONS	4
VIII. REFERENCES	4
APPENDIX A DOSIMETRY QUALITY CONTROL TRENDING GRAPHS	

LIST OF TABLES

	<u>Page</u>
1. Percentage of Individual Analyses Which Passed EDC Internal Criteria, January - December 2015	5
2. Mean Dosimeter Analyses (n=6), January - December 2015	5
3. Summary of Independent QC Results for 2015	5

EXECUTIVE SUMMARY

Routine quality control (QC) testing was performed for dosimeters issued by the Environmental Dosimetry Company (EDC) .

During this annual period, 100% (72/72) of the individual dosimeters, evaluated against the EDC internal performance acceptance criteria (high-energy photons only), met the criterion for accuracy and 100% (72/72) met the criterion for precision (Table 1). In addition, 100% (12/12) of the dosimeter sets evaluated against the internal tolerance limits met EDC acceptance criteria (Table 2) and 100% (6/6) of independent testing passed the performance criteria (Table 3). Trending graphs, which evaluate performance statistic for high-energy photon irradiations and co-located stations are given in Appendix A.

One internal assessment was performed in 2015. There were no findings.

I. INTRODUCTION

The TLD systems at the Environmental Dosimetry Company (EDC) are calibrated and operated to ensure consistent and accurate evaluation of TLDs. The quality of the dosimetric results reported to EDC clients is ensured by in-house performance testing and independent performance testing by EDC clients, and both internal and client directed program assessments.

The purpose of the dosimetry quality assurance program is to provide performance documentation of the routine processing of EDC dosimeters. Performance testing provides a statistical measure of the bias and precision of dosimetry processing against a reliable standard, which in turn points out any trends or performance changes. Two programs are used:

A. QC Program

Dosimetry quality control tests are performed on EDC Panasonic 814 Environmental dosimeters. These tests include: (1) the in-house testing program coordinated by the EDC QA Officer and (2) independent test perform by EDC clients. In-house test are performed using six pairs of 814 dosimeters, a pair is reported as an individual result and six pairs are reported as the mean result. Results of these tests are described in this report.

Excluded from this report are instrumentation checks. Although instrumentation checks represent an important aspect of the quality assurance program, they are not included as process checks in this report. Instrumentation checks represent between 5-10% of the TLDs processed.

B. QA Program

An internal assessment of dosimetry activities is conducted annually by the Quality Assurance Officer (Reference 1). The purpose of the assessment is to review procedures, results, materials or components to identify opportunities to improve or enhance processes and/or services.

II. PERFORMANCE EVALUATION CRITERIA

A. Acceptance Criteria for Internal Evaluations

1. Bias

For each dosimeter tested, the measure of bias is the percent deviation of the reported result relative to the delivered exposure. The percent deviation relative to the delivered exposure is calculated as follows:

$$\frac{(H'_i - H_i)}{H_i} 100$$

where:

H'_i = the corresponding reported exposure for the i^{th} dosimeter (i.e., the reported exposure)

H_i = the exposure delivered to the i^{th} irradiated dosimeter (i.e., the delivered exposure)

2. Mean Bias

For each group of test dosimeters, the mean bias is the average percent deviation of the reported result relative to the delivered exposure. The mean percent deviation relative to the delivered exposure is calculated as follows:

$$\sum \left(\frac{(H'_i - H_i)}{H_i} \right) 100 \left(\frac{1}{n} \right)$$

where:

H'_i = the corresponding reported exposure for the i^{th} dosimeter (i.e., the reported exposure)

H_i = the exposure delivered to the i^{th} irradiated test dosimeter (i.e., the delivered exposure)

n = the number of dosimeters in the test group

3. Precision

For a group of test dosimeters irradiated to a given exposure, the measure of precision is the percent deviation of individual results relative to the mean reported exposure. At least two values are required for the determination of precision. The measure of precision for the i^{th} dosimeter is:

$$\left(\frac{(H'_i - \bar{H})}{\bar{H}} \right) 100$$

where:

H'_i = the reported exposure for the i^{th} dosimeter (i.e., the reported exposure)

\bar{H} = the mean reported exposure; i.e., $\bar{H} = \sum H'_i \left(\frac{1}{n} \right)$

n = the number of dosimeters in the test group

4. EDC Internal Tolerance Limits

All evaluation criteria are taken from the "EDC Quality System Manual," (Reference 2). These criteria are only applied to individual test dosimeters irradiated with high-energy photons (Cs-137) and are as follows for Panasonic Environmental dosimeters: $\pm 15\%$ for bias and $\pm 12.8\%$ for precision.

B. QC Investigation Criteria and Result Reporting

EDC Quality System Manual (Reference 2) specifies when an investigation is required due to a QC analysis that has failed the EDC bias criteria. The criteria are as follows:

1. No investigation is necessary when an individual QC result falls outside the QC performance criteria for accuracy.
2. Investigations are initiated when the mean of a QC processing batch is outside the performance criterion for bias.

C. Reporting of Environmental Dosimetry Results to EDC Customers

1. All results are to be reported in a timely fashion.
2. If the QA Officer determines that an investigation is required for a process, the results shall be issued as normal. If the QC results, prompting the investigation, have a mean bias from the known of greater than $\pm 20\%$, the results shall be issued with a note indicating that they may be updated in the future, pending resolution of a QA issue.
3. Environmental dosimetry results do not require updating if the investigation has shown that the mean bias between the original results and the corrected results, based on applicable correction factors from the investigation, does not exceed $\pm 20\%$.

III. DATA SUMMARY FOR ISSUANCE PERIOD JANUARY-DECEMBER 2015

A. General Discussion

Results of performance tests conducted are summarized and discussed in the following sections. Summaries of the performance tests for the reporting period are given in Tables 1 through 3 and Figures 1 through 4.

Table 1 provides a summary of individual dosimeter results evaluated against the EDC internal acceptance criteria for high-energy photons only. During this period, 100% (72/72) of the individual dosimeters, evaluated against these criteria met the tolerance limits for accuracy and 100% (72/72) met the criterion for precision. A graphical interpretation is provided in Figures 1 and 2.

Table 2 provides the Bias + Standard deviation results for each group (N=6) of dosimeters evaluated against the internal tolerance criteria. Overall, 100% (12/12) of the dosimeter sets evaluated against the internal tolerance performance criteria met these criteria. A graphical interpretation is provided in Figures 3

Table 3 presents the independent blind spike results for dosimeters processed during this annual period. All results passed the performance acceptance criterion. Figure 4 is a graphical interpretation of Seabrook Station blind co-located station results.

B. Result Trending

One of the main benefits of performing quality control tests on a routine basis is to identify trends or performance changes. The results of the Panasonic environmental dosimeter performance tests are presented in Appendix A. The results are evaluated against each of the performance criteria listed in Section II, namely: individual dosimeter accuracy, individual dosimeter precision, and mean bias.

All of the results presented in Appendix A are plotted sequentially by processing date.

IV. STATUS OF EDC CONDITION REPORTS (CR)

No condition reports were issued during this annual period.

V. STATUS OF AUDITS/ASSESSMENTS

A. Internal

EDC Internal Quality Assurance Assessment was conducted during the fourth quarter 2015. There were no findings identified.

B. External

None.

VI. PROCEDURES AND MANUALS REVISED DURING JANUARY - DECEMBER 2015

Procedure 1052 was revised on December 23, 2015. Several procedures were reissued with no changes as part of the 5 year review cycle.

VII. CONCLUSION AND RECOMMENDATIONS

The quality control evaluations continue to indicate the dosimetry processing programs at the EDC satisfy the criteria specified in the Quality System Manual. The EDC demonstrated the ability to meet all applicable acceptance criteria.

VIII. REFERENCES

1. EDC Quality Control and Audit Assessment Schedule, 2015.
2. EDC Manual 1, Quality System Manual, Rev. 3, August 1, 2012.

TABLE 1

**PERCENTAGE OF INDIVIDUAL DOSIMETERS THAT PASSED EDC INTERNAL CRITERIA
JANUARY – DECEMBER 2015^{(1), (2)}**

Dosimeter Type	Number Tested	% Passed Bias Criteria	% Passed Precision Criteria
Panasonic Environmental	72	100	100

⁽¹⁾This table summarizes results of tests conducted by EDC.

⁽²⁾Environmental dosimeter results are free in air.

TABLE 2

**MEAN DOSIMETER ANALYSES (N=6)
JANUARY – DECEMBER 2015^{(1), (2)}**

Process Date	Exposure Level	Mean Bias %	Standard Deviation %	Tolerance Limit +/- 15%
4/16/2015	55	4.5	1.1	Pass
4/28/2015	91	2.7	1.6	Pass
05/07/2015	48	0.3	1.3	Pass
7/22/2015	28	1.5	1.4	Pass
7/24/2015	106	2.9	1.8	Pass
8/06/2015	77	-3.3	1.3	Pass
10/30/2015	28	3.7	2.2	Pass
11/04/2015	63	2.5	1.0	Pass
11/22/2015	85	-2.9	1.7	Pass
1/27/2016	61	3.1	0.9	Pass
1/31/2016	112	2.2	1.3	Pass
2/05/2016	36	3.2	1.4	Pass

⁽¹⁾This table summarizes results of tests conducted by EDC for TLDs issued in 2015.

⁽²⁾Environmental dosimeter results are free in air.

TABLE 3

**SUMMARY OF INDEPENDENT DOSIMETER TESTING
JANUARY – DECEMBER 2015^{(1), (2)}**

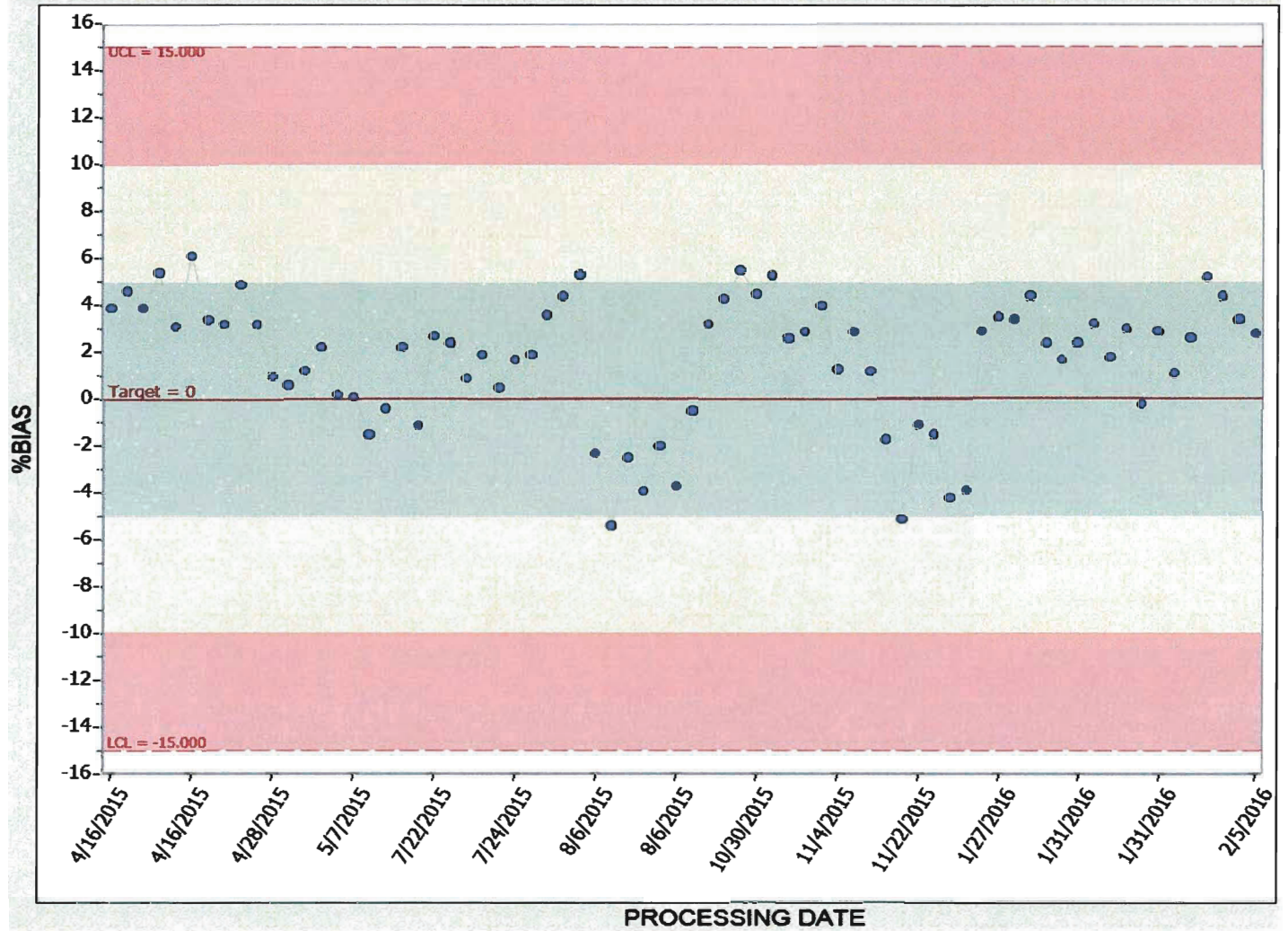
Issuance Period	Client	Mean Bias %	Standard Deviation %	Pass / Fail
1 st Qtr. 2015	Millstone	-6.5	2.9	Pass
2 nd Qtr. 2015	Millstone	-2.2	3.7	Pass
2 nd Qtr. 2015	Seabrook	1.4	0.9	Pass
3 rd Qtr. 2015	Millstone	-3.4	1.1	Pass
4 th Qtr. 2015	Millstone	-1.5	2.3	Pass
4 th Qtr. 2015	Seabrook	0.8	1.8	Pass

⁽¹⁾Performance criteria are +/- 30%.

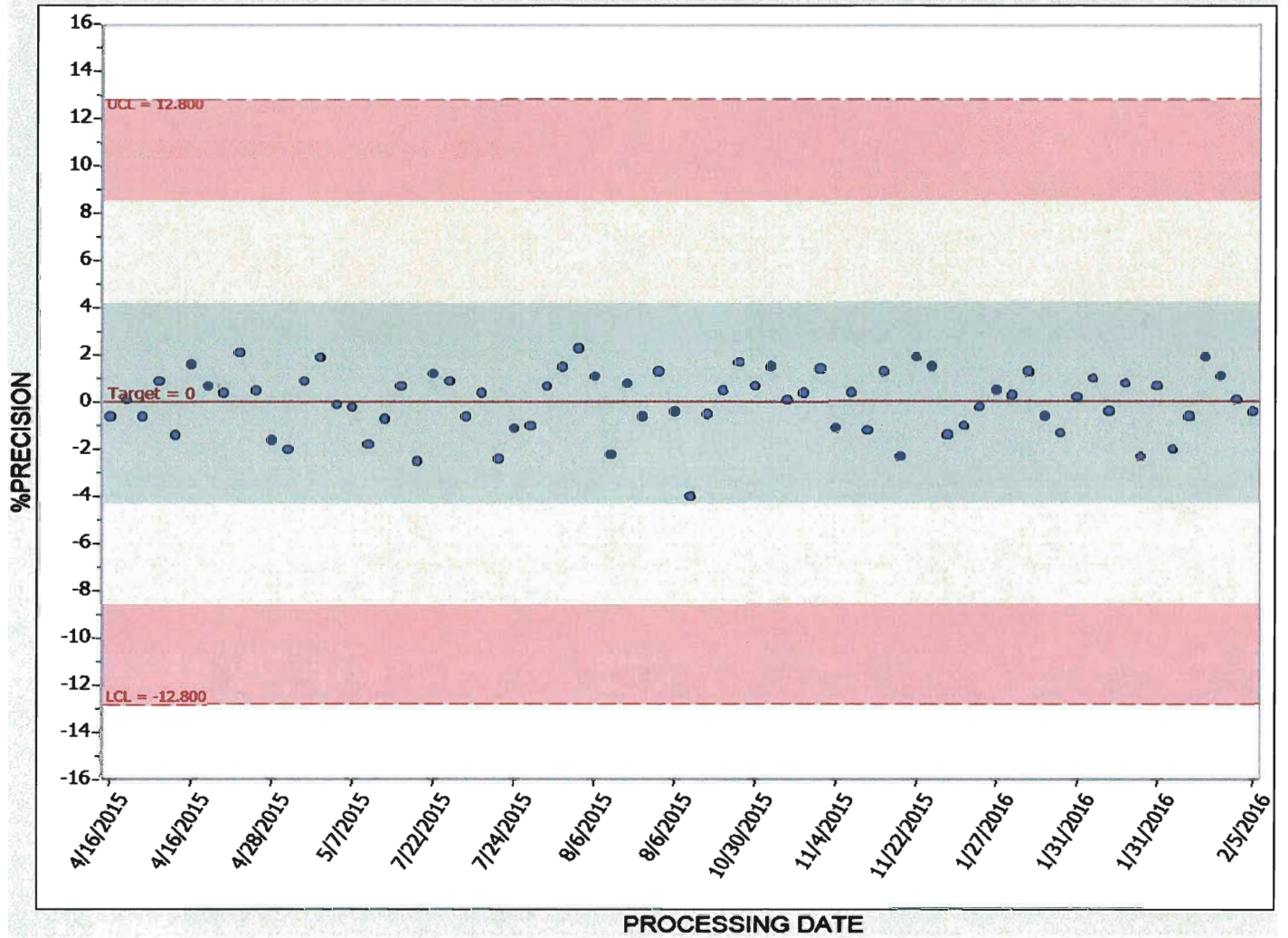
⁽²⁾Blind spike irradiations using Cs-137

APPENDIX A
DOSIMETRY QUALITY CONTROL TRENDING GRAPHS
ISSUE PERIOD JANUARY - DECEMBER 2015

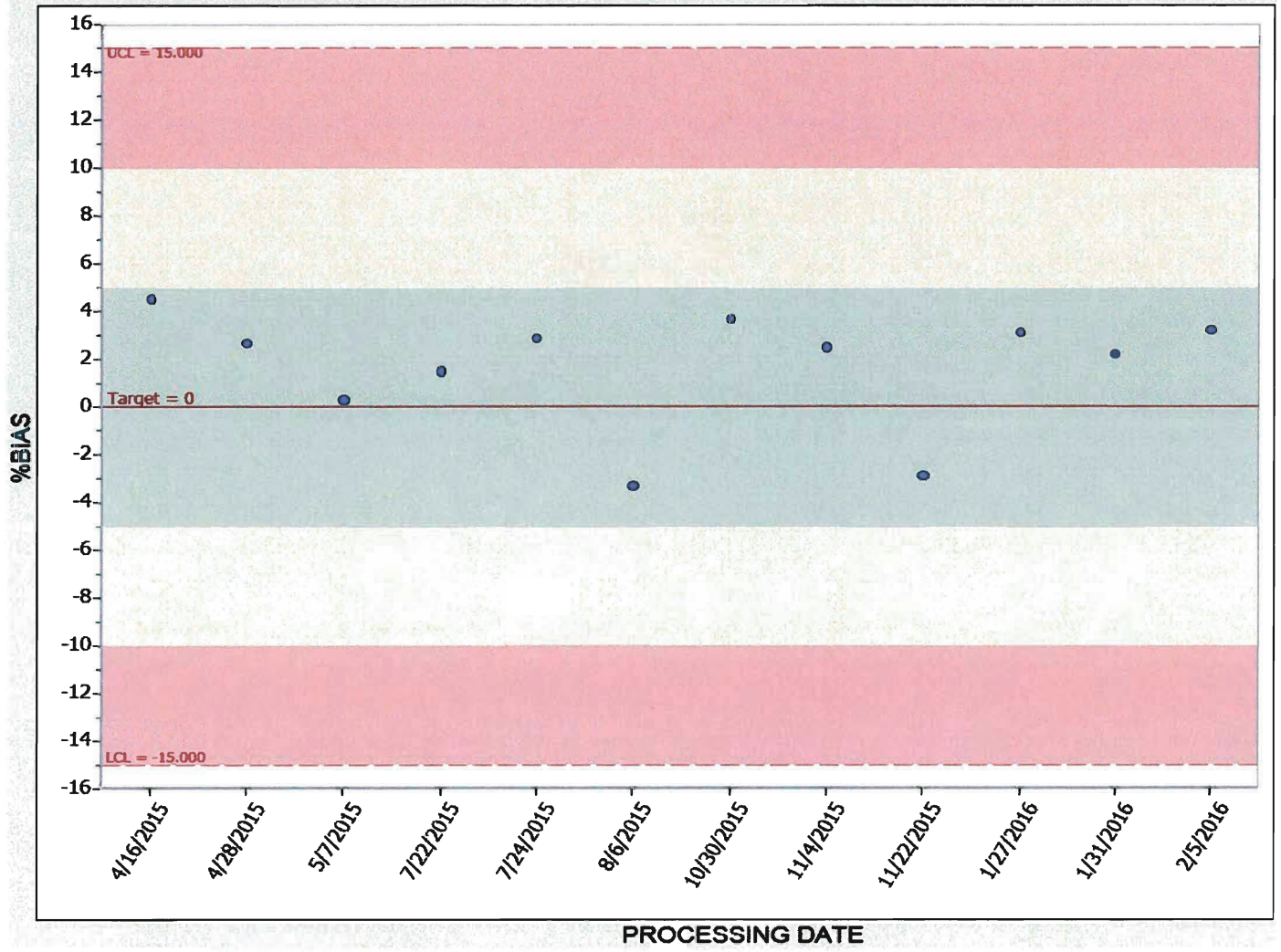
INDIVIDUAL ACCURACY ENVIRONMENTAL
FIGURE 1



INDIVIDUAL PRECISION ENVIRONMENTAL
FIGURE 2



MEAN ACCURACY ENVIRONMENTAL
FIGURE 3



SEABROOK CO-LOCATE ACCURACY
FIGURE 4

