Pacific Gas and Electric Company®

Jon A. Franke
Vice President
Power Generation

P.O. Box 56
Avila Beach, CA 93424

805.545.4888
E-Mail: Jon.Franke@pge.com

July 19, 2018

PG&E Letter HBL-18-008

ATTN: Document Control Desk
U.S Nuclear Regulatory Commission
Washington, DC 20555-0001

Docket No. 50-133, License No. DPR-7
Humboldt Bay Power Plant, Unit 3

Final Status Survey Report for Mobile Emergency Power Plant Station Area (Survey Unit OOL10-04)

References:

1. PG&E Letter HBL-18-001, Revision 12 to the Defueled Safety Analysis Report, Revision 2 of the License Termination Plan, and Revisions 34, 35, and 36 to the Humboldt Bay Quality Assurance Plan, dated February 23, 2018.

2. PG&E Letter HBL-16-008, Request for Partial Release of Humboldt Bay Power Plant Unit 3 Property from the Part 50 Site, dated November 9, 2016.

3. NRC Letter to PG&E, Humboldt Bay Power Plant Unit 3 – Request for Partial Site Release from Part 50 License (CAC No. L53153), dated January 5, 2018.

Dear Commissioners and Staff:

On February 23, 2018, Pacific Gas & Electric (PG&E) submitted PG&E Letter HBL-18-001 (Reference 1), which included Revision 2 of the License Termination Plan (LTP). Section 1.2 of the LTP describes a phased decommissioning approach to accomplish site release for unrestricted use and license termination.

The first phase consisted of a partial site release of an area south of King Salmon Avenue. In Reference 2, PG&E submitted a request for the partial site release of this area. Reference 2 included a Final Status Survey (FSS) Report for the survey units within the area proposed to be released. The release was approved by the NRC in Reference 3.

In the subsequent phases, PG&E will submit FSS Reports for the remaining survey units as they are completed. Upon completion of FSS reports for all survey units, PG&E will request that the remainder of the site be released from the 10 CFR Part 50 license.

The Enclosure to this letter contains the FSS Report for the Mobile Emergency Power Plant Station (MEPPS) area. The FSS Report demonstrates that the aggregate of the radiological data provides sufficient confidence to ensure that the MEPPS area meets the release criteria in accordance with the HBPP Unit 3 LTP. This is based on a review of the design methodology, surveys, and sample results in reference to the site-specific derived concentration guideline level. The FSS Report concludes that the survey units surveyed and sampled during the FSS should be released from further radiological controls. Therefore, the FSS Report supports the regulatory decision to terminate the 10 CFR Part 50 license for the MEPPS area.

PG&E requests that the NRC review the enclosed information and concur that the area meets the LTP release criteria.

There are no new or revised regulatory commitments (as defined in NEI 99-04) made in this letter.

If you have any questions regarding this submittal, please contact Mr. William Barley at (707) 444-0856.

Sincerely,

Jon A. Franke
Vice President, Power Generation

cc: Kriss M. Kennedy, NRC Region IV Administrator
John B. Hickman, NRC Project Manager
HBPP Humboldt Distribution

Enclosure
PG&E Letter HBL-18-008

Humboldt Bay Power Plant Unit 3

Final Status Survey Report
Mobile Emergency Power Plant Station Area

Survey Unit: OOL10-04

Pacific Gas and Electric Company®

HUMBOLDT BAY POWER PLANT
FINAL STATUS SURVEY REPORT
HBPP-FSS-OOL10-04

Final Status Survey Report for Survey Unit:

OOL10-04

Report Prepared by: _____ Date: 5/24/18
Gordon Madison, CHP - FSS Engineer

Technical Review: _____ Date: 5/24/18
Marshall Blake - FSS Engineer

Initial Report Approval: _____ Date: 5/24/18
Kris Rowberry, MHP, AHP - Expert Site Closure Specialist

Final Report Approval: _____ Date: 5/24/18
William Barley, CHP - Site Closure Manager

EXECUTIVE SUMMARY

In accordance with the provisions of the Humboldt Bay License Termination Plan (LTP), Rev. 0 (Ref. 1), Survey Unit OOL10-04 was Final Status Surveyed (FSS) for phased release from the site's 10CFR50 license. This report was prepared as a stand-alone document to demonstrate that the designated survey unit satisfies the radiological release criteria.

The area under consideration consists of an open land area northeast of King Salmon Avenue (southwest of the New Generation Footprint). The area is approximately 2,244 square meters (m^2) in total and is industrialized. Survey Unit OOL10-04 can be described in general as the footprint of the former Mobile Emergency Power Plant Station (MEPPS) and is bordered on the south by survey unit OOL10-15, on the west by Survey Unit OOL10-06, and on the north and east by Survey Unit NFGA-WST. The survey unit was designated as a Class 3 land area per Table 2-3 of the LTP, indicating that the areas were determined to have a low likelihood of having radiological contaminants in excess of the Derived Concentration Guideline Levels (DCGLs).

The surveys performed included a total of fifteen (15) soil samples. Each of the sample locations selected were based on an approved randomized methodology and the locations were confirmed by a high precision Global Positioning System (GPS). The sampling included two (2) split-samples and one (1) sample recount that were taken for quality assurance purposes. The land area (Survey Unit OOL10-04) was also partially walkover scanned with a gamma sensitive instrument probe. No Quality Assurance (QA) related discrepancies were noted that could impact the overall confidence in the results or conclusions of the FSS.

The survey unit walkover scans results found no elevated locations. The sample analysis results indicated that only naturally-occurring isotopes from the Uranium and Thorium decay series were detected. The maximum hypothetical dose, from all sources, including groundwater, to a future resident farmer was determined to be less than 0.20 mrem/yr. The report concludes that this survey unit has met the FSS data quality objectives and meets the regulatory release criteria of less than 25 mrem/yr to the average member of the critical group plus ALARA (As Low As Reasonably Achievable).

Executive Summary Table

Feature	Design Criteria	Comment
Synopsis of OOL10-04		
Survey Unit Land Area	2,244 m^2	Based on AutoCAD
Classification	Class 3	Based on the HBPP LTP, Rev. 0.
Final Status Survey Plan No.	HBPP-FSS-OOL10-04-00	HBPP Procedure RCP FSS-2
Grid Spacing	NA	NA for Class 3 areas
DCGL	7.93 pCi/g(1) Cs-137	Per Table 5-1 of the LTP for soils to achieve 25 mrem/yr Total Effective Dose Equivalent (TEDE)
Scan Survey Area Coverage	Approximately 25%	The LTP requires 1-10% of area coverage for Class 3 survey units
Number of Measurements	15 soil samples (non-parametric test)	14 required per LTP Section 5.3.3.3.1 using Table 5-5 of MARSSIM for relative shift of >3, selected randomly with random start point
Min. Value	-3.80E-02	pCi/g Cs-137
Max. Value	6.01E-02	pCi/g Cs-137
Mean	1.03E-02	pCi/g Cs-137
Median	1.22E-02	pCi/g Cs-137
Std. Dev.	3.27E-02	pCi/g Cs-137
No. of Bias Measurements	2	Judgmental locations selected by FSS Engineer in drainage ditch along south side of access road

Note (1)-pico-curies per gram

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ATTACHMENTS

1.0 INTRODUCTION

This radiological FSS Report documents the radiological status of a portion of the Humboldt Bay Power Plant (i.e., the Site) in Eureka, CA. Presently, the 1000 King Salmon Ave, Eureka, CA site is subject to U.S. NRC Radioactive Materials License No. DPR-7 (Ref. 2) due to its historical use of licensable quantities of radioactive materials. The long-term objective of the licensee, Pacific Gas and Electric Company (PG&E), is to decommission the Site such that it will meet the criteria for unrestricted use as specified in the License Termination Rule at 10 CFR Part 20, Subpart E and to terminate NRC Facility Operating License No. DRP-7. The Site has been undergoing phased decommissioning, and this FSS Report documents the final condition of OOL10-04 in preparation for license termination. This report documents the final radiological status of the former MEPPS area of the site, along with other report submittals, serves collectively to demonstrate that the criteria for unrestricted use have been met, and serves to support the regulatory decision to terminate the license.

1.1 PHASED RELEASE AREA DESCRIPTION

As described in the LTP, the Phase 2 Area for release consists of all remainder of site land areas that are to the north (site east) of King Salmon Avenue. Figure 1 depicts an aerial overview that indicates the extent of the current Phase 1 and Phase 2 Release Areas of the site. This will be changed in a revision to the LTP to stipulate that when an additional phased release is done the Phased Release Area map will be updated.

Figure 1 – Overview of Site Phased Release Area Extents

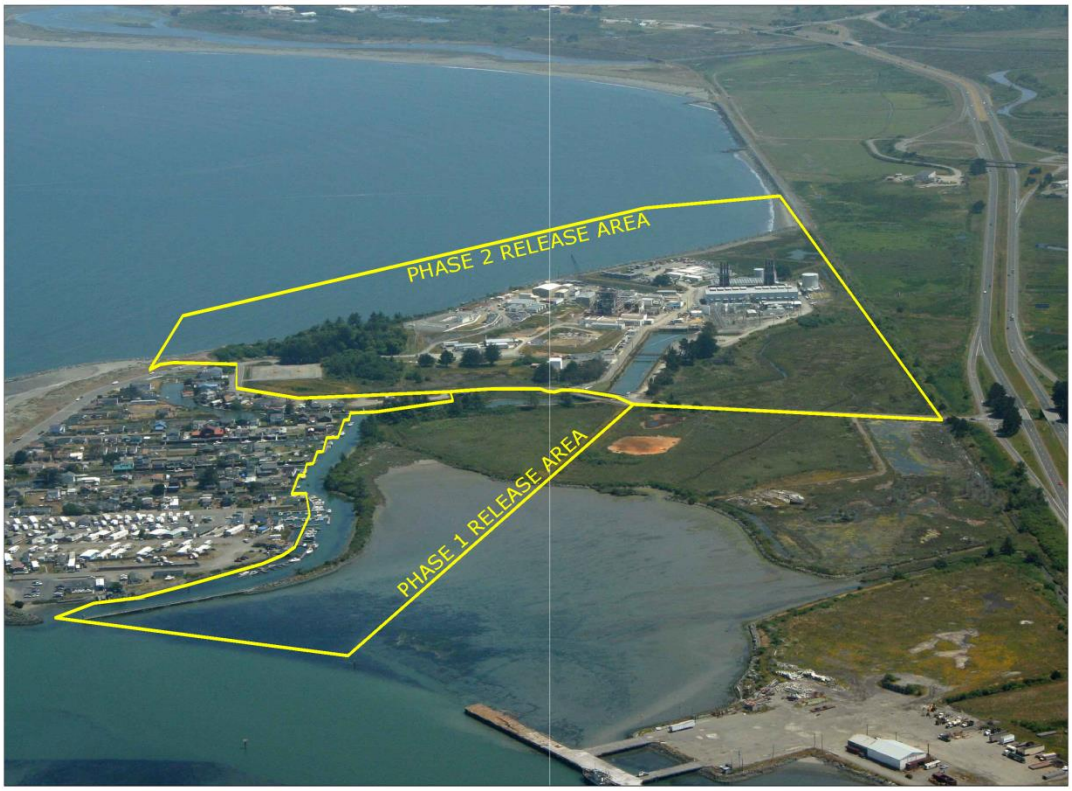


Photo taken June 2011

The Area includes Survey Unit OOL10-04. In the following figures, Figure 2 is an orthogonal aerial photograph of the area. Figure 3 is a ground level picture of the area after backfill facing to the northwest near the south access road. Figure 4 is a map of the Phase 2 Release area.

Figure 2 – Aerial Photo of Survey Unit HBPP-FSS-OOL10-04

Photo taken 6/26/2012

Figure 3 – Photo of backfilled survey unit property facing northwest

Photo taken 11/23/2013

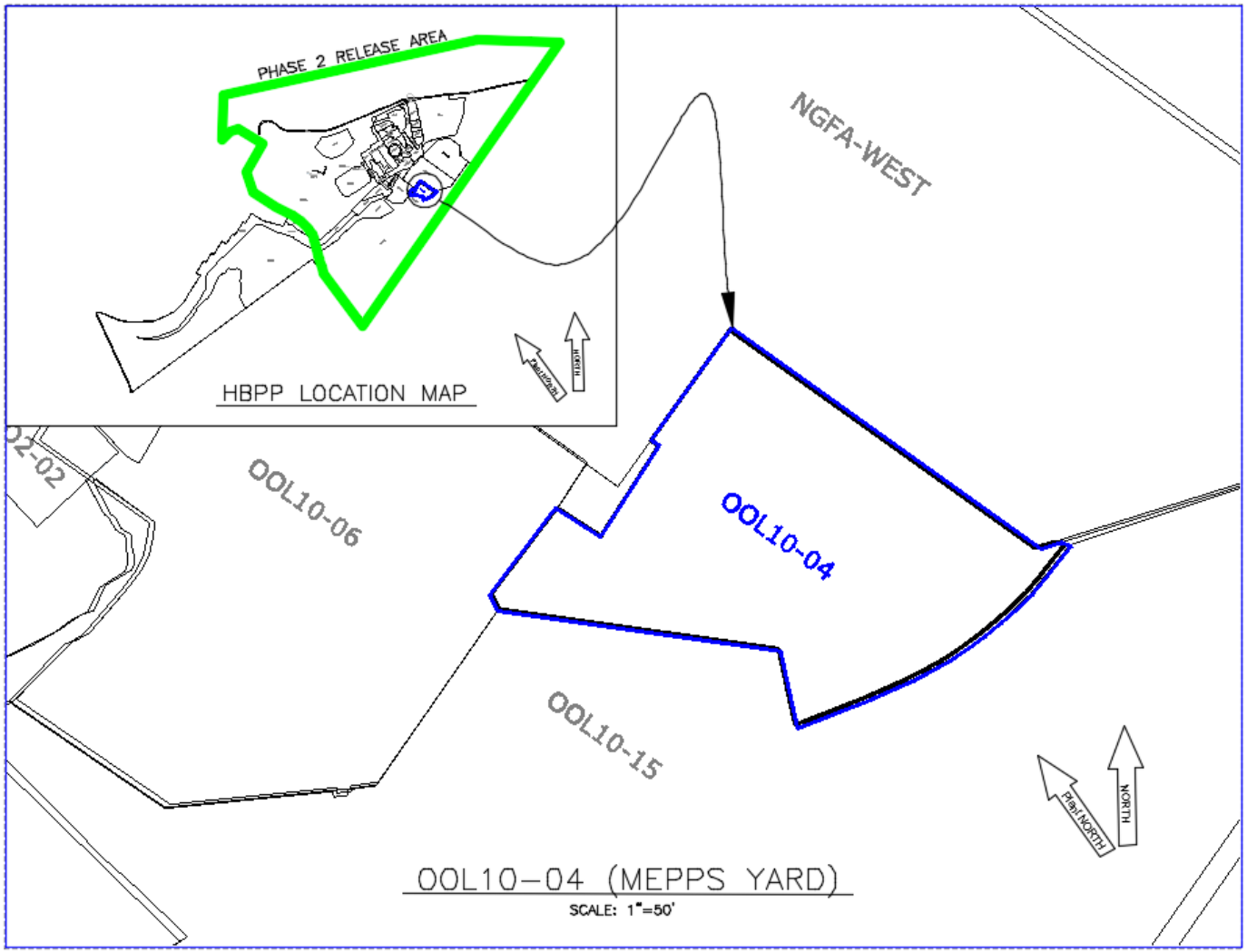
1.2 SURVEY UNIT DESIGNATION

In accordance with Humboldt Bay Power Plant (HBPP) RCP Procedure FSS-1, Survey Unit OOL10-04 is designated as a Class 3 Survey Unit per the HBPP LTP (Ref. 1) and was confirmed by subsequent reviews.

1.3 SURVEY UNIT DESCRIPTION

Survey Unit OOL10-04 (former MEPPS area footprint) is approximately 2,244 m^2 of surface area. The survey unit's boundary abuts Survey Units OOL10-06, OOL10-15 and NGFA-WST (See Figure 4). As mentioned in the FSS plan (Attachment 1), the energized transformer yard was deemed inaccessible due to safety concerns. There were no other areas within or beneath the survey unit that were considered inaccessible, such as process piping or building footers.

Figure 4 – Map of the Phase 2 Release Area



1.3.1 HISTORICAL SITE ASSESSMENT (HSA) EVENTS

Within the HSA, there is no mention of plant-related activities occurring within the boundaries of this Survey Unit.

1.3.2 SCOPING SURVEYS

Scoping Surveys were not performed in this area based on its assessment as a non-industrialized area.

1.3.3 CHARACTERIZATION

Based on a review of the general plant characterization data of the HBPP environs, Cs-137 was the only plant-related radionuclide that was identified consistently in the characterization samples analyzed. Seventy-one (71) samples from previous characterization data were used to provide the characterization data for Survey Area OOL10. The following data was sufficient to support the planning of Survey Unit OOL10-04:

- Cs-137 was present in 72% (51 detects) of the characterization samples.
- No other Easy to Detect (ETD) nuclides were identified > Minimum Detectable Activity (MDA).
- No Hard to Detect (HTD) nuclides were identified in the four samples analyzed.

A more recent (2013) continuing characterization effort collected forty-six (46) randomly located soil samples which were analyzed by gamma spectroscopy. All characterization samples tested less than minimum detection levels for Cs-137. No other plant related isotopes were detected. As a conservative measure the characterization data for OOL10 soils were used to formulate the survey design. An HTD analysis for samples reporting the highest values for plant-related ETD radionuclides (e.g., Cs-137) was not performed as no HTD radionuclides were identified in the four characterization samples analyzed. Based on the low levels of residual radioactivity expected to be present, it is unlikely that any HTD radionuclides, if present, would collectively be identified at levels that were considered significant contributors to dose (i.e., >10% of the release limit).

1.3.4 REMEDIAL ACTION SURVEYS AND ACTIVITIES

No remedial actions or surveys are known to have been performed in this Survey Unit.

2.0 SURVEY UNIT DESIGN INFORMATION

The survey unit was classified in accordance with Procedure RCP FSS-1, "Survey Unit Classification" (Ref. 3). OOL10-04 was classified as a Class 3 survey unit based on the potential to contain residual radioactive material relative to the DCGLs.

Guidance for preparing FSS plans is provided in Procedure RCP FSS-2, "Preparation of Final Status Survey Plans" (Ref. 4). The FSS plan uses an integrated sample design that combines scanning surveys with either random or biased sampling.

2.1 DATA QUALITY OBJECTIVES (DQOS)

FSS design and planning used the Data Quality Objective (DQO) process as described by the LTP, Procedure RCP FSS-2 and the NUREG 1575, *Multi-Agency Radiation Survey and Site*

Investigation Manual (MARSSIM) (Ref. 5). A summary of the main features of the DQO process are provided herein.

The DQO process incorporated hypothesis testing and probabilistic sampling distributions to control decision errors during data analysis. In designing the survey plan, the underlying assumption, or null hypothesis was that residual activity in the survey unit exceeded the release criteria. Rejection of the null hypothesis would indicate that residual activity within the survey unit does not exceed the release criteria.

The primary objective of the FSS plan was to demonstrate that the level of residual radioactivity in Survey Unit OOL10-04 did not exceed the release criteria specified in the LTP and that the potential dose from residual radioactivity is ALARA.

A fundamental precursor to survey design is to establish a relationship between the release criteria and some measurable quantity. This is done through the development of DCGLs. The DCGLs represent average levels of radioactivity above background levels and are presented in terms of surface or mass activity concentrations. Chapter 6 of the LTP describes in detail the modeling used to develop the DCGLs for soil.

The total dose under the LTP criteria is 25 mrem/yr Total Effective Dose Equivalent (TEDE) from all of the potentially present plant-derived nuclides.

2.2 DQOs Regarding Nuclide Selection And DCGLs

Four characterization samples were analyzed by a National Environmental Laboratory Accreditation Program (NELAP) certified off-site laboratory for the HTD nuclides that could be present. There were no HTD nuclides that were positively identified greater than method detection levels in the four samples analyzed. Additionally, during FSS, two soil samples were split and analyzed for the HTD nuclides that are listed in bold in Table 1. It should be noted that the HTD nuclide results for the two FSS soil split samples were all less than their associated a-posteriori Minimum Detectable Concentrations (MDC) (Attachment 2). Table 1 presents the Soil DCGLs per the HBPP LTP. Cs-137, the only nuclide that could potentially be present based on characterization data, was not scaled to account for any HTD nuclides that might be present. However, it has been shown that even for Class 1 areas, the low potential for HTD nuclide dose was considered to be an insignificant contributor to TEDE for the critical exposure group evaluated (i.e., resident farmer). As mentioned previously and evaluated during the FSS planning process, there were no HTD or ETD radionuclides identified. Therefore, the Cs-137 DCGL was not adjusted as an additional conservatism to account for potential dose from HTD radionuclides, as these were not identified.

Table 1 – Soil DCGLs and Analysis Lower Limits of Detection (LLDs)

Radionuclide [1]	Soil DCGL (pCi/g) [2]	LLD (pCi/g) [3] 10% to 50%	
H-3	6.80E+02	6.80E+01	3.40E+02
C-14	6.30E+00	6.30E-01	3.15E+00
Co-60	3.82E+00	3.82E-01	1.91E+00
Ni-59	1.97E+03	1.97E+02	9.85E+02
Ni-63	7.24E+02	7.24E+01	3.62E+02
Sr-90	1.51E+00	1.51E-01	7.55E-01
Nb-94	7.13E+00	7.13E-01	3.57E+00
Tc-99	1.24E+01	1.24E+00	6.20E+00
Cs-137	7.93E+00	7.93E-01	3.97E+00
Eu-152	1.01E+01	1.01E+00	5.05E+00
Eu-154	9.40E+00	9.40E-01	4.70E+00
Np-237	1.11E+00	1.11E-01	5.55E-01
Pu-238	2.97E+01	2.97E+00	1.49E+01
Pu-239/240 [5]	2.67E+01	2.67E+00	1.34E+01
Am-241 [4]	2.58E+01	2.58E+00	1.29E+01
Pu-241	8.61E+02	8.61E+01	4.31E+02
Cm-243/244[5]	2.90E+01	2.90E+00	1.45E+01
Cm-245/246[5]	1.78E+01	1.78E+00	8.90E+00

(1) Bold text indicates radionuclides that are considered Hard to Detect (HTD)

(2) The Soil DCGL(s) are specified by the LTP in Chapter 6 and are equivalent to twenty-five (25) mrem/yr TEDE.

(3) The required LLD is between 10% to 50% of the Soil DCGL.

(4) Americium-241 can be analyzed by gamma and alpha spectroscopy and is considered to be Easy to Detect (ETD). The preferred result is the alpha spectroscopy's when both analyses are performed.

(5) For radiochemical analyses whose results cannot discern between two isotopes, i.e. Pu-239/240, Cm-243/244 and Cm-245/246, the lower of the two DCGLs was selected from the LTP.

Another important facet of the DQO process is to identify the radionuclides of concern and determine the concentration and variability.

As part of the DQOs applied to laboratory processes, analysis results were reported as actual calculated results. Sample report summaries included unique sample identification, analytical method, radionuclide, result, and uncertainty to two (2) standard deviations, laboratory data qualifiers, units, and the required and observed MDC.

2.2.1 SURVEY APPROACH/METHODS

The prescribed survey approach for Class 3 land areas consisted of soil collection of statistically random locations and walk-over scanning of biasedly selected areas with a 2" x 2" Thallium-activated Sodium Iodide (NaI(Tl)) scintillation detector. Additionally, all direct non-parametric and biased soil sample locations were accessed.

2.2.2 NUMBER OF SAMPLES AND MEASUREMENTS

The DQO process determined that Cs-137 is the radionuclide of concern in the survey unit. Other radionuclides (if present) that were positively identified in concentrations greater than the screening criteria during the performance of this FSS would be evaluated to ensure adequate survey design. With the exception of Cs-137, no other plant-derived radionuclides were identified in the survey unit direct soil samples analyzed in the onsite and offsite laboratories, indicating that the survey design was adequate.

The Sign Test was selected as the non-parametric statistical test. The use of the Sign Test did not require the selection or use of a background reference area, which simplified survey design and implementation. This approach was conservative since it included background Cs-137 as part of the sample set.

The minimum number of soil samples for FSS was determined in accordance with Procedure RCP FSS-7, "Determination of the Number and Location of FSS Samples" (Ref. 6). The Lower Bound of the Gray Region (LBGR) was set in accordance with Procedure RCP FSS-7 to achieve a relative shift (Δ/σ) in the range of 1 and 3. The resulting relative shift corresponded to an LBGR of 7.57 pCi/g Cs-137.

A Prospective Power Curve was generated with these settings using MARSSIM Power 2000 (Ref. 7) and is provided in the survey plan (Attachment 1). MARSSIM Power 2000 is a software package developed under the sponsorship of the United States Department of Energy (DOE) Environmental Measurement Laboratory. The results of the a posteriori (retrospective) computer run showed adequate power for the survey design. This indicates that the survey area had a high probability of rejecting the null hypothesis, assuming that the characterization data are representative of the FSS results. The retrospective power curve is provided in Attachment 4.

The grid pattern and locations of the soil samples were determined using Visual Sample Plan (VSP) in accordance with Procedure RCP FSS-18, "Computer Determination of Number and Locations of FSS Samples" (Ref. 8) Visual Sample Plan was created by Pacific Northwest National Laboratory (PNNL) for the DOE (Ref. 9). A random sampling pattern with a random starting point was selected for sample design, which is appropriate for a Class 3 area.

Sample locations were identified using AutoCAD, a commercially available plotting software package with coordinates consistent with the California State Plane System. These coordinates were integrated with a GPS to locate sample locations in the field. Sample Measurement Locations for the design are listed with the GPS coordinates in Table 2.

Table 2 – Sample Measurement Locations with Associated GPS Coordinates

Designation	Easting	Northing
OOL10-04-001-F	5949680.79	2160777.96
OOL10-04-002-F	5949738.95	2160752.13
OOL10-04-003-F	5949629.10	2160749.78
OOL10-04-004-F	5949704.49	2160742.73
OOL10-04-005-F	5949626.95	2160730.99
OOL10-04-006-F	5949652.79	2160721.60
OOL10-04-007-F	5949749.72	2160714.55
OOL10-04-008-F	5949594.64	2160707.51
OOL10-04-009-F	5949756.18	2160700.46
OOL10-04-010-F	5949646.33	2160693.41
OOL10-04-011-F	5949601.10	2160688.72
OOL10-04-012-F	5949566.64	2160679.32
OOL10-04-013-F	5949695.87	2160667.58
OOL10-04-014-F	5949663.56	2160665.23
OOL10-04-015-F	5949721.72	2160658.19
OOL10-04-016-F-B	5949709.13	2160632.21
OOL10-04-017-F-B	5949732.62	2160640.95

NOTE: See Posting Plot in Attachment 4 for corresponding map of these sample locations.

Procedure RCP FSS-2 specifies that 5% of the samples are required to be selected for HTD analysis. Two (2) soil samples or greater than 5% (i.e., 13%) of the number of samples that would be used for non-parametric statistical testing were randomly selected for HTD radionuclide analyses using the Microsoft Excel "RAND" function. Each of the selected samples were sent off-site for a full suite analysis of the HTD radionuclides specified in Table 1.

The LTP requires a minimum of 5% of the samples taken for non-parametric statistical testing be selected for split sample analyses with the off-site laboratory. The implementation of quality control measures as referenced by Procedure RCP FSS-11, "Split Sample Assessment for Final Status Survey," (Ref. 10) included the collection of two (2) soil samples for "split sample" analysis by the off-site laboratory. These locations were selected randomly using the Microsoft

Excel "RAND" function. Additionally, Procedure HBAP C-202, "Final Status Survey Quality Assurance Project Plan" (Ref. 11) requires that 5% of the samples taken for non-parametric statistical testing be selected for QC Replicate analyses.

Table 5-4 of the LTP specifies scanning coverage of "Judgmental" 1-10% for Class 3 areas. A variance from this requirement was taken as noted. Table 3 provides a synopsis of the survey design.

Table 3 – Synopsis of the Survey Design

Feature	Design Criteria	Basis
Survey Unit Land Area	2,244 m^2	Based on AutoCAD
Number of Measurements	15 required (15 Randomly selected)	Type 1 and Type 2 errors were 0.05, sigma was 0.18 pCi/g, the LBGR was set at 7.57 pCi/g to achieve a Relative Shift in the range of 1 and 3 (Δ/σ=2.0)
Grid Spacing	NA	NA for Class 3 areas
Design DCGL	7.93 pCi/g Cs-137	To achieve 25 mrem/yr TEDE
Soil Investigation Level	3.97 pCi/g Cs-137	>50% of the Cs-137 DCGL from investigation criteria provided from Table 5-5 of the LTP for a Class 3 survey unit.
Scan Survey Area Coverage	Approximately 25%	Table 5-4 of the LTP requires judgmental 1- 10% coverage area for Class 3 survey units
Scan Investigation Level	Discernable and reproducible audible indication of activity above background	Detectable above background, Per Table 5-5 of the LTP for Class 3 Survey Units.

3.0 SURVEY RESULTS

Final Status Survey field activities were conducted under FSS Plan HBPP-FSS-OOL10-04-00. The preparations for work included a detailed review of the FSS Plan, job safety analysis, job planning checklist and related procedures for reference. Daily briefings were conducted to discuss the expectations for job performance and the safety aspects of the survey. The Daily Survey Journal was used to document field activities and other information pertaining to the FSS. All field survey activities were performed on November 6, 2013. Sample measurement locations using GPS coordinates were identified in the 1983 North American Datum (NAD) coordinate system.

3.1 SAMPLE MEASUREMENTS RESULTS

Each of the fifteen (15) samples collected for non-parametric statistical testing were analyzed by gamma spectroscopy at the on-site laboratory. All samples obtained during the FSS of OOL10-04 were collected using Procedure FSS-8, "Collection of Site Characterization and Final Status Survey Samples" (Ref. 12). In addition, two of the samples were split in the field and analyzed for each of the nuclides in the FSS nuclide suite. The off-site laboratory employed for the radiological analyses of samples was General Engineering Laboratories, LLC (GEL), located in Charleston, South Carolina. GEL processed two (2) samples for HTD analyses as required by the sample plan. The requested analyses included alpha spectroscopy, gas proportional counting, and liquid scintillation depending on the radionuclide and the measurement method. All analyses performed met the required minimum MDC. Neither of these two split samples tested positive for Cs-137 or other plant-derived nuclides (Attachment 2).

Gamma spectroscopy analysis was performed to the required MDCs. A results summary for samples collected for non-parametric statistical testing is provided in Table 4. Additionally, while not considered in the non-parametric statistical evaluation of compliance with the release criteria, two biased samples were collected as mentioned earlier in this report and analyzed using gamma spectroscopy. A summary of these two samples is provided in Table 5. As described in the LTP, biased measurements are performed at locations selected using professional judgment based on unusual appearance, location relative to known contaminated areas, high potential for residual radioactivity, general supplemental information, etc. Judgmental measurements are not included in the statistical evaluation of the survey unit data because they are not randomly selected, independent measurements. Instead, judgmental measurement results are individually compared to the DCGL. No plant-derived isotopes were positively detected in the randomly selected non-parametric samples or the two biased samples analyzed by the on-site laboratory. The on-site laboratory gamma results summary is provided in Attachment 3.

As none of the non-parametric or the biased samples contained activity levels exceeding the investigation levels for soil samples (i.e., 50% of the DGCL), no soil investigations were warranted for Survey Unit OOL10-04.

Table 4 – Summary of Randomly Selected Soil Sample Results

Sample Number	Cs-137 pCi/g[(1)]	Fraction of DCGL
OOL10-04-001-F	4.77E-02	6.02E-03
OOL10-04-002-F	-7.70E-03	-9.71E-04
OOL10-04-003-F	1.22E-02	1.54E-03
OOL10-04-004-F	-3.62E-02	-4.56E-03
OOL10-04-005-F	4.13E-02	5.21E-03
OOL10-04-006-F	-2.56E-02	-3.23E-03
OOL10-04-007-F	-3.80E-02	-4.79E-03
OOL10-04-008-F	4.36E-02	5.50E-03
OOL10-04-009-F	1.84E-02	2.32E-03
OOL10-04-010-F	5.39E-03	6.80E-04
OOL10-04-011-F	4.75E-02	5.99E-03
OOL10-04-012-F	6.01E-02	7.58E-03
OOL10-04-013-F	-2.08E-02	-2.62E-03
OOL10-04-014-F	-1.03E-02	-1.30E-03
OOL10-04-015-F	1.71E-02	2.16E-03

Table 5 – Summary of Biased Soil Sample Results

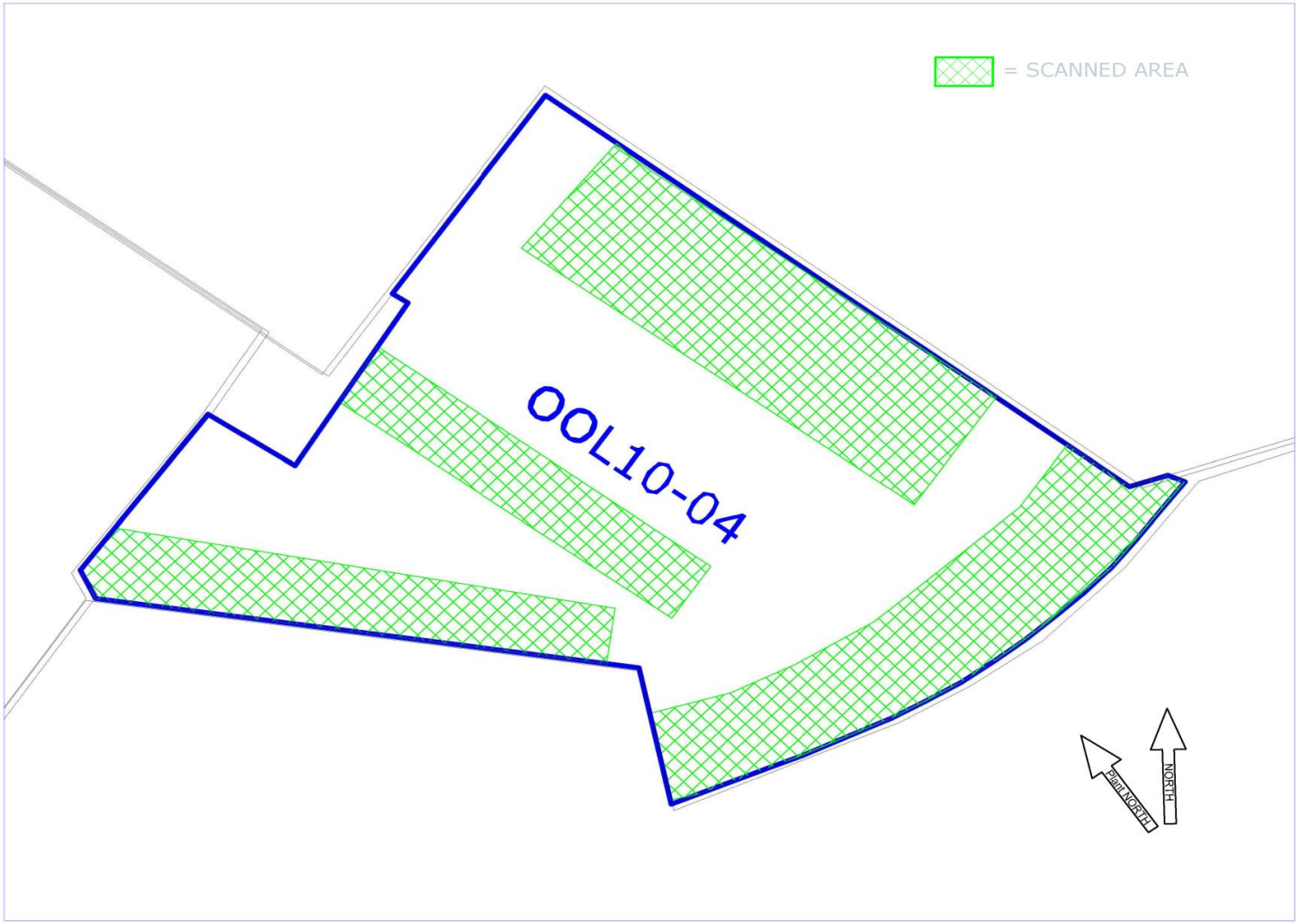
Sample Number	Cs-137 pCi/g[(1)]	Fraction of DCGL
OOL10-04-016-F-B	5.06E-02	6.38E-03
OOL10-04-017-F-B	1.06E-01	1.34E-02

Note (1) - All Cs-137 results listed were less than MDA.

3.2 SCAN SUMMARY

Approximately 25% of the open land surfaces of survey unit OOL10-04 were scanned during the FSS. No scanned locations were noted that exceeded the LTP investigation criteria of detectable over background. Therefore no scan investigations were performed. A map of the OOL10-04 Footprint Survey Scanned Area is provided in Figure 5. The completed scan survey can be reviewed in Attachment 3.

Figure 5 – Survey Unit OOL10-04 Footprint Survey Scanned Area



4.0 SURVEY UNIT DATA ASSESSMENT

4.1 STATISTICAL EVALUATIONS

The DQO sample design and data were reviewed in accordance with Procedure RCP FSS-14, "Data Quality Assessment" (Ref. 13) for completeness and consistency. The sampling design had adequate power as indicated by the Retrospective Power Curve. The Sign Test was performed (by inspection) on the data and compared to the original assumptions of the DQOs. The evaluation of the Sign Test results demonstrates that the survey unit passes the unrestricted release criteria, thus, the null hypothesis is rejected.

Survey documentation was complete and legible. Surveys and sample collection were consistent with the DQOs and were sufficient to ensure that the survey unit was properly designated as Class 3.

The final data review consisted of calculating basic statistical quantities (e.g., mean, median, standard deviation). The mean and median values are well below the Operational DCGL. Also, the retrospective power curve shows that a sufficient number of samples were collected to achieve the desired power. Therefore, the survey unit meets the unrestricted release criteria with adequate power as required by the DQOs. The basic statistical quantities for the statistical sample population are provided below in Table 6.

Table 6 – Basic Statistical Quantities

Statistic	Cs-137 pCi/g	Fraction of the DCGL
Minimum Value:	-3.80E-02	-4.79E-03
Maximum Value:	6.01E-02	7.58E-03
Mean:	1.03E-02	1.30E-03
Median:	1.22E-02	1.54E-03
Standard Deviation:	3.27E-02	4.12E-03

The range of the data is approximately 3 standard deviations. The difference between the mean and median was about 5.78% of the standard deviation which indicates limited skewness in the data. The data was represented graphically through posting plots, a frequency plot, and a quantile plot. The frequency plot indicates a slight negative skewness as confirmed by the calculated skew of -0.02, indicating a nearly normal distribution.

All measurements were non-detects (i.e., no plant-derived radionuclides indicated above MDA). The sign test was not needed to formerly evaluate the data regarding the conclusion that the survey unit meets the release criteria as all direct measurement result values were less than the Cs-137 DCGL. Since the sign test is passed if none of the data values exceed the DCGL, performing the test is unnecessary as it is passed by inspection.

4.2 GRAPHICAL EVALUATIONS

The data, assessments, and graphical representations are provided in Attachment 4.

4.3 SURVEY UNIT INVESTIGATIONS AND RESULTS

As noted previously, no investigations were performed for Survey Unit OOL10-04.

4.4 CHANGES IN INITIAL SURVEY UNIT ASSUMPTIONS

None of the initial assumptions were changed or challenged as a result of information gained in the performance of the FSS survey or in reviewing its results.

The calculation of the number of samples required for the sign test is given by Equation 1 below.

$$N = \frac{\left(Z_{1-\alpha}+Z_{1-\beta}\right)^2}{4(Sign\ p-0.5)^2} \qquad (\textbf{\textit{Equation 1}})$$

Where, N is the number of samples required to perform the sign test. The number of samples is determined for a given α and β error at a specified value for the relative shift. The relative shift determines the value of *Sign p*.

The MARSSIM guidance recommends that this number be increased by at least 20% to ensure sufficient power of the test and to allow for possible data losses.

5.0 DATA QUALITY ASSURANCE

An important aspect of any survey or sampling evolution is the effort made to assure the quality of data collected. It is critical to assure the quality of the data through quality checks and controls, calibrations, and training. The purpose of data quality assurance (DQA) is to evaluate the data collected from the field in light of its intended use in decision making.

Quality checks and controls were designed into the FSS to ensure adequate data quality. Quality Control (QC) measurements were designed to provide a means of assessing the quality of the data set as a whole and demonstrate that measurement results had the required precision and were sufficiently free of errors to accurately represent the residual radiological conditions in the soils of the various survey units within the potentially impacted areas. The DQA uses guidance from MARSSIM and professional judgment.

The calibration and efficiency curves, calibration source certificates, as well as other documentation relating to the calibration of the on-site gamma spectroscopy system are presented in Attachment 6. A QA check of the on-site gamma spectroscopy system for both energy and efficiency parameters was performed daily, prior to counting operations. This was achieved by using a National Institute of Standards and Technology (NIST) traceable multi-line standard calibration source in a comparable geometry (with a volumetric equivalent density) as the samples to be counted. The QA checks performed on the gamma spectroscopy system verify that the system parameters have not changed such that the energy and efficiency calibrations are

still valid. This was accomplished by tracking peak location from a low-energy peak (59 kilo-electron volts [keV]) and a high-energy peak (1,332 keV) from a calibration source (to indicate a problem relative to the energy calibration), peak energy resolution (full width at half maximum [FWHM]) (indicate a problem relative to the energy shape calibration), and decay corrected activity (indicate a problem relative to the efficiency calibration). Examination of this data concludes that the gamma spectroscopy system was functioning correctly during FSS. A check of the gamma spectroscopy system QA Background measurements (in units of cps) covering the significant time periods when FSS sample analysis occurred showed no issues related to instrument background prior to FSS sample analysis. Coupled with the gamma spectroscopy system's source check QA measurements, the measured background data presents additional evidence of the gamma spectroscopy system's stability. The Background and Source Check QA Last Results Reports are provided in Attachment 6.

An internal QC method used to assess the accuracy and precision with laboratory measurements of volumetric soil media is to perform split sample and laboratory replicate (recount) measurement comparisons analyzed with the onsite gamma spectroscopy system, using the naturally occurring radioactive material (NORM) activity levels which are present in every soil sample. The split sample and laboratory recount measurement Cs-137 results are very low compared to its corresponding DCGL, either at or below the detection capability of the instrument in all instances. MARSSIM states that "Determining precision by replicating measurements with results at or near the detection limit of the measurement system is not recommended because the measurement uncertainty is usually greater than the desired level of precision." Since several NORM nuclides are routinely identified during analysis of the FSS volumetric soil samples, a good test of accuracy and precision for a particular analytical program is to compare the detected radionuclide results for the samples homogenized and split from a single sample location, laboratory recounts of the same sample, and third party analysis of split samples. This comparison method provides a more realistic view of the detection capability of the analytical method. Since there is much less uncertainty with a detected result that may be more than several times its detection threshold than a result near or less than its detection level, it is reasonable and appropriate to evaluate the accuracy and precision data quality indicators using quantifiable radionuclide concentrations.

Direct soil measurement results are subjected to a focused DQA prior to using the data in FSS activities. The results are evaluated for precision, accuracy, representativeness, completeness, and comparability; the appropriate data qualifiers are applied to the data set. QC checks and measurements performed are described in the FSS Plan for Survey Unit OOL10-04 in Attachment 1.

To provide an assessment of precision, a measurement of the repeatability of a measurement or measurement technique was performed by the on-site analytical laboratory by performing a recount gamma analysis on sample OOL10-04-011-F (as OOL10-04-011-F-RC) and performing a comparison to the original count using the split sample assessment method described in HBPP Procedure RCP FSS-11, "Split Sample Assessment for Final Status Survey" (Ref. 10). No DQA issues were noted during the comparison evaluation. The recount sample results were within the expected tolerance for the analysis, providing additional evidence that the sample preparation and measurement processes were precise (Attachment 4).

To provide an assessment of accuracy, the degree to which a measurement technique or method can reflect a known value or be compared to a known value or standard, QC measurements in the form of split sample analysis (in the form of duplicate sampling) were performed. As a QC metric for split samples, two samples (OOL10-04-001-F and OOL10-04-015-F) were collected and analyzed by the on-site gamma laboratory and the corresponding split samples were analyzed by the off-site analytical laboratory (as OOL10-04-001-F-S and OOL10-04-015-F-S). The inter-laboratory comparison was evaluated using the split sample assessment method previously described. No DQA issues were noted during the split sample comparison evaluation. The split sample results were within the expected tolerance for the analysis, providing additional evidence that the sample preparation and measurement processes were accurate (Attachment 4).

To provide an assessment of representativeness, the degree to which a data set is actually a sample of a population the survey was designed to produce a random sample allocation distribution that ensured DQOs were met. The sample locations identified using VSP meet the survey design DQOs and are considered to be representative of the conditions for Site soils in the survey area. No DQA issues regarding analytical or measurement effects (e.g., holding times or compositing effects) were noted during the data evaluation process that suggest that representativeness was affected.

To provide an assessment of completeness, the ability of the data set to encompass the entirety of the target system, a minimum of 12 volumetric soil samples from the survey unit were planned, as classified according to area contamination potential. Using guidance provided in Section 5 of the MARSSIM, as a contingency, the minimum sample size specified was increased by 20% to accommodate the possibility that some data might be lost, unusable, or otherwise incomplete. A total of 15 (not including QC split samples) volumetric soil samples were actually collected from the survey unit. There were no DQA issues regarding completeness as greater than the minimum number of samples were collected for the survey unit.

To provide an assessment of comparability, the degree to which a data set, or single datum, can be compared to another measurement for purposes of assessing change over time, or other dynamic conditions, sampling procedures and protocols were used throughout the FSS process for the impacted Site area described in this report. There were no DQA issues regarding comparability as no critical deviation from procedures and protocols was encountered.

5.1 CORRECTIVE ACTIONS

No corrective actions were warranted during the performance and subsequent evaluation of FSS Survey Unit OOL-10-04. It should be noted that a review of the periodic surveillance survey process was performed for the Humboldt Bay Generating Station (HBGS) areas that had undergone FSS. As a result of the review, an improvement item (documented in Systems Application and Products Notification (SAPN) 1303139) was identified to the periodic surveillance survey program to designate exempt survey units that have undergone successful FSS which are covered by an engineered surface or protective barrier (e.g., asphalt, concrete, or compacted backfill). Since OOL10-04 has been backfilled and covered by an engineered surface it has been designated as an exempt area by the Site Closure Manager. Therefore, area periodic surveillance is not required for OOL10-04. Additionally, an FSS was not conducted over the backfilled survey unit as it exists in the final site restoration condition which supports the HBGS as all materials used to restore this area originated from off site and did not contain any HBPP-

derived radionuclides. It should also be noted that there were no remedial actions performed in or proximal to any adjacent survey units which could compromise the isolation and control measures established for the area which includes a fence that separates the HBGS portion from the HBPP side.

5.2 QUALITY VERIFICATION

There were no quality verification assessments that were performed on survey unit OOL10-04.

6.0 ALARA STATEMENT

The cost benefit analysis indicates that residual radioactivity in soils at the Site has been reduced to concentrations that are ALARA. A Generic ALARA Statement has been prepared to demonstrate that it is not ALARA to further remediate soil at levels below the DCGL. The analysis shows that shipping affected soil to a low-level waste disposal facility is not cost effective for unrestricted release. Therefore by demonstrating that the rest of the decision criteria have been met, also demonstrates that the level of residual radioactivity is ALARA without taking additional remedial action. The decision rules, having been derived from the dose-based radiological criteria for unrestricted release, ensure that residual radioactivity in soils on the site will not pose an unacceptable radiological risk to humans under any reasonable and foreseeable future use or occupancy (Attachment 5).

7.0 SUMMARY AND CONCLUSIONS

This report demonstrates that FSS Survey Unit OOL10-04 has met the release requirements associated with the DCGLs listed in the HBPP LTP. Additionally, the data show that the ALARA criteria for soils as specified in Chapter 4 of the HBPP LTP were achieved.

All identified radionuclides of concern were used for statistical testing to determine the adequacy of the survey unit for FSS. Although it is not required to demonstrate compliance with the release criteria, the sample data passed the Sign Test and the null hypothesis was rejected. The survey unit was properly designated as Class 3.

The hypothetical dose contribution from soil for Survey Unit OOL10-04 was determined to be less than 0.04 mrem/yr. This value is the TEDE based on the average concentration of the samples used for non-parametric statistical sampling. To uphold the commitments in License Amendment No. 40 to DPR 7, periodic surveillance surveys are performed for survey units that have undergone FSS to ensure adequate isolation controls are being maintained to preclude recontamination from Unit 3 decommissioning activities in accordance with HBPP Procedure RCP C-220, “Cross Contamination Prevention Plan” (Ref. 14). As discussed earlier in Section 5.1 of this report, OOL10-04 is exempt from periodic surveillance surveys since an engineered surface barrier has been applied. However, in the event that isolation and control measures established for this area are compromised, a survey on the backfilled area may be warranted as a supplement of a documented evaluation to confirm that no HBPP plant-derived radioactive material has been introduced in the area that could jeopardize FSS results, or change conclusions.

On the basis of the analysis presented in this report, FSS data demonstrates that the subject area associated with potentially impacted areas has met the decision criteria, specifically:

- No unexpected results or trends are evident in the data.

- The sampling and survey results demonstrate that soil residual radioactivity in the potentially impacted areas is very minimal, and essentially indistinguishable from background.
- The data quality is judged to be adequate for its intended purpose.
- The amount of data collected from each survey unit is adequate to provide the required statistical confidence needed to decide that the DCGLs were met.
- The retrospective power of the sign test, used to judge compliance, was almost 100%.

Thus, the null hypothesis that residual radioactivity in the survey unit exits in concentrations above the applicable DCGLs should be rejected for the survey unit in the potentially impacted area. The area surveyed and sampled for OOL10-04 should be released from further radiological controls. Therefore, this FSS Report submittal supports the regulatory decision to terminate the license following completion of all FSS report submittals for the site.

8.0 REFERENCES

1 Humboldt Bay Power Plant License Termination Plan, Rev. 0 Submitted, May, 2013.

2 NRC Docket No. 50-133, Humboldt Bay Power Plant, Unit No. 3 Facility License DPR-7, As Amended.

3 HBPP Procedure RCP FSS-1, "Survey Unit Classification", Rev 0C, September 11, 2013.

4 HBPP Procedure RCP FSS-2, "Preparation of FSS Plans", Rev. 0D, September 11, 2013.

5 NUREG 1575 *Multi Agency Radiation Site Survey and Investigation Manual*, (MARSSIM), USNRC Rev. 1 August 2000.

6 HBPP Procedure RCP FSS-7, "Determination of the Number and Location of FSS Samples" Rev. 0C, September 11, 2013.

7 MARSSIM Power 2000 software, V. 1.0.0 Environmental Measurements Laboratory, US Department of Energy, December 2000.

8 HBPP Procedure RCP FSS-18, "Computer Determination of Number and Locations of FSS Samples", Rev. 0C, September 11, 2013.

9 VSP Development Team (2014). *Visual Sample Plan: A Tool for Design and Analysis of Environmental Sampling*, Version 6.2d, Pacific Northwest National Laboratory. Richland, WA. http://vsp.pnnl.gov.

10 HBPP Procedure RCP FSS-11, "Split Sample Assessment for Final Status Survey" Rev. 0C, September 11, 2013.

11 HBPP Procedure HBAP C-202, "Final Status Survey Quality Assurance Project Plan" Rev. 1, December 7, 2012.

12 HBPP Procedure FSS-8, "Collection of Site Characterization and Final Status Survey Samples" Rev 1D, September 11, 2013.

13 HBPP Procedure RCP FSS-14, "Data Quality Assessment" Rev. 0C, September 11, 2013.

14 HBPP Procedure C-220, "Cross Contamination Prevention and Monitoring Plan" Rev 1B, February 11, 2016.

LIST OF ACRONYMS AND ABBREVIATIONS

ALARA	As Low As Reasonably Achievable
DCGL	Derived concentration guideline level, the radionuclide specific activity concentration that corresponds to the release criterion (25 mrem/y) within a survey unit
DOE	United States Department of Energy
DQA	Data Quality Assurance
DQO	Data Quality Objectives
ETD	easy to detect
FSS	Final Status Survey
GEL	General Engineering Laboratories, LLC
GPS	global positioning system
HBGS	Humboldt Bay Generating Station
HBPP	Humboldt Bay Power Plant
HSA	Historical Site Assessment
HTD	hard to detect (for this purpose, nuclides that are not detectable by gamma analysis)
keV	kilo-electron volts
LBGR	lower bound of the gray region
LTP	License Termination Plan
m^2	meter(s) squared
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MEPPS	Mobile Emergency Power Plant Station
MDA	minimum detectable activity
MDC	minimum detectable concentration

NAD	North American Datum
NaI (Tl)	Thallium-activated sodium iodide gamma scintillation detector
NELAP	National Environmental Laboratory Accreditation Program
NIST	National Institute of Standards and Technology
NORM	naturally occurring radioactive material
NRC	Nuclear Regulatory Commission
pCi/g	picocuries per gram
PG&E	Pacific Gas and Electric Company
QA	quality assurance
QC	quality control
SAPN	Systems Application and Products Notification
TEDE	total effective dose equivalent
TRU	transuranic
VSP	Visual Sample Plan computer program

Attachment 1

Survey Plan

Final Status Survey Planning Worksheet
Page 1 of 14

GENERAL SECTION

Survey Area No: OOL10	Survey Unit No: 04

Survey Unit Name: Mobile Electric Power Plant Area

Final Status Survey Number: HBPP-FSS-OOL10-04-**00**

PREPARATION FOR FINAL STATUS SURVEY ACTIVITIES

Check marks in the boxes below signify affirmative responses and completion of the action.

1.1 Files have been established for survey unit FSS records. Yes ☑ No ☐ N/A ☐

1.2 ALARA review has been completed for the survey unit. Yes ☑ No ☐ N/A ☐

1.3 The survey unit has been turned over for final status survey. Yes ☑ No ☐ N/A ☐

1.4 An initial walkdown has been performed ☑

1.5 Activities conducted within area since turnover has been reviewed. ☑

Based on reviewed information, subsequent walkdown: ☑ not warranted ☐ warranted

If warranted, subsequent walkdown has been performed and documented performed 1-10-13.

OR

The basis has been provided to and accepted for not performing a subsequent walkdown. ☐

1.6 A final classification has been performed. ☑

Classification: CLASS 1 ☐ CLASS 2 ☐ CLASS 3 ☑

DATA QUALITY OBJECTIVES (DQO)

1.0 State the problem:

Survey Area OOL-10 consists of the surface area of the remainder of the HBPP land area. The open land area is comprised of soil. Survey Unit OOL10-04 is a sub unit of survey area OOL10 and is bordered by the New Generation Footprint to the North. The balance of survey unit's boundary abuts OOL10. It is approximately 2,244 square meters of surface area. A small portion of the area lies inside an energized transformer yard which will is deemed to be inaccessible due to safety concerns.

The problem as defined by this survey plan is to demonstrate that the years of plant operation did not result in an accumulation of plant-related radioactivity that exceeds the release criteria.

The planning team for this effort consists of the Site Closure Manager, FSS Engineers, FSS Lead Technician and FSS Technicians. The FSS Engineers will make primary decisions with the concurrence of the Site Closure Manager.

2.0 Identify the decision:

Does residual plant-related radioactivity, if present in the survey unit, exceed the release criteria?

Alternative actions may include no action, investigation, resurvey, remediation and reclassification.

3.0. Identify the inputs to the decision:

Sample media:		Soil			
Types of measurements:		Soil samples and 44-10 gamma scans			
Radionuclides-of-concern:		Cs-137			
Applicable DCGL:		The DCGLs applied under this survey plan are for soil media as determined in Table 5-1 of the LTP, Rev.0.			
Nuclide	DCGL (pCi/g)	Nuclide	DCGL (pCi/g)	Nuclide	DCGL (pCi/g)
H-3	6.86E+02	I-129	4.83E+00	Pu-241	8.61E+02
C-14	6.30E+00	Cs-137	7.93E+00	Am-241	2.58E+01
Ni-59	1.97E+03	Eu-152	1.01E+01	Cm-243	2.90E+01
Co-60	3.82E+00	Eu-154	9.40E+00	Cm-244	4.81E+01
Ni-63	7.24E+02	Np-237	1.11E+00	Cm-245	1.78E+01
Sr-90	1.51E+00	Pu-238	2.97E+01	Cm-246	2.58E+01
Nb-94	7.13E+00	Pu-239	2.67E+01		
Tc-99	1.24E+01	Pu-240	2.67E+01		

Seventy one (71) samples from previous characterization data were used to provide the characterization data for survey area OOL10. The data is sufficient to support the planning of Survey Unit OOL10-04.

Based on a review of the characterization data, Cs-137 was the only plant-related radionuclide that was identified consistently in the characterization samples analyzed. The results from the characterization data are summarized below:

- Cs-137 (51 detects) — Cs-137 is present in 72 % of the characterization samples.
- Other HBPP ETD — There were no other easy to detect nuclides identified >MDA.
- HBPP HTD — There were no hard to detect nuclides identified in the four samples analyzed.

The presence of all radionuclides listed in this plan (gamma-emitters, HTD beta-emitters, and TRUs) in the soil will be evaluated under this survey plan. The HBPP Site Closure Laboratory will analyze each soil sample for all listed gamma-emitting nuclides. In addition, 2 FSS soil samples will be sent to an independent laboratory for analyses of gamma-emitters and HTD radionuclides.

Survey Design /Release Criteria

Classification:	Class 3
Average Cs-137 concentration:	0.38 pCi/g
Standard deviation Cs- 137 (σ):	0.18 pCi/g
Surrogate DCGL:	N/A (a surrogate DCGL will not be used)
LBGR:	Initial = 0.5xDCGL = 3.9 pCi/g Cs-137
Adjusted LBGR(set $\Delta/\sigma = 2.0$)	= 7.57 pCi/g Cs-137
Number of Samples:	Calculated = 15
Survey Unit Area:	2,244 m^2
Grid Area (A/N):	N/A Class 3
$DCGL_{emc}$ Cs-137:	N/A Class 3
Investigation Level for soil samples:	> 50% DCGL for Cs-137 = 3.97 pCi/g Cs-137
Gamma scanning Coverage:	Approximately 25% of Survey Unit

(Note: The area within the energized switchyard may not be accessible due to safety concerns)

Investigation Level for SPA-3 Scans:	Reproducible indication above background using 44-10 and audible discrimination. The expected background range for 44-10 scans is between 3200 cpm and 5400 cpm.
Radionuclides for analysis:	All listed nuclides with the focus on Cs-137

MDCs for gamma analysis of soil samples:

Nuclide	10% to %50 of the DCGL (pCi/g)		
Co-60	3.82E-01	to	1.91E+00
Nb-94	7.13E-01	to	3.57E+00
I-129	4.83E-01	to	2.42E+00
Cs-137	7.93E-01	to	3.97E+00
Eu-152	1.01E+00	to	5.05E+00
Eu-154	9.40E-01	to	4.70E+00
Np-237	1.11E-01	to	5.55E-01

The desired MDCs in the laboratory analyses of FSS soil samples will be the 10% DCGL values. If it is impractical to achieve those, the 50% DCGL values must be achieved in the laboratory analyses of the soil samples.

MDC's for HTD nuclide:

Nuclide	10%	to	50% of the DCGL (pCi/g)
H-3	6.86E+01		3.43E+02
C-14	6.30E-01		3.15E+00
Ni-59	1.97E+02		9.85E+02
Ni-63	7.24E+01		3.62E+02
Sr-90	1.51E-01		7.55E-01
Tc-99	1.24E+00		6.20E+00
Pu-238	2.97E+00		1.49E+01
Pu-239/240	2.67E+00		1.34E+01
Pu-241	8.61E+01		4.31E+02
Am-241	2.58E+00		1.29E+01
Cm-243	2.90E+00		1.45E+01
Cm-244	4.81E+00		2.41E+01
Cm-245	1.78E+00		8.90E+00
Cm-246	2.58E+00		1.29E+01

	The MDC values for difficult to detect nuclides will be conveyed to the outside laboratory via the sample Chain-Of-Custody form which will accompany the soil samples.
QC checks and measurements:	QC checks for the 44-10 will be performed in accordance with RCP-7U2 Two QC split samples will be collected One QC recount for soil samples will be performed by the HBPP Site Closure Lab

4.0 Define the boundaries of the survey:

- Boundaries of Survey Unit OOL10-04 are as shown on the attached map. This area is bordered by the Survey Area OOL10 on all sides.
- The survey will be performed under appropriate weather conditions (as defined by instrumentation limitations and human factors). Surveys may be performed on any shift of work.

5.0 Develop a decision rule:

Upon review of the FSS data collected under this survey plan:

(a) If all the sample data show that the soil concentrations of plant related nuclides are below the DCGLs and the sum of fractions of nuclides are below unity, then reject the null hypothesis (i.e., Survey Unit OOL10-04 meets the release criteria).

(b) If the investigation levels are exceeded, then perform an investigation survey.

(c) If the average concentration of any listed nuclide exceeds its respective DCGL or the average sum of fractions for any listed nuclide exceeds one, then accept the null hypothesis (i.e., Survey Unit OOL10-04 fails to meet the release criteria).

Note: Alternate actions beyond investigations include, remediation, reclassification and resurvey

6.0 Specify tolerable limits on decision errors:

Null hypothesis:	Residual plant-related radioactivity in Survey Unit OOL10-04 exceeds the release criteria.
Probability of type I error:	0.05
Probability of type II error:	0.05
LBGR:	Adjusted to 7.57 pCi/g Cs-137

7.0 Optimize Design:

Type of statistical test: WRS Test ☐ Sign Test ☑ (background will not be subtracted)

Number and Location of Samples:	Fifteen (15) soil samples will be collected at locations based on a random selection
Biased samples:	A minimum of two (2) biased sample locations will be selected before, or at the time of sample collection and their locations will be added to the map, with the letter "B" added to the sample number. The addition of these samples and the relocation of any samples may be added to the map without requiring a revision. The coordinates of the bias sample locations will be determined and added to the record.
Biased sample locations:	The two (2) (or more) biased sample locations will be determined in field by the Lead Technician and/or the FSS Engineer based on historical data and process knowledge of the area.

GENERAL INSTRUCTIONS

1. Where possible, measurement locations will be identified using GPS. Each location will be marked to assist in identifying the location. Any locations that are not suitable for soil sampling will be relocated to the nearest suitable location and documented on the survey map.

2. Chain of Custody form/process will be used for all samples being shipped to the offsite laboratory.

3. All soil samples will be received and prepared as directed by the FSS Engineer.
   Note: The split sample aliquot to be sent to an off-site lab for HTD analysis will not be dried prior to counting on site or shipping.

4. Survey instrument: Operation of the 2350-1 w/44-10 will be in accordance with RCP-7U3 with QC checks performed in accordance with RCP-7U2. The instrument response checks shall be performed before issue and after use.

5. All 44-10 scans will be performed with the audible feature activated. FSS Technicians will listen for upscale readings to which they will respond by slowing down or stopping the probe to distinguish between random fluctuations in the background and greater than background readings.

6. The job hazards associated with the Survey described in this package will be addressed in the pre-job brief.

7. All personnel participating in this survey shall be trained in the operation of the instrumentation.

SPECIFIC INSTRUCTIONS

1. All designated measurement locations will be identified by GPS or by use of reference points and tape measure as necessary. If a designated sample location is obstructed for any reason, the FSS Engineer or the Lead FSS Technician will select an alternate location within one meter of the original location. A detailed description of the alternate location will be recorded on the survey form, the survey unit map will be annotated appropriately, and the alternate location will be conspicuously marked to facilitate re-visiting to identify and record the coordinates with GPS or by measurement from a known reference point when GPS is not available.

2. Sample Requirements:

   - Collect fifteen (15) random 1-liter soil samples in accordance with RCP FSS-8. Two (2) of the 15 random soil samples will be analyzed as QC split samples and one (1) will be a sample recount to fulfill the QC requirement. The QC split samples will also be analyzed for Hard-to-Detect nuclides.

   - Collect two (2) (or more) biased l-liter soil samples. The FSS engineer assigned to this survey unit or the FSS Lead Technician will determine the locations of the biased samples.

   - If a sample location falls on an engineered surface, collect a sample of the engineered material and a sample of the soil below. The soil sample will be used as the statistical sample and not the engineered material sample. The engineered material sample will have the designation OOL10-04-xxx-EM where the "xxx" is the sample number corresponding to the soil sample location.

   - Soil samples will be collected as follows:

     - At the sample location, using a clean implement, dig a hole in the soil approximately 4 inches in diameter to a depth of 15 cm placing the soil in a plastic bag.
     - Enlarge the hole as necessary radially until the desired amount of soils is collected. Do not dig deeper than 15 cm.
     - Label the plastic bag with the sample location identifier.
     - Transfer the bag of soils to the sample preparation area.

3. Soil Sample Designation:

Statistical soil samples:	OOL10-04-001-F through OOL10-04-015-F corresponding to sample locations 001 through 015.
Biased soil samples:	OOL10-04-016-F-B through OOL10-04-017-F-B corresponding to the biased sample locations 016 through 017.
QC split samples:	OOL10-04-001-F-S and OOL10-04-015-F-S are to be designated as QC split samples. These samples will be sent to the off-site laboratory.
Recount samples:	OOL10-04-011-F-RC is to be counted twice on site. The results will be compared as directed by the FSS Engineer.

4. Sample Analysis:

- Gamma analysis will be performed on all soil samples. If any of the gamma analyses show that an investigation level has been exceeded an investigation survey will be conducted at that sample location as directed in specific instruction # 6.
- HBPP will analyze OOL10-04-001-F through OOL10-04-015-F and OOL10-04-016-FB through OOL10-04-017-F-B for gamma-emitting nuclides.
- HBPP will analyze OOL10-04-011-F as a sample recount. The recounted sample will possess the naming convention OOL10-04-011-F-RC.
- HBPP will analyze OOL10-04-001-F-S and OOL10-04-015-F-S for gamma-emitting nuclides prior to being sent to the off-site laboratory. These samples will be analyzed for gamma emitting nuclides and HTD at the off-site laboratory.
- On-site gamma analysis of the samples shall achieve the MDC values stated in the DQO section of this plan. The MDC's for off-site analysis will be communicated to the laboratory using an attachment to the Chain-of-Custody form or previous direction that meets specified MDC's of this characterization survey plan.

5. Gamma scans:

- Scan 25% of the accessible survey area with a 44-10 in rate-meter mode moving the detector at a speed of 0.2 m or less per second, keeping the probe at a distance of approximately 3" from the surface and following a serpentine path that includes at least 3

passes across each square meter.
- Note the area scanned on the survey map
- If an indication of greater than background is discovered:
  - Rescan the area to determine if the indication was due to background fluctuation
  - If the indication was due to background fluctuation continue to scan the remainder of the area
  - If the indication was due to an elevated area then slowly scan the elevated area to determine the elevated activity boundaries and note on the map
  - Obtain a 1 liter biased soil sample at the point of the highest reading in the elevated area. Denote the sample using the naming methodology described in step 6.

6. If the results of any sample (statistical and/or biased points) analysis exceed an investigation level, perform a first level investigation as follows:

   - Scan a 1 m radius footprint around the sample location with a 44-10 in rate-meter mode moving the detector at a speed of 0.2 m or less per second, keeping the probe at a distance of approximately 3" from the surface and following a serpentine path that includes at least 3 passes across each square meter. The area of scan should be increased as necessary to bound any areas of elevated activity identified.

   - Mark the boundaries around any detected elevated areas in the soil and identify the boundaries on a survey map. Measure the total area of each outlined area in square centimeters.
   - Mark the location of the highest identified activity for each of the elevated areas in the soil and on the survey map.

   - At each of the highest identified activity area:

     - Perform and record a 1-minute scaler mode 44-10 measurement. Designate the reading as "OOL10-04-xxx-F-SC-I" where "xxx" continues sequentially from the last number assigned to a investigation measurement.
     - Obtain a soil sample at the location. Designate the sample as "OOL10-04 -xxx-F-I" where "xxx" continues sequentially from the last number assigned to an investigative sample.
     - Perform and record a post sample 1-minute 44-10 measurement. Designate the reading as described above.

Final Status Survey Planning Worksheet
Page 10 of 14

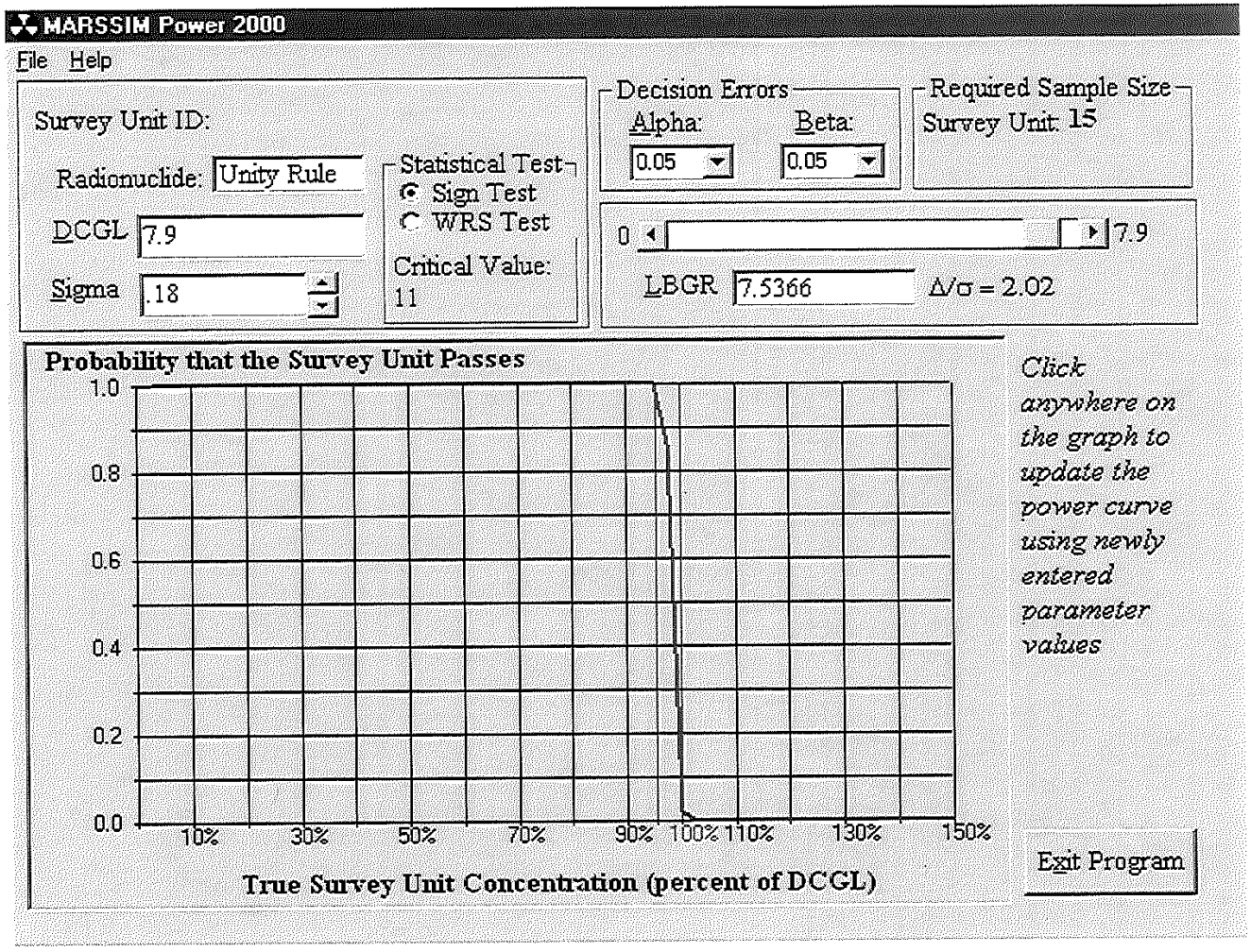
Prepared by: Carl Randall — Date: 9-13-13
FSS Engineer

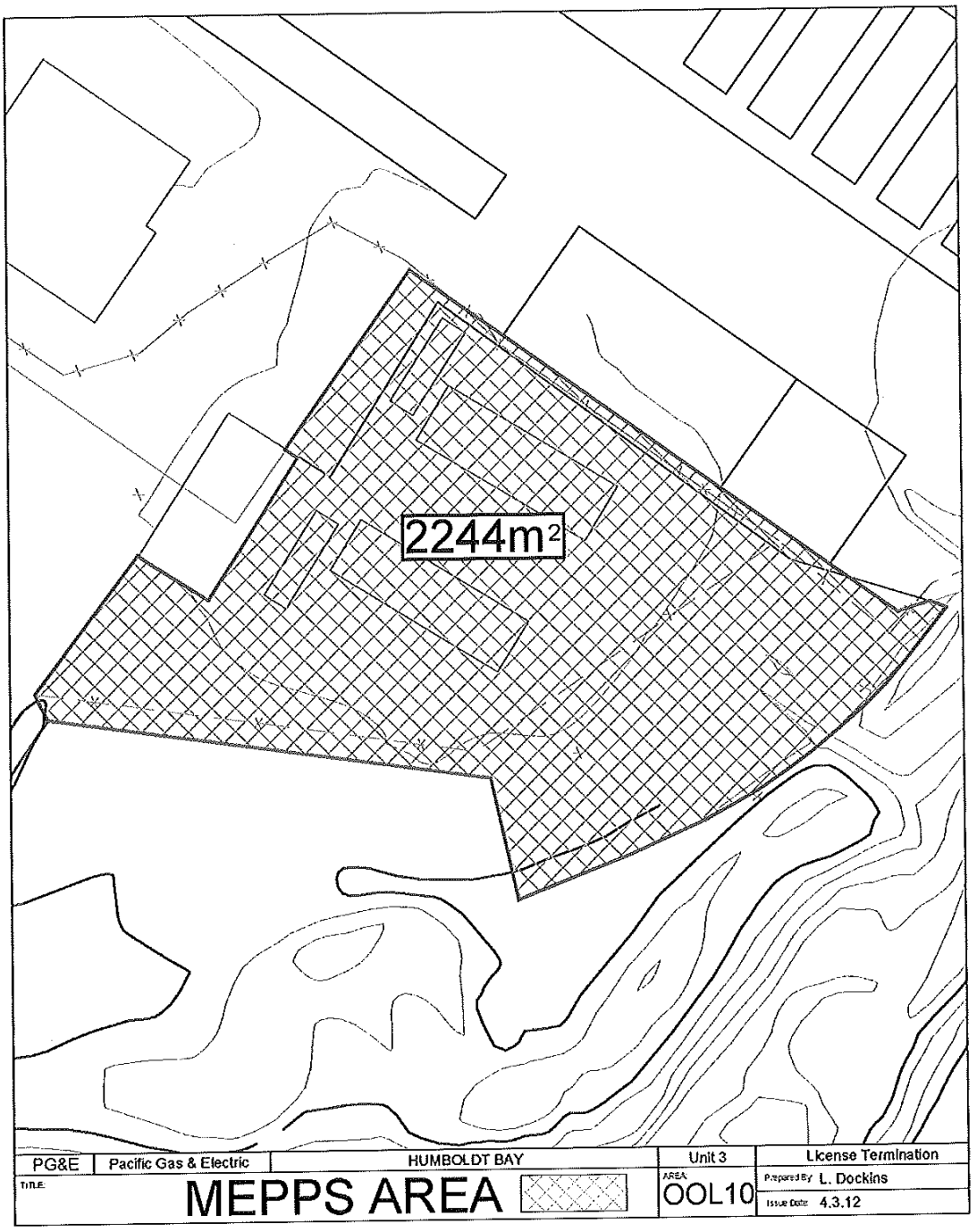
Reviewed by: Martin C Ejnar — Date: 9/13/13
FSS Engineer

Approved by: W A Barley — Date: 9/13/13
Site Closure Manager

OOL10-04 VSP Sample Locations			
Sample	Easting*	Northing*	
01	5949680.79	2160777.96	QC split
02	5949738.95	2160752.13	
03	5949629.10	2160749.78	
04	5949704.49	2160742.73	
05	5949626.95	2160730.99	
06	5949652.79	2160721.60	
07	5949749.72	2160714.55	
08	5949594.64	2160707.51	
09	5949756.18	2160700.46	
10	5949646.33	2160693.41	
11	5949601.10	2160688.72	Recount
12	5949566.64	2160679.32	
13	5949695.87	2160667.58	
14	5949663.56	2160665.23	
15	5949721.72	2160658.19	QC Split
*CA Zone 1 NAD83/NAVD88			

OOL10-04 Prospective Power Curve




2244m²
PG&E
Pacific Gas & Electric
HUMBOLDT BAY
Unit 3
License Termination
TITLE
MEPPS AREA
AREA
OOL10
Prepared By L. Docklns
Issue Date 4.3.12


01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
Plant NORTH
NORTH
PG&E
Pacific Gas & Electric
HUMBOLDT BAY
Unit 3
License Termination
TITLE:
OOL10-04 VSP Sample Locations
AREA:
MEPPS
Prepared By L. Dockins
Issue Date 4.4.12

CLASSIFICATION BASIS SUMMARY

Page 1 of 1

SURVEY AREA NUMBER OOL 10 SURVEY UNIT NUMBER 04

TYPE OF CLASSIFICATION

Initial ☐ Verification ☐ Change ☐ Final ☑

- ☑ Spill history reviewed [1]
- ☑ Historical Site Assessment [2] and Characterization summary reviewed
- ☑ Current survey records reviewed [3]
- ☑ Personnel interviews performed [4]
- ☑ Visual inspection and Walkdown completed [5]

Comments:

1.) The LTP Spill History (implied For review in step 5.2.1) Contains No information regarding t MEPIS area

2.) The "Soils in the NewGen/HBRP/HBGS section mentions this area and concludes it is designated as Class 3.

3.) This area is not a part of routine Surveys by RP Ops.

4.) Personnel were Interviewed as a part of the HSA/CTP development.

5.) A Visual inspection and walkdown was performed prior to the Commencement of digging in the area to support new construction The FSS is being performed concurrently to capture the radiological Status of excavations. Various commodities and shallow concrete structures are to be removed From the area as part of the new construction process this was done 9-10-13 @ ~1pm.

CLASSIFICATION WORKSHEET

SURVEY AREA NUMBER 004 10 SURVEY UNIT NUMBER 04

SECTION 1

Previously subjected to remedial actions ☐
Leaks or spills are known to have occurred ☐
Formal burial or disposal site ☐
Waste storage site ☐
Discrete solid pieces of material with high specific activity ☐

CLASS 1

Considering the potential for all impacted areas to exceed the DCGL, does existing data provide a high degree of confidence that no individual measurement will exceed the applicable DCGL in the survey unit?
Yes ☑ No ☐

IF NO OR UNKNOWN, THEN AREA IS A CLASS 1.

IF YES, CONTINUE WITH THE CLASSIFICATION PROCESS BELOW.

SECTION 2

Radioactive materials present in unsealed form ☐
Potentially contaminated transport route ☐
Area downwind from stack release point ☐
Upper walls or ceiling of building subjected to airborne radioactivity ☐
Area where low levels of radioactive materials were handled ☐
Perimeter of former contamination control area ☐

CLASS 2

Does existing data provide a high degree of confidence that no individual measurement will exceed 5% of the applicable DCGL?
Yes ☑ No ☐

IF NO OR UNKNOWN, THEN THE AREA IS A CLASS 2.

IF YES, CONTINUE WITH THE CLASSIFICATION PROCESS BELOW.

SECTION 3

Buffer zone around a Class 1 or a Class 2 area ☐
Low potential for residual activity ☐

CLASS 3

Does existing data provide a high degree of confidence that no reasonable potential for residual contamination exists in this area?
Yes ☐ No ☑

IF NO OR UNKNOWN, THEN THE AREA IS A CLASS 3.

IF YES, CONTINUE WITH CLASSIFICATION PROCESS IN SECTION 4

IMPACTED AREA

CLASSIFICATION WORKSHEET

SURVEY AREA NUMBER 001 10 SURVEY UNIT NUMBER 04

SECTION 4

Sufficient process knowledge and/or historical data to warrant a non-impacted designation?

Yes ☐ No ☐

IF NO OR UNKNOWN, THEN THE AREA IS A CLASS 3.

IF YES, THE AREA IS NON-IMPACTED.

Submitted: Orl Rudall 9-13-13 Reviewed: Martin C Finch 9/13/13

Attachment 8.1
Sample Number Calculation Sheet – Single Radionuclide

Reference FSSP Worksheet Number:HBPP-FSS-OOL10-04	
Survey Area Number:OOL10 Survey Unit Number: 04	
Classification: 3 Total Area (A): 2,244 m^2	
Maximum Length: N/A ft or m Maximum Width: N/A ft or m	
INPUT PARAMETERS FROM DQOs	*VALUE*
Type I error (α)	*0.05*
Type II error (β)	*0.05*
Radionuclide	*Cs-137*
Radioactive concentration variability (Standard Deviation (σ)) Source Document: HBPP-LTP Table 5-2	*0.18*
RESULTS	*VALUE*
DCGL	*7.93*
LBGR	*3.97*
Shift (Δ)	*3.96*
Calculated Relative Shift (Δ/σ)	*22.05*
Adjusted Relative Shift when required, otherwise n/a	*2.0*
Adjusted LBGR when required, otherwise n/a	*7.57*
Number of samples (N from Appendix 9.1 or N/2 from Appendix 9.2)	*15*
Grid Pattern: X Not Applicable Square Triangular	
Calculate grid spacing, L, for square grid pattern: $L = \sqrt{A/N}$	*n/a*
Calculate grid spacing, L, for triangular pattern: $L = \sqrt{(A/0.866N)}$	*n/a*

Performed by: [signature] Date: 9-13-13
FSS Engineer

Independent Review by: [signature] Date: 9/13/13
Site Closure Manager or designee

Attachment 2

Off Site Laboratory Data

Case Narrative
for
Pacific Gas and Electric Company
SDG: 337645

December 04, 2013

Laboratory Identification:

GEL Laboratories LLC
2040 Savage Road
Charleston, South Carolina 29407
(843) 556-8171

Summary

Sample Receipt The samples arrived at GEL Laboratories LLC, Charleston, South Carolina on November 15, 2013 for analysis.

Sample Identification The laboratory received the following samples:

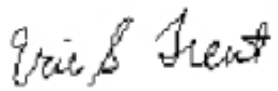
Laboratory ID	Client ID
337645001	FSS-2013-0245
337645002	FSS-2013-0259

Case Narrative

Sample analyses were conducted using methodology as outlined in GEL Laboratories, LLC (GEL) Standard Operating Procedures. Any technical or administrative problems during analysis, data review, and reduction are contained in the analytical case narratives in the enclosed data package.

Data Package

The enclosed data package contains the following sections: General Narrative, Chain of Custody and Supporting Documentation, and data from the following fractions: Radiochemistry.



Erin Trent
Project Manager

Sample Data Summary

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

GEL Sample ID: 337645001
Client Sample ID: FSS-2013-0245
Client Matrix: Soil
Amount of Sample Received:
Sample Description: OOL10-04-001-F-S

Client: Pacific Gas and Electric Company
Collect Date: November 06, 2013
Receive Date: November 15, 2013
Report Date: December 04, 2013

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
H-3	11/22/13	U	-1.39E+00	2.44E+00	4.21E+00	5.50E+00	2.44E+00	pCi/g
C-14	11/26/13	U	-5.44E-02	2.84E-01	4.78E-01	6.30E-01	2.84E-01	pCi/g
Ni-63	11/21/13	U	-1.43E-01	1.89E+01	3.18E+01	7.24E+01	1.89E+01	pCi/g
Sr-90	11/26/13	U	3.46E-02	4.97E-02	7.33E-02	1.51E-01	5.01E-02	pCi/g
Tc-99	11/24/13	U	-1.29E-01	4.94E-01	8.45E-01	1.24E+00	4.94E-01	pCi/g
Pu-241	11/22/13	U	-5.85E+00	2.03E+01	3.47E+01	8.61E+01	2.03E+01	pCi/g
Alpha Spec								
Pu-238	11/19/13	U	-1.65E-02	7.30E-02	1.91E-01	2.97E+00	7.32E-02	pCi/g
Pu-239/240	11/19/13	U	6.88E-02	1.18E-01	1.03E-01	2.67E+00	1.18E-01	pCi/g
Am-241	11/19/13	U	3.30E-02	1.83E-01	3.51E-01	2.58E+00	1.84E-01	pCi/g
Cm-243/244	11/19/13	U	3.26E-02	1.81E-01	3.47E-01	2.90E+00	1.81E-01	pCi/g
Cm-245/246	11/19/13	U	7.26E-02	2.04E-01	2.18E-01	1.78E+00	2.05E-01	pCi/g
Gamma Spec								
Be-7	11/18/13	U	8.80E-03	1.53E-01	2.68E-01		1.53E-01	pCi/g
Na-22	11/18/13	U	8.36E-04	1.78E-02	2.93E-02		1.78E-02	pCi/g
K-40	11/18/13		8.00E+00	6.46E-01	2.42E-01		9.84E-01	pCi/g
Cr-51	11/18/13	U	1.12E-01	1.60E-01	3.02E-01		1.68E-01	pCi/g
Mn-54	11/18/13	U	3.03E-03	1.77E-02	3.07E-02		1.77E-02	pCi/g
Fe-59	11/18/13	U	3.84E-02	4.22E-02	7.83E-02		4.64E-02	pCi/g
Co-56	11/18/13	U	-8.48E-03	1.81E-02	2.96E-02		1.85E-02	pCi/g
Co-57	11/18/13	U	4.32E-03	1.24E-02	2.34E-02		1.26E-02	pCi/g
Co-58	11/18/13	U	-6.39E-04	2.00E-02	2.93E-02		2.00E-02	pCi/g
Co-60	11/18/13	U	-1.03E-02	1.86E-02	2.51E-02	3.82E-01	1.92E-02	pCi/g
Ni-59	11/20/13	U	-4.02E+01	1.48E+01	2.01E+01	1.97E+02	2.37E+01	pCi/g
Zn-65	11/18/13	U	1.75E-02	4.44E-02	6.89E-02		4.53E-02	pCi/g
Y-88	11/18/13	U	6.26E-03	1.70E-02	3.03E-02		1.73E-02	pCi/g
Zr-95	11/18/13	U	-1.30E-02	3.03E-02	5.05E-02		3.09E-02	pCi/g
Nb-94	11/18/13	U	8.09E-03	1.60E-02	2.90E-02	7.13E-01	1.64E-02	pCi/g
Nb-95	11/18/13	U	8.85E-04	2.22E-02	3.27E-02		2.22E-02	pCi/g
Ru-106	11/18/13	U	-1.61E-01	1.47E-01	2.39E-01		1.65E-01	pCi/g
Ag-110m	11/18/13	U	6.43E-03	2.28E-02	3.99E-02		2.30E-02	pCi/g
Sn-113	11/18/13	U	3.36E-03	2.05E-02	3.67E-02		2.05E-02	pCi/g
Sb-124	11/18/13	U	-2.31E-02	2.99E-02	4.30E-02		3.17E-02	pCi/g
Sb-125	11/18/13	U	-1.76E-02	4.98E-02	7.29E-02		5.04E-02	pCi/g
I-129	11/19/13	U	5.40E-03	1.02E-01	1.80E-01	5.00E-01	1.02E-01	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.

4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

GEL Sample ID: 337645001
Client Sample ID: FSS-2013-0245
Client Matrix: Soil
Amount of Sample Received:
Sample Description: OOL10-04-001-F-S

Client: Pacific Gas and Electric Company
Collect Date: November 06, 2013
Receive Date: November 15, 2013
Report Date: December 04, 2013

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
Cs-134	11/18/13	U	8.22E-03	1.87E-02	3.35E-02		1.91E-02	pCi/g
Cs-136	11/18/13	U	-7.78E-03	3.98E-02	6.79E-02		4.00E-02	pCi/g
Cs-137	11/18/13	U	-8.59E-03	1.73E-02	2.92E-02	7.93E-01	1.77E-02	pCi/g
Ba-133	11/18/13	U	1.70E-02	2.17E-02	3.61E-02		2.31E-02	pCi/g
Ba-140	11/18/13	U	-4.00E-02	9.31E-02	1.62E-01		9.48E-02	pCi/g
Ce-139	11/18/13	U	1.51E-02	1.51E-02	2.86E-02		1.69E-02	pCi/g
Ce-141	11/18/13	U	1.41E-02	3.13E-02	5.74E-02		3.20E-02	pCi/g
Ce-144	11/18/13	U	3.73E-02	9.96E-02	1.87E-01		1.01E-01	pCi/g
Nd-147	11/18/13	U	5.35E-02	2.01E-01	3.68E-01		2.02E-01	pCi/g
Pm-144	11/18/13	U	1.50E-02	1.63E-02	3.05E-02		1.77E-02	pCi/g
Pm-146	11/18/13	U	4.07E-03	2.04E-02	3.62E-02		2.05E-02	pCi/g
Eu-152	11/18/13	U	-1.99E-02	6.22E-02	8.15E-02	1.01E+00	6.29E-02	pCi/g
Eu-154	11/18/13	U	4.61E-03	5.08E-02	8.39E-02	9.40E-01	5.09E-02	pCi/g
Eu-155	11/18/13	U	5.10E-02	5.23E-02	1.02E-01		5.73E-02	pCi/g
Ir-192	11/18/13	U	-4.95E-03	1.59E-02	2.82E-02		1.60E-02	pCi/g
Hg-203	11/18/13	U	1.78E-02	2.71E-02	3.18E-02		2.72E-02	pCi/g
Tl-208	11/18/13		1.39E-01	3.52E-02	2.59E-02		3.71E-02	pCi/g
Pb-210	11/18/13	U	8.74E-01	2.00E+00	3.67E+00		2.04E+00	pCi/g
Pb-212	11/18/13		5.15E-01	6.32E-02	4.87E-02		7.68E-02	pCi/g
Pb-214	11/18/13		4.51E-01	9.10E-02	6.26E-02		9.80E-02	pCi/g
Bi-212	11/18/13	U	3.38E-01	4.25E-01	5.04E-01		4.53E-01	pCi/g
Bi-214	11/18/13		3.56E-01	8.51E-02	6.14E-02		9.02E-02	pCi/g
Ra-228	11/18/13		6.80E-01	1.37E-01	1.03E-01		1.77E-01	pCi/g
Ac-228	11/18/13		6.80E-01	1.37E-01	1.03E-01		1.77E-01	pCi/g
Th-234	11/18/13	UI	1.28E+00	1.63E+00	1.28E+00		1.66E+00	pCi/g
U-235	11/18/13	U	6.41E-02	1.07E-01	1.98E-01		1.07E-01	pCi/g
U-238	11/18/13	UI	1.28E+00	1.63E+00	1.28E+00		1.66E+00	pCi/g
Np-237	11/18/13	U	9.51E-03	2.93E-02	5.42E-02	1.11E-01	2.96E-02	pCi/g
Np-239	11/18/13	U	-9.21E-02	2.02E-01	3.67E-01		2.06E-01	pCi/g
Am-241	11/18/13	U	6.09E-02	8.93E-02	1.51E-01		9.35E-02	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.

4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

GEL Sample ID: 337645002
Client Sample ID: FSS-2013-0259
Client Matrix: Soil
Amount of Sample Received:
Sample Description: OOL10-04-015-F-S

Client: Pacific Gas and Electric Company
Collect Date: November 06, 2013
Receive Date: November 15, 2013
Report Date: December 04, 2013

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
H-3	11/22/13	U	8.28E-01	2.59E+00	4.27E+00	5.50E+00	2.59E+00	pCi/g
C-14	11/22/13	U	-2.01E-01	2.89E-01	4.91E-01	6.30E-01	2.89E-01	pCi/g
Ni-63	11/21/13	U	-3.07E+00	2.36E+01	3.98E+01	7.24E+01	2.36E+01	pCi/g
Sr-90	11/27/13	U	-3.49E-02	3.42E-02	6.74E-02	1.51E-01	3.42E-02	pCi/g
Tc-99	11/24/13	U	2.41E-01	4.88E-01	7.92E-01	1.24E+00	4.89E-01	pCi/g
Pu-241	11/22/13	U	3.19E+00	2.06E+01	3.43E+01	8.61E+01	2.06E+01	pCi/g
Alpha Spec								
Pu-238	11/19/13	U	0.00E+00	6.79E-02	1.01E-01	2.97E+00	6.80E-02	pCi/g
Pu-239/240	11/19/13	U	6.73E-02	1.15E-01	1.01E-01	2.67E+00	1.16E-01	pCi/g
Am-241	11/19/13	U	0.00E+00	1.46E-01	2.18E-01	2.58E+00	1.47E-01	pCi/g
Cm-243/244	11/19/13	U	-1.72E-02	1.48E-01	3.43E-01	2.90E+00	1.49E-01	pCi/g
Cm-245/246	11/19/13	U	0.00E+00	1.67E-01	2.49E-01	1.78E+00	1.68E-01	pCi/g
Gamma Spec								
Be-7	11/18/13	U	-1.94E-02	2.14E-01	3.63E-01		2.14E-01	pCi/g
Na-22	11/18/13	U	3.05E-02	3.49E-02	6.63E-02		3.76E-02	pCi/g
K-40	11/18/13		7.75E+00	9.47E-01	3.94E-01		1.17E+00	pCi/g
Cr-51	11/18/13	U	1.29E-02	2.22E-01	3.52E-01		2.22E-01	pCi/g
Mn-54	11/18/13	U	-4.85E-03	2.78E-02	4.60E-02		2.79E-02	pCi/g
Fe-59	11/18/13	U	-5.83E-02	5.96E-02	8.49E-02		6.59E-02	pCi/g
Co-56	11/18/13	U	-1.25E-02	2.56E-02	3.97E-02		2.62E-02	pCi/g
Co-57	11/18/13	U	4.56E-03	1.05E-02	1.99E-02		1.07E-02	pCi/g
Co-58	11/18/13	U	-4.81E-03	2.73E-02	4.53E-02		2.74E-02	pCi/g
Co-60	11/18/13	U	8.81E-03	3.10E-02	5.69E-02	3.82E-01	3.12E-02	pCi/g
Ni-59	11/21/13	U	1.69E+01	4.46E+01	8.02E+01	1.97E+02	4.53E+01	pCi/g
Zn-65	11/18/13	U	1.52E-02	7.22E-02	1.11E-01		7.26E-02	pCi/g
Y-88	11/18/13	U	1.73E-03	2.96E-02	5.00E-02		2.96E-02	pCi/g
Zr-95	11/18/13	U	5.86E-02	5.37E-02	1.04E-01		6.01E-02	pCi/g
Nb-94	11/18/13	U	1.63E-02	2.25E-02	4.16E-02	7.13E-01	2.37E-02	pCi/g
Nb-95	11/18/13	U	2.02E-02	3.26E-02	5.35E-02		3.39E-02	pCi/g
Ru-106	11/18/13	U	-4.77E-02	2.10E-01	3.60E-01		2.11E-01	pCi/g
Ag-110m	11/18/13	U	2.54E-02	4.07E-02	7.10E-02		4.24E-02	pCi/g
Sn-113	11/18/13	U	1.71E-02	2.39E-02	4.51E-02		2.51E-02	pCi/g
Sb-124	11/18/13	U	9.90E-03	6.08E-02	1.07E-01		6.10E-02	pCi/g
Sb-125	11/18/13	U	1.87E-02	5.51E-02	9.93E-02		5.58E-02	pCi/g
I-129	11/19/13	U	-1.46E-01	2.88E-01	4.31E-01	5.00E-01	2.96E-01	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.

4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

GEL Sample ID: 337645002
Client Sample ID: FSS-2013-0259
Client Matrix: Soil
Amount of Sample Received:
Sample Description: OOL10-04-015-F-S

Client: Pacific Gas and Electric Company
Collect Date: November 06, 2013
Receive Date: November 15, 2013
Report Date: December 04, 2013

Isotope	Run Date	Qualifier	Activity	2 Sigma Uncertainty	MDC	LLD	2 Sigma TPU	Units
Cs-134	11/18/13	U	3.51E-02	3.18E-02	6.13E-02		3.57E-02	pCi/g
Cs-136	11/18/13	U	-2.57E-02	6.88E-02	1.12E-01		6.99E-02	pCi/g
Cs-137	11/18/13	U	1.93E-02	2.67E-02	5.04E-02	7.93E-01	2.81E-02	pCi/g
Ba-133	11/18/13	U	5.83E-03	2.31E-02	3.74E-02		2.33E-02	pCi/g
Ba-140	11/18/13	U	9.74E-02	1.45E-01	2.78E-01		1.52E-01	pCi/g
Ce-139	11/18/13	U	9.98E-03	1.42E-02	2.66E-02		1.50E-02	pCi/g
Ce-141	11/18/13	U	-4.86E-03	2.68E-02	4.80E-02		2.69E-02	pCi/g
Ce-144	11/18/13	U	-1.44E-02	9.29E-02	1.60E-01		9.31E-02	pCi/g
Nd-147	11/18/13	U	1.53E-01	2.84E-01	5.38E-01		2.92E-01	pCi/g
Pm-144	11/18/13	U	2.63E-02	2.68E-02	4.17E-02		2.93E-02	pCi/g
Pm-146	11/18/13	U	1.23E-02	2.57E-02	4.68E-02		2.64E-02	pCi/g
Eu-152	11/18/13	U	2.15E-02	6.22E-02	1.01E-01	1.01E+00	6.30E-02	pCi/g
Eu-154	11/18/13	U	8.65E-02	9.91E-02	1.88E-01	9.40E-01	1.07E-01	pCi/g
Eu-155	11/18/13	U	4.18E-02	4.03E-02	7.99E-02		4.47E-02	pCi/g
Ir-192	11/18/13	U	5.65E-03	1.85E-02	3.42E-02		1.87E-02	pCi/g
Hg-203	11/18/13	U	-1.08E-02	1.95E-02	3.39E-02		2.01E-02	pCi/g
Tl-208	11/18/13		1.64E-01	6.20E-02	3.55E-02		6.36E-02	pCi/g
Pb-210	11/18/13	U	2.30E-01	4.57E-01	4.07E-01		4.57E-01	pCi/g
Pb-212	11/18/13		3.95E-01	8.83E-02	5.99E-02		9.58E-02	pCi/g
Pb-214	11/18/13		5.16E-01	1.01E-01	7.03E-02		1.10E-01	pCi/g
Bi-212	11/18/13	U	6.82E-01	3.82E-01	7.85E-01		4.94E-01	pCi/g
Bi-214	11/18/13		4.44E-01	1.01E-01	8.55E-02		1.08E-01	pCi/g
Ra-228	11/18/13	UI	3.08E-01	1.91E-01	3.08E-01		3.21E-01	pCi/g
Ac-228	11/18/13	UI	3.08E-01	1.91E-01	3.08E-01		3.21E-01	pCi/g
Th-234	11/18/13		6.91E-01	5.04E-01	4.38E-01		5.28E-01	pCi/g
U-235	11/18/13	U	7.61E-02	9.18E-02	1.72E-01		9.22E-02	pCi/g
U-238	11/18/13		6.91E-01	5.04E-01	4.38E-01		5.28E-01	pCi/g
Np-237	11/18/13	U	-3.77E-03	3.59E-02	6.40E-02	1.11E-01	3.59E-02	pCi/g
Np-239	11/18/13	U	-1.04E-02	1.62E-01	2.99E-01		1.62E-01	pCi/g
Am-241	11/18/13	U	9.41E-03	2.69E-02	4.88E-02		2.73E-02	pCi/g

Notes:
1. LLDs are a-priori values.
2. MDCs are calculated a-posteriori values.
3. Gamma spectroscopy analysis results are calculated from a measurement using only one gamma energy line.

4. Air sample volumes are received in units of ft3. GEL converts the units and reports them as m3.

Qualifiers:
U Target isotope was analyzed for but not detected above the MDC and LLD.
UI Uncertain identification for gamma spectroscopy.
X Lab-specific qualifier-please see case narrative, data summary package or contact your project manager for details.
M Reported result is less than the LLD and greater than the MDC.

Attachment 3

Survey and On Site Laboratory Data

HUMBOLDT BAY POWER PLANT

AREA SURVEY REPORT

FSS SURVEY#: 2013-109

DATE: 11-6-2013 TIME: 1000 LOCATION: MEPPS AREA HBPP-FSS-OOL10-04-00

PURPOSE: FINAL STATUS SURVEY

INSTRUMENT			SOURCE CHECK (INIT.&DATE)		SURVEY PERFORMED BY	
TYPE	SERIAL NO.	CAL. DUE	PRE	POST	PRINT	SIGN
2350-1	149789	8-14-14	(PASS) FAIL	(PASS) FAIL	R. MEADE	R Meade
2350-1	180738	8-7-14	(PASS) FAIL	(PASS) FAIL	SHARON ERICKSON	Sharon Erickson

COMMENTS: 2SS = AREA SURVEYED NO ELEVATED AUDIBLE READINGS DETECTED

SUPERVISOR REVIEW: [signature] DATE: 11/6/13

Cs-137 Results for FSS Direct Soil Samples Analyzed using the On-Site Laboratory HPGe Gamma System		
Sample Number	**Cs-137 (pCi/g)**	**MDA (pCi/g)**
OOL10-04-001-F	4.77E-02	9.38E-02
OOL10-04-002-F	-7.70E-03	5.86E-02
OOL10-04-003-F	1.22E-02	8.39E-02
OOL10-04-004-F	-3.62E-02	7.00E-02
OOL10-04-005-F	4.13E-02	8.17E-02
OOL10-04-006-F	-2.56E-02	7.84E-02
OOL10-04-007-F	-3.80E-02	8.64E-02
OOL10-04-008-F	4.36E-02	8.65E-02
OOL10-04-009-F	1.84E-02	6.94E-02
OOL10-04-010-F	5.39E-03	7.00E-02
OOL10-04-011-F	4.75E-02	1.04E-01
OOL10-04-011-F-RC*	3.59E-02	7.96E-02
OOL10-04-012-F	6.01E-02	1.09E-01
OOL10-04-013-F	-2.08E-02	9.99E-02
OOL10-04-014-F	-1.03E-02	8.03E-02
OOL10-04-015-F	1.71E-02	7.35E-02

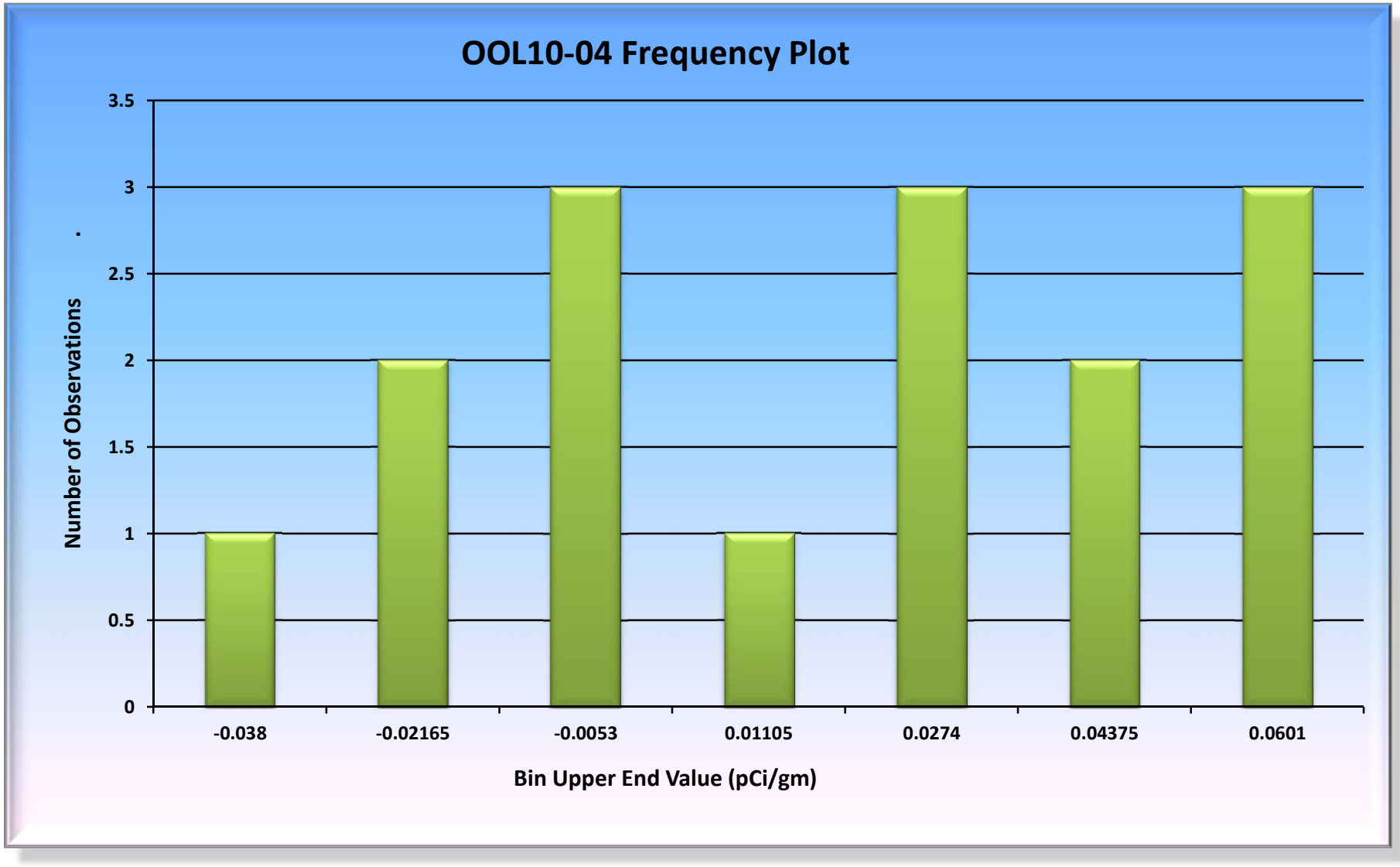
Note: Statistical Summary not presented of above data as all FSS direct measurement values were non-detects for Cs-137 (i.e., <MDA)

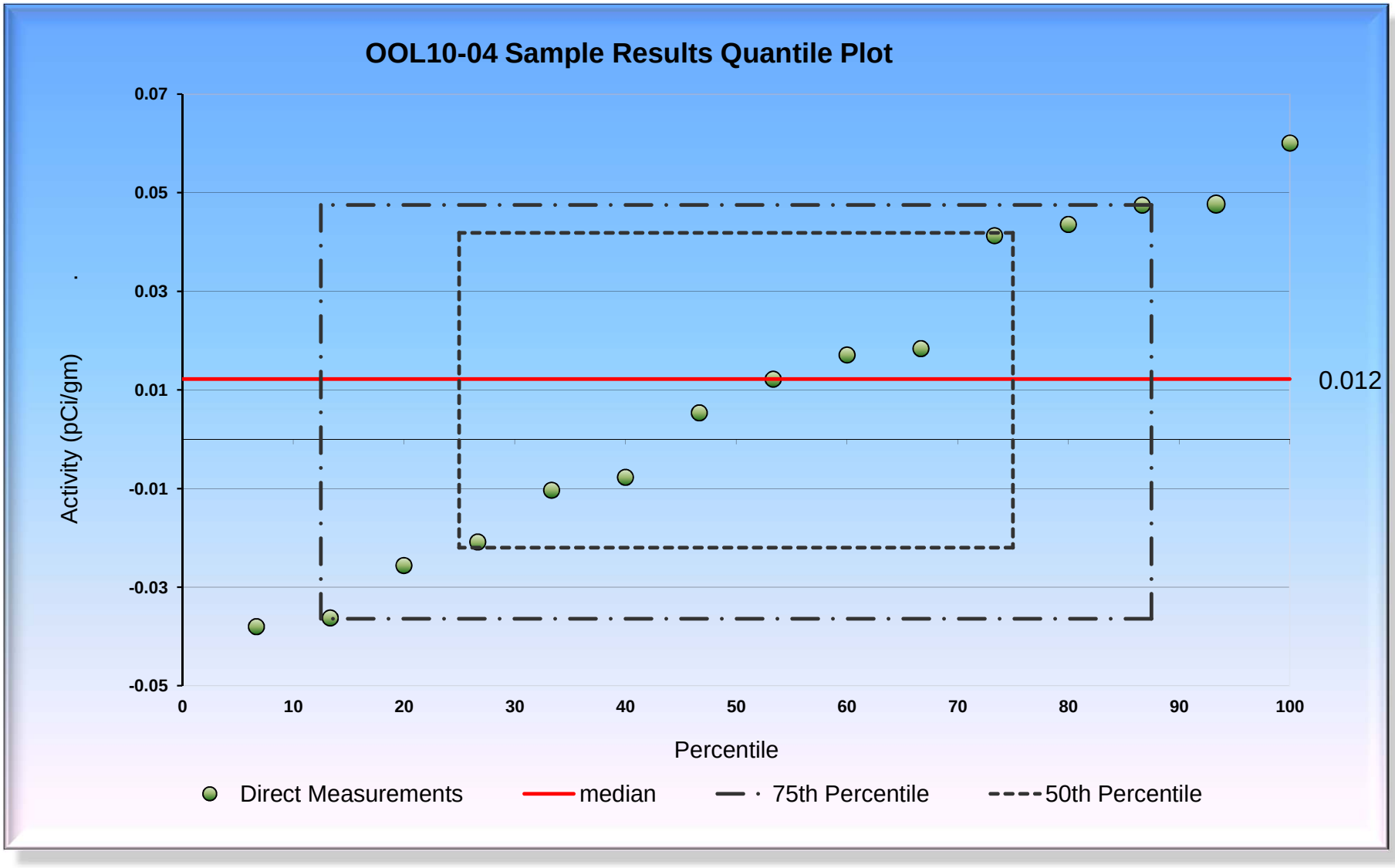
* Recount

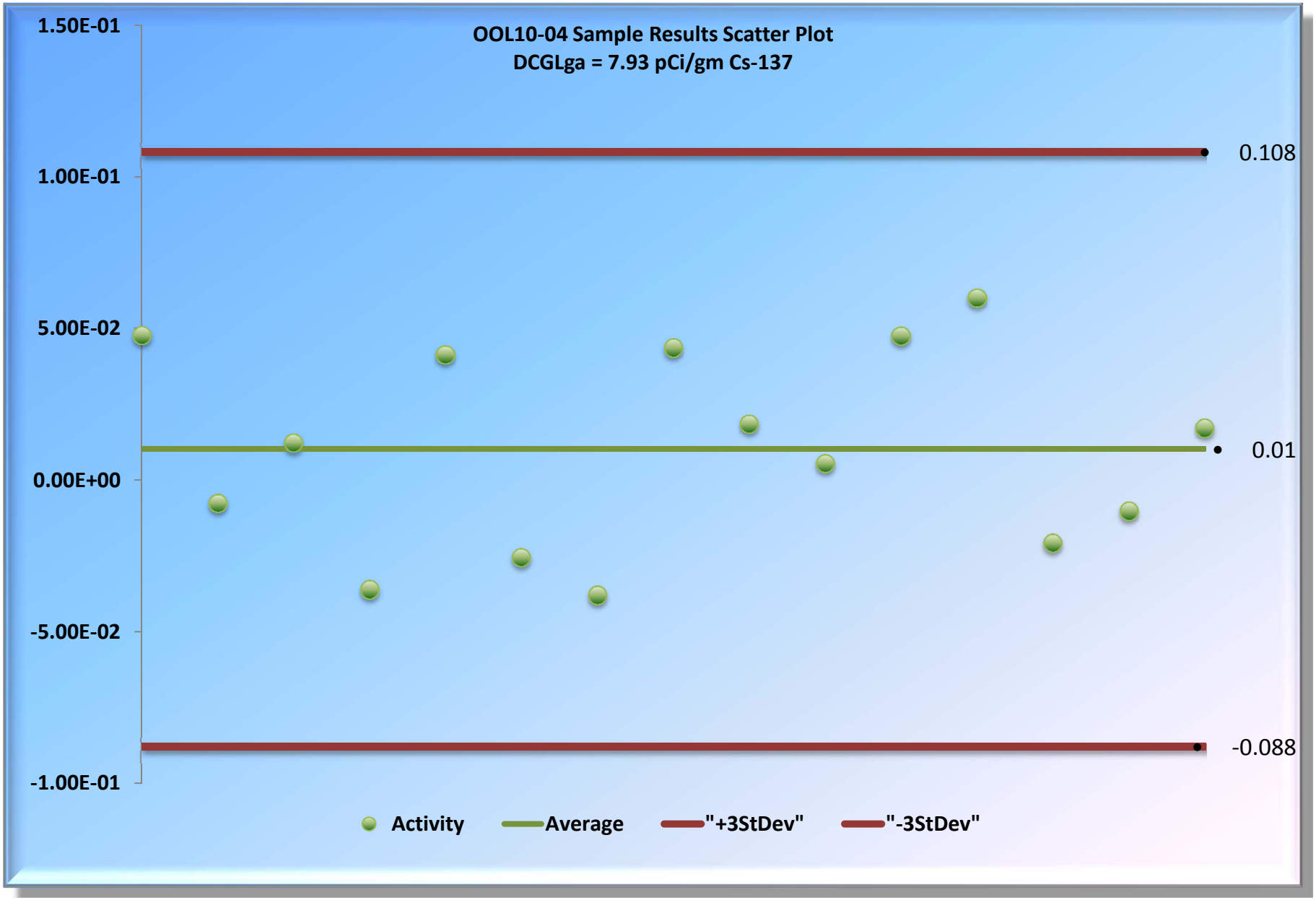
Cs-137 Results for Biased Soil Samples		
Sample Number	**Cs-137 (pCi/g)**	**MDA (pCi/g)**
OOL10-04-016-F-B	5.06E-02	1.29E-01
OOL10-04-017-F-B	1.06E-01	1.25E-01

Attachment 4

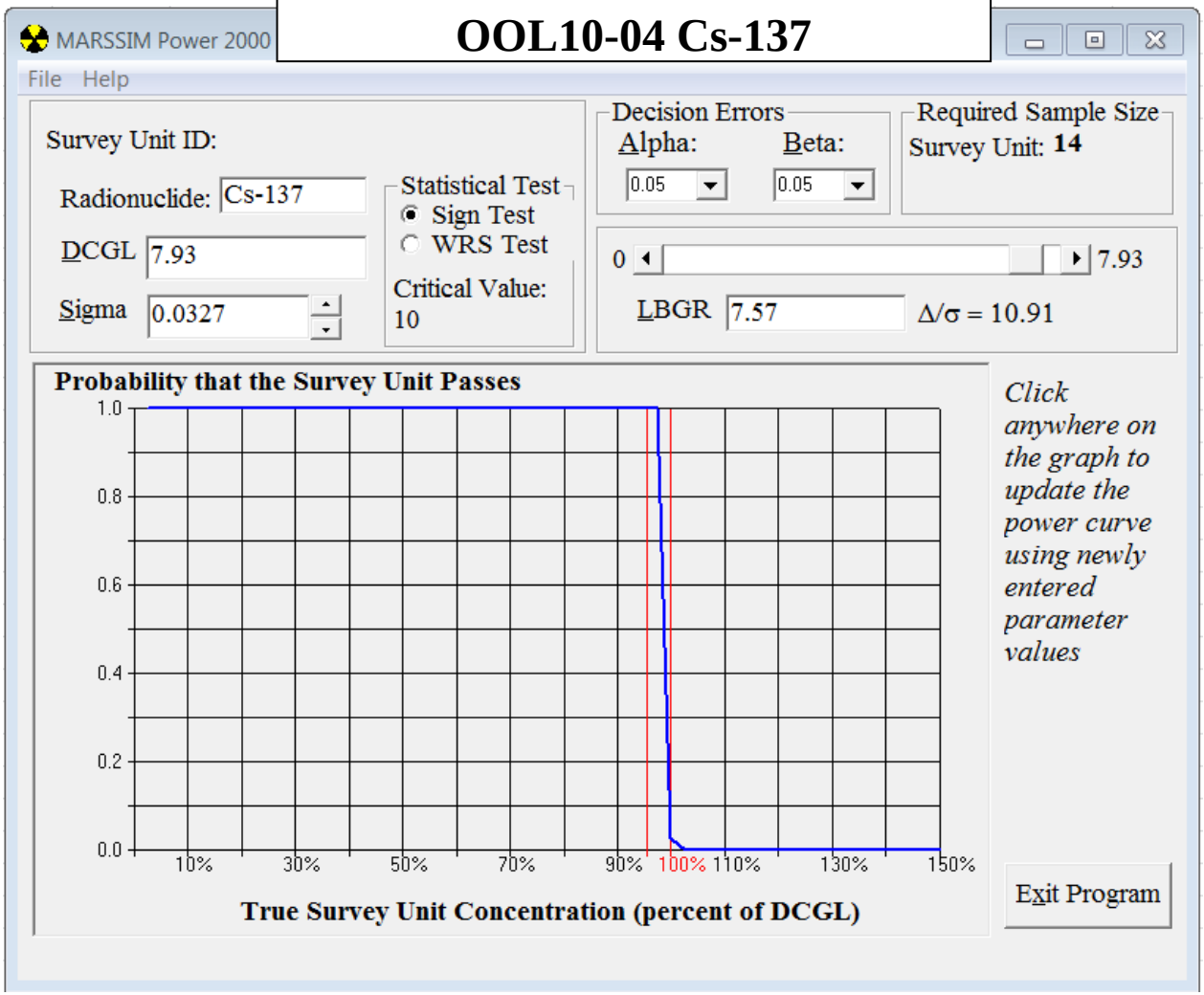
Data Assessment

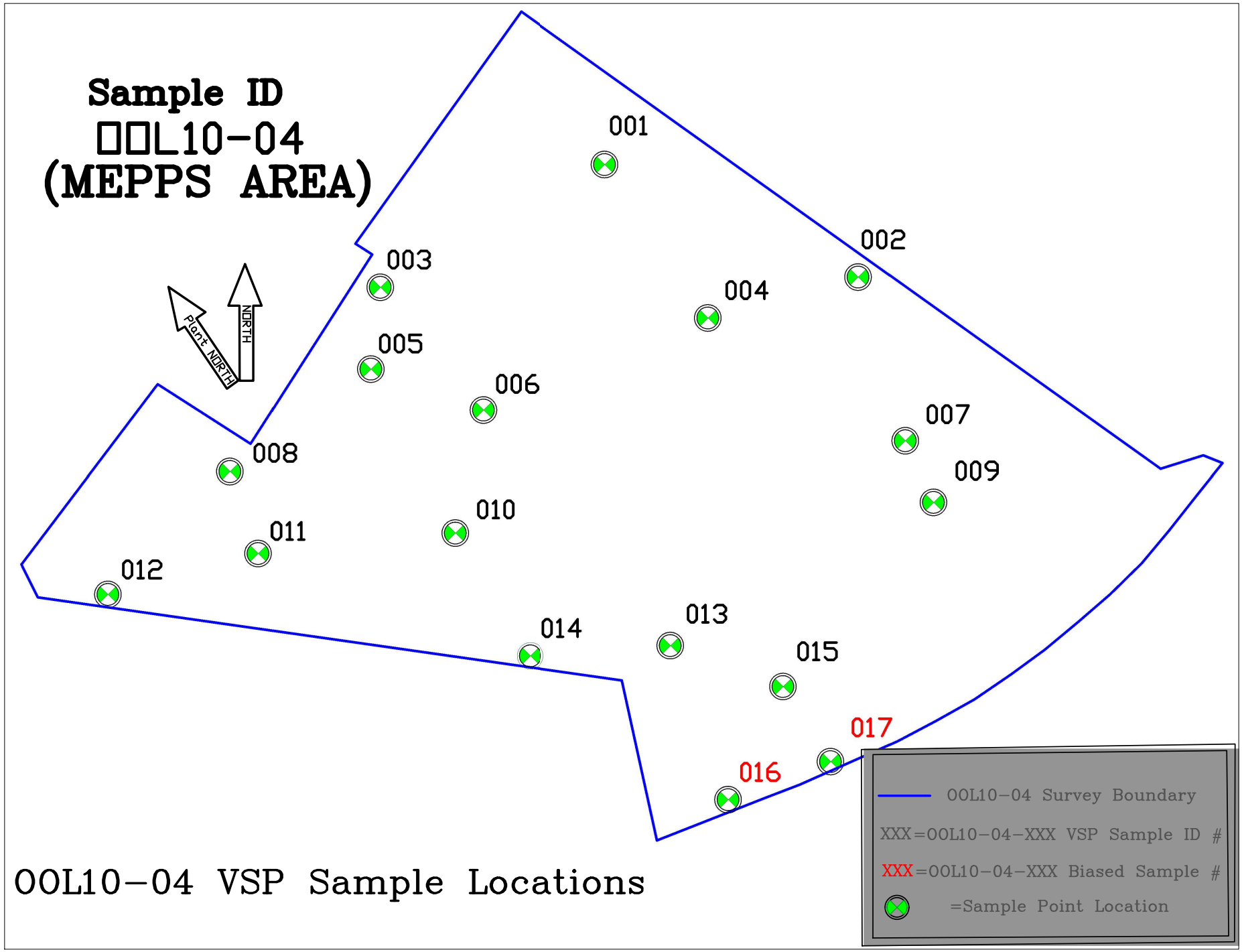

OOL10-04 Frequency Plot
Number of Observations
3.5
3
2.5
2
1.5
1
0.5
0
-0.038
-0.02165
-0.0053
0.01105
0.0274
0.04375
0.0601
Bin Upper End Value (pCi/gm)

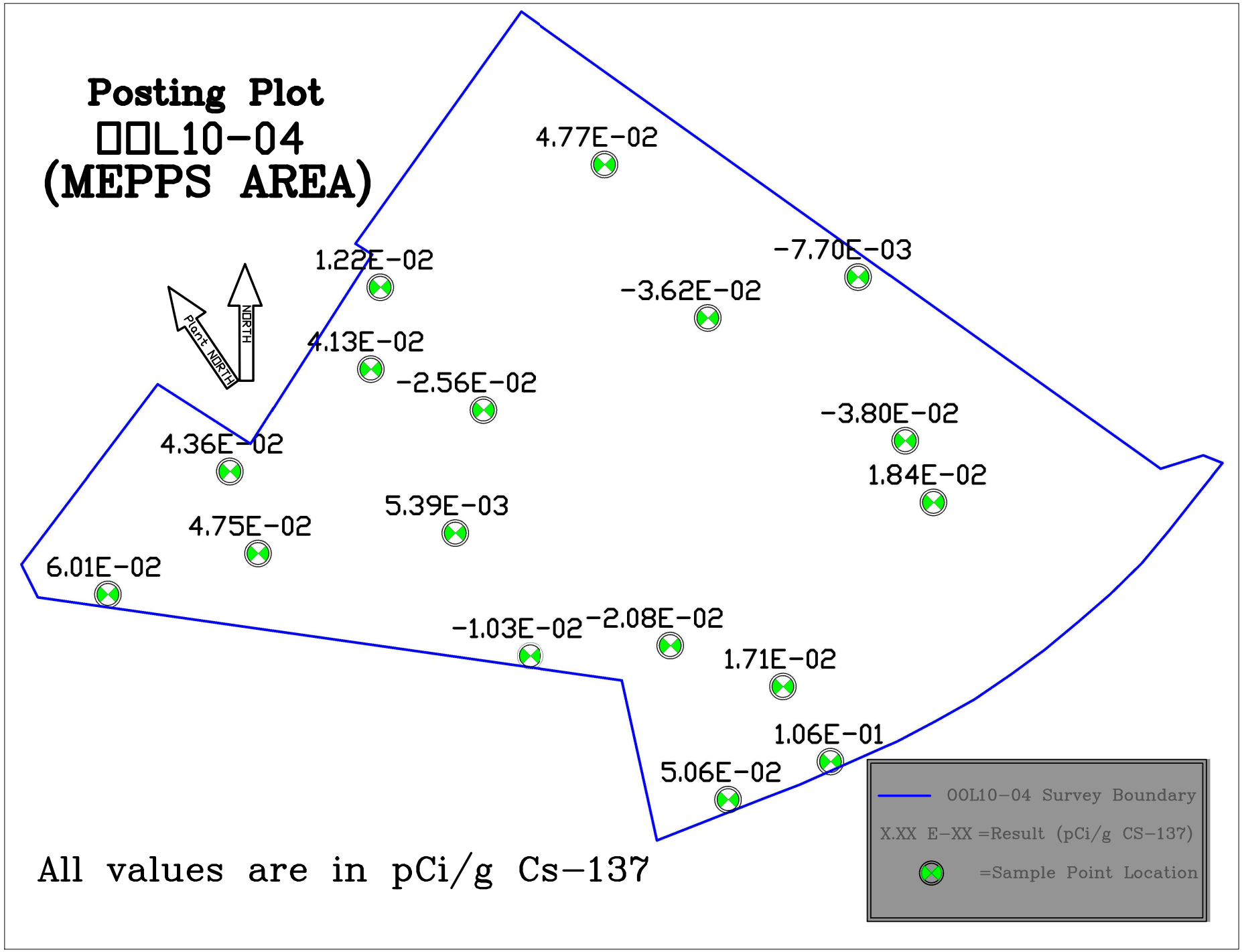

OOL10-04 Sample Results Quantile Plot
0.07
0.05
0.03
0.01
-0.01
-0.03
-0.05
Activity (pCi/gm)
0
10
20
30
40
50
60
70
80
90
100
Percentile
0.012
Direct Measurements
median
75th Percentile
50th Percentile


OOL10-04 Sample Results Scatter Plot
DCGLga = 7.93 pCi/gm Cs-137
1.50E-01
1.00E-01
5.00E-02
0.00E+00
-5.00E-02
-1.00E-01
0.108
0.01
-0.088
Activity
Average
"+3StDev"
"-3StDev"

Retrospective Power Curve
OOL10-04 Cs-137




Sample ID
□□L10-04
(MEPPS AREA)
001
002
003
004
005
006
007
008
009
010
011
012
013
014
015
016
017
PLANT NORTH
NORTH
00L10-04 Survey Boundary
XXX=00L10-04-XXX VSP Sample ID #
XXX=00L10-04-XXX Biased Sample #
=Sample Point Location
00L10-04 VSP Sample Locations


Posting Plot
OOL10-04
(MEPPS AREA)
4.77E-02
1.22E-02
-7.70E-03
-3.62E-02
Plant NORTH
NORTH
4.13E-02
-2.56E-02
-3.80E-02
4.36E-02
1.84E-02
5.39E-03
4.75E-02
6.01E-02
-1.03E-02
-2.08E-02
1.71E-02
1.06E-01
5.06E-02
00L10-04 Survey Boundary
X.XX E-XX =Result (pCi/g CS-137)
=Sample Point Location
All values are in pCi/g Cs-137

Split Sample Assessment Form

Survey Area No.: OOL-10	Survey Unit No.: 04	Survey Unit Name: MEPPS
Sample Plan No.: HBPP-FSS-OOL10-04-00		Sample Measurement Location: #01

Sample Description: Comparison of split samples collected from sample measurement location #01 and analyzed using gamma spectroscopy by an off-site vendor laboratory. The on-site result is the standard count and the off-site is the comparison.

STANDARD					COMPARISON			
Radio-nuclide chosen (a)	Standard Activity (b)	1σ *Uncertainty* (c)	Resolution (d)=(b)/(c)	Agreement Range (e)	Comparison Activity (f)	Comparison Error (g)	Comparison Ratio (h)=(f)/(b)	Acceptable (Y/N)
K-40	7.09E+00	6.30E-01	1.13E+01	0.6-1.66	8.00E+00	3.23E-01	1.13E+00	Y
Pb-214	3.35E-01	3.44E-02	9.75E+00	0.6-1.66	4.51E-01	4.55E-02	1.35E+00	Y

Comments/Corrective Actions: None.

Table 1 is provided to show acceptance criteria to assess split samples.

Resolution (d)	Agreement Range (e)
<4	No Comparison
4 – 7	0.5 – 2.0
8 – 15	0.6 – 1.66
16 – 50	0.75 – 1.33
51 – 200	0.80 – 1.25
>200	0.85 – 1.18

Performed By: [signature]	Date: 12-11-13	Concurrence: [signature]	Date: 12/11/13

Split Sample Assessment Form

Survey Area No.: OOL-10	Survey Unit No.: 04	Survey Unit Name: MEPPS
Sample Plan No.: HBPP-FSS-OOL10-04-00		Sample Measurement Location: # 11
Sample Description: Comparison of a recounted sample collected from sample measurement location #11 and analyzed using gamma spectroscopy at the on-site laboratory.		

	STANDARD				COMPARISON			
Radio-nuclide chosen (a)	Standard Activity (b)	1σ *Uncertainty* (c)	Resolution (d)=(b)/(c)	Agreement Range (e)	Comparison Activity (f)	Comparison Error (g)	Comparison Ratio (h)=(f)/(b)	Acceptable (Y/N)
K-40	6.81E+00	6.50E-01	1.05E+01	0.6-1.66	9.05E+00	7.55E-01	1.33E+00	Y
Pb-212	2.78E-01	3.88E-02	7.17E+00	0.5-2.0	2.99E-01	3.83E-02	1.08E+00	Y

Comments/Corrective Actions: None.

Table 1 is provided to show acceptance criteria to assess split samples.

Resolution (d)	Agreement Range (e)
<4	No Comparison
4 – 7	0.5 – 2.0
8 – 15	0.6 – 1.66
16 – 50	0.75 – 1.33
51 – 200	0.80 – 1.25
>200	0.85 – 1.18

Performed By: Carl Rudall	Date: 12-11-13	Concurrence:	Date: 1/10/17

Split Sample Assessment Form

Survey Area No.: OOL-10	Survey Unit No.: 04	Survey Unit Name: MEPPS
Sample Plan No.: HBPP-FSS-OOL10-04-00		Sample Measurement Location: #015

Sample Description: Comparison of split samples collected from sample measurement location #015 and analyzed using gamma spectroscopy by an off-site vendor laboratory. The on-site result is the standard count and the off-site is the comparison.

STANDARD					COMPARISON			
Radio-nuclide chosen (a)	Standard Activity (b)	1σ *Uncertainty* (c)	Resolution (d)=(b)/(c)	Agreement Range (e)	Comparison Activity (f)	Comparison Error (g)	Comparison Ratio (h)=(f)/(b)	Acceptable (Y/N)
K-40	6.38E+00	5.30E-01	1.20E+01	0.6-1.66	7.75E+00	4.74E-01	1.21E+00	Y
Pb-212	2.94E-01	3.03E-01	9.72E-01	0.6-1.66	3.95E-01	4.42E-02	1.34E+00	Y

Comments/Corrective Actions: None.

Table 1 is provided to show acceptance criteria to assess split samples.

Resolution (d)	Agreement Range (e)
<4	No Comparison
4 – 7	0.5 – 2.0
8 – 15	0.6 – 1.66
16 – 50	0.75 – 1.33
51 – 200	0.80 – 1.25
>200	0.85 – 1.18

Performed By: Dan Rudall	Date: 12-11-13	Concurrence:	Date: 1/10/17

Attachment 5

ALARA Statement

Generic ALARA Evaluation Comparison Worksheet

Survey Area:	OOL10	**Survey Unit:**	04
Reference Generic ALARA Evaluation No.:			2
Applicable Generic ALARA AL:			144

	Radionuclide	Average Concentration (pCi/g)	DCGL (pCi/g)	Fraction DCGL
1.	Cs-137	1.03E-02	7.93	1.30E-03
2.				
3.				
4.				

If the ∑(fraction DCGL) <the generic ALARA AL, then the generic ALARA evaluation is applicable to the survey unit.

Check one:

X Generic ALARA AL IS satisfied

_____ Generic ALARA AL IS NOT satisfied

Prepared by: Gordon Madison — Date: 5/24/18
FSS Engineer (Print/Sign)

Reviewed by: M H BLAKE / M H Blake — Date: 5-24-18
FSS Engineer (Print/Sign)

Approved by: W H BARLEY / W H Barley — Date: 5-24-18
Site Closure Manager or Designee (Print/Sign)

Pacific Gas and Electric Company®

Generic ALARA Review for Final Status Survey of Soil at HBPP

July, 08, 2013
Martin C. Erickson

Reviewed By: Larry Dockins **Date:** 7/10/2013

Approved By: M A Barley **Date:** 8/1/13

Table of Contents

Executive Summary

In addition to the requirement to limit the dose from residual, plant-related radioactivity in soil to members of the critical group to 25 mrem in any year, the License Termination Plan (LTP) requires an evaluation demonstrating that these levels are as low as reasonably achievable (ALARA). If compliance with the ALARA criterion cannot be demonstrated, remediation of the soil is required, even though this would further reduce the otherwise acceptable exposure to the critical group to levels below those required. This report is intended to provide a generic ALARA review to bound the conditions under which no further remediation is necessary for soils. Calculations were performed using LTP equations and conservative assumptions. The conclusion is that it is not cost-beneficial to remediate soil in which the levels of residual, plant-related radioactivity are below LTP release criteria.

1.0 Introduction

Section 4.4 of the LTP [1] states that a generic ALARA evaluation for soils may be developed to determine if the clean up of soils beyond the DCGLs will be cost-beneficial for HBPP. Section 4.5 of the LTP provides equations and default values for this calculation. This process will be followed, assuming that the soil is at the DCGL and using conservative estimates of costs, distances and other inputs that the worksheet requires. The equation will calculate an action level (AL) that represents the ratio of concentration to the DCGL that would be cost-beneficial to remediate. If that ratio is greater than 1, remediation is not cost-beneficial.

This calculation is meant to apply to areas of any MARSSIM class and any size. In a Class 1 area, where values of residual contamination may exceed the $DCGL_W$ in limited areas, the mean concentration may never exceed the $DCGL_W$. Since it is assumed that the entire volume of soil removed is at $DCGL_W$, the assumed mean will be at $DCGL_W$. Therefore, the assumed case will be bounding.

2.0 Discussion

The total cost ($Cost_T$) will be calculated using LTP equation in Section 4.4.1):

$$Cost_T = Cost_R + Cost_{WD} + Cost_{ACC} + Cost_{TF} + Cost_{WDose} + Cost_{PDose} + Cost_{other}$$

These terms are defined and their values calculated as follows:

2.1 Cost of performing remediation work ($Cost_R$):

- Initially it will be assumed that the job is big enough to require earthmoving equipment. At a minimum, this would be either an excavator or a loader and truck. This turns out not to be a constraint, as explained later.

- To come up with a conservative scenario, the cost of remediating one square meter from a larger project is calculated. Any smaller job by, itself, would have planning and administration costs that would be dominant. Factors contributing to $Cost_R$ are identified in Attachment 1. The initial estimate for $Cost_R$ is based on a job to remediate 2000 square meters of soil, but to make it comparable to the other costs, that value is adjusted to reflect the cost of 1 square meter.

- The adjusted value of $Cost_R$ is \$7.32 to remediate 1 square meter of soil.

- Rounding down to the dollar, $Cost_R$ = \$7

Note: The value of $Cost_R$ calculated above bounds the cost of a smaller excavation, e.g., one that doesn't require earthmoving equipment. For example, two workers who take an hour to dig up some soil and bring it back

in wheelbarrow, with no work order or other formal planning, would cost the project about $100 in labor costs (assuming the cost to the project is $50/hr). So, the constraint that this only applies to jobs big enough to require earthmoving equipment can be removed.

2.2 Cost of waste disposal ($Cost_{WD}$):

- As above, it will be assumed that one square meter of surface soil is to be remediated. Surface soil is considered to be the top 15 cm. The estimated waste volume will therefore be 15 cm times the area of 1 m^2. This comes to 0.15 m^3.

- The current cost of waste disposal for radiologically contaminated soil is $100 per cubic meter. This includes burial fees and shipping.

- Rounding down to the dollar, $Cost_{WD}$ = $15

2.3 Cost of workplace accident ($Cost_{ACC}$):

- $Cost_{ACC}$ = ($3,000,000)x(4.2E-8/h)x(Time to perform remediation) .
- $3,000,000 is the monetary value of a fatality equivalent to $2000 per person-rem.
- 4.2E-8 is the workplace fatality rate, in fatalities per hour worked.
- For a 1 square meter excavation, this would not be more than a few person-hours. (Assume Time = 1.62 hr)
- ($3,000,000) x (4.2E-8/h) x (1.62 h) = $0.20
- Rounding down to the dollar, $Cost_{ACC}$ = $0

2.4 Cost of traffic fatality ($Cost_{TF}$):

- $Cost_{TF}$ = ($3,000,000)x(3.8E-8/km)x(Volume)x(Distance)/(Volume/shipment) .
- Round trip distance from HBPP to Grand View, ID: 2292 km/shipment ... (from Google Maps)
- Waste volume per shipment: 13.6 m^3/shpmt ... (default in LTP, Section 4.5.1.7.
- ($3,000,000)x(3.8E-8/km)x(0.15 m^3)(2292 km/shpmt)/(13.6 m^3/shpmt) = $2.88
- Rounding down to the dollar, $Cost_{TF}$ = $2

2.5 Cost of worker dose ($Cost_{WDose}$):

- $Cost_{WDose}$ = ($2000/person-rem)x(Worker dose rate)x(Time) .
- Dose rates would be insignificant. (Assume dose rate = 0.1 mrem/h = 1E-4 rem/h)

- ($2000/person-rem) x (1E-4 rem/h) x (1.62 h) = $0.32
- Rounding down to the dollar, $Cost_{WDose}$ = $0

2.6 Cost of Dose to the Public ($Cost_{PDose}$):

- $Cost_{DP}$ is assumed to be no more than the $Cost_{WD}$.
- Assumed $Cost_{PDose}$ = $0

2.7 Other costs associated with this situation ($Cost_{other}$)

There are no other costs associated with this remediation.

3.0 Calculation

ALARA Action Level (AL):

$$AL = \frac{Conc}{DCGL_W} = \frac{Cost_T}{\$2{,}000 \times P_D \times 0.025 \times F \times A} \times \frac{r+\lambda}{1-e^{-(r+\lambda)N}}$$

where:

- $Cost_T$ has been calculated above
- $2000 is the monetary value of one person-rem (Table 4-1, LTP)
- F = removable fraction = 1 … (most conservative possible)
- 0.025 is the annual dose in rem to an average member of critical group from residual radioactivity.
- r = monetary discount rate = 0.03/y … (Table 4-1, LTP)
- N = Number of years over which the collective dose is calculated = 1000 y … (Table 4-1, LTP)
- PD = Population density for the critical group = 0.0001 people/m^2. (Table 4-1, LTP)
- A = Area being evaluated = 1 m^2
- Most conservative nuclide of concern is that with the longest half-life, Tc-99, with a half-life of 2.13E5 years (Table 6-1, LTP) and a decay constant (λ) of 3.254E-6 y^{-1} (Note: With the values for other variables used for this calculation, the 1-e… term equals 1 for any value of λ. Therefore, the smallest AL, which is the most conservative, will occur when λ, in the top of the equation, is smallest.)

Applying these values to the equation:

$$AL = \frac{24}{2000 \times 0.0001 \times 0.025 \times 1 \times 1} \times \frac{0.03 + 3.254E-06}{1 - e^{-(0.03+3.254E-6)*1000}}$$

AL = 144

If Tc-99 were at DCGL:
- Sum of DCGL Fractions = 1

Since AL is greater than the Sum of DCGL Fractions, remediation is not cost-beneficial. In fact, remediation would not be cost-beneficial unless the concentration of any LTP nuclide in soil were at least 144 times the DCGL.

4.0 Conclusions

Based upon the results of this ALARA evaluation, it is not cost-beneficial to remediate soil in which the levels of residual, plant-related radioactivity are below LTP release criteria.

5.0 References

1. HBPP License Termination Plan
2. U.S. Nuclear Regulatory Commission, NUREG-1530, "Reassessment of NRC's Dollar per Person-Rem Conversion Factor Policy," December 1995

Attachment 1
Cost estimate basis

Cost estimate for remediation work ($Cost_R$)

Assume larger project, to dilute fixed costs: 2000 m^2, removing the top 15 cm of soil

	Time (hr)	Rate ($/hr)	Cost
Const. Planner, Rad Engineer	50	$100	$5000
Supervision/management	1	$200	$200
Resurvey	50	$50	$2500
Additional off-site analysis			$2400
Additional on-site analysis			$1500
Equip + Operators	10	$250	$2500
RP Coverage	10	$50	$500
Total for 2000 m^2			$14,640
Cost per m^2			$7.32

Attachment 6

Gamma Spectroscopy Instrumentation Documentation

CANBERRA

COPY

Rev. 6/15/99

DETECTOR SPECIFICATION AND PERFORMANCE DATA

Specifications

DETECTOR MODEL	GC3020	SERIAL NUMBER	05069128
CRYOSTAT MODEL	7915-GA	PREAMPLIFIER MODEL	2002C

The purchase specifications, and therefore the warranted performance, of this detector are as follows:
(Electric cooling may degrade performance by as much as 10%.)

Active Volume _____ cc Relative Efficiency 30 %

Resolution 2.0 keV (FWHM) at 1.33 MeV
_____ keV (FWTM) at 1.33 MeV
_____ keV (FWHM) at _____
_____ keV (FWTM) at _____

Peak/Compton 54 :1 Cryostat well diameter _____ mm Cryostat well depth _____ mm

Cryostat description (if special) 3"Ø Endcap

Physical Characteristics

Geometry Closed-end coaxial

Diameter	62.5 mm	Active Volume	_____ cc
Length	40.5 mm	Well Depth	_____ mm
Distance from window	5 mm	Well Diameter	_____ mm

Electrical Characteristics

Depletion voltage (+)2500 V dc
Recommended bias voltage (+)3500 V dc
Test point voltage at recommended bias (-)0.05 V dc (RC preamp only)
Reset interval at recommended bias ---- sec. (Reset preamp only)
Capacitance at recommended bias ~16 pF

Resolution and Efficiency

With amp time constant of 6 microseconds

Isotope	^{57}Co	^{60}Co			
Energy (keV)	122	1332			
FWHM (keV)	1.04	1.78			
FWTM (keV)	1.92	3.31			
Peak/Compton		57.6:1			
Rel. Efficiency %		31.4			

Cool Down Time 8 hours. Cryostat Liquid Nitrogen Consumption Rate <1.6 Liters per Day.

Tested by: Wesley Amos Date: 05/26/06

Approved by: Stephen Bishop Date: 05/26/06

800 Research Parkway, Meriden, CT USA 06450 • Tel. 203-238-2351/Fax. 203-235-1347

MCA: Type: DSA-2000 Serial No.4061393

Stab.: Type: DSA-2000 Serial No.0
Zero centroid: 512 ch
Zero window: 8 chs
Zero spacing: 64 chs
Zero rate div: 1
Zero range: Ge
Zero mode: Off
Zero correct: 0
Zero overrange: clear
Gain centroid: 7680 ch
Gain window: 8 chs
Gain spacing: 64 chs
Gain rate div: 1
Correction rng: Ge
Gain mode: Off
Gain correct: 4096
Gain overrange: clear
Zero ratio: 1.000
Gain ratio: 1.000

Chnger: Type: GChanger Serial No.0
sample changer status: ready
PLC hard error register: 0
PLC soft error register: 0
PLC out-of-service reason: 0

HVPS: Type: DSA-2000 Serial No.0
Voltage: 3500.6v
Inh. signal: 5V
Polarity: positive
Status: on
Range: 5000
Fault: clear

Gain: Type: DSA-2000 Serial No.0
Coarse gain: 40
Fine gain: 0.4884
S-fine gain: 0.014645
Conv. gain: 8192
Range: 8192
Offset: 0
LLD: 1.001%
Zero: 0.000%
FDisc Mode: Auto
FDisc Setting: 1.0%
Inp. Polarity: positive
Inh. polarity: positive
LTC mode: On
Coinc. mode: anti.
PUR Guard: 1.10x
Inhibit Mode: manual
LT Trim: 250
ICR: 6

F ter: Type: DSA-2000 Serial No.0
Rise Time: 5.6
Flat Top: 0.8
BLR mode: Auto
Preamp type: RC
Pole zero: 3064

GENIE-2000
Calibration Records
Detector 6, Sn 05069128

COPY

- **Energy Re-Calibration**

Performed by _____ **Date** 2-22-12

Reviewed by D. Anderson **Date** 3/2/12

Apex™

Analysis Report for Energy Calibration Sample

ENERGY CALIBRATION REPORT

Detector Name : DET06

ENERGY CALIBRATION COEFFICIENTS

Energy Calibrate Performed on : 2/22/2012 4:51:55PM
by : Administrator
Energy Calibrate Type : POLY

Energy (keV) = -0.006 + 0.500*ch + -1.22E-07*ch^2 + 3.27E-11*ch^3

SHAPE CALIBRATION COEFFICIENTS

Shape Calibrate Performed on : 2/22/2012 4:51:55PM
by : Administrator

FWHM = 1.114 + 2.61E-02 *E^1/2

LOW TAIL = 1.05E+00 + 1.01E-03*E

ENERGY CALIBRATION RESULTS TABLE

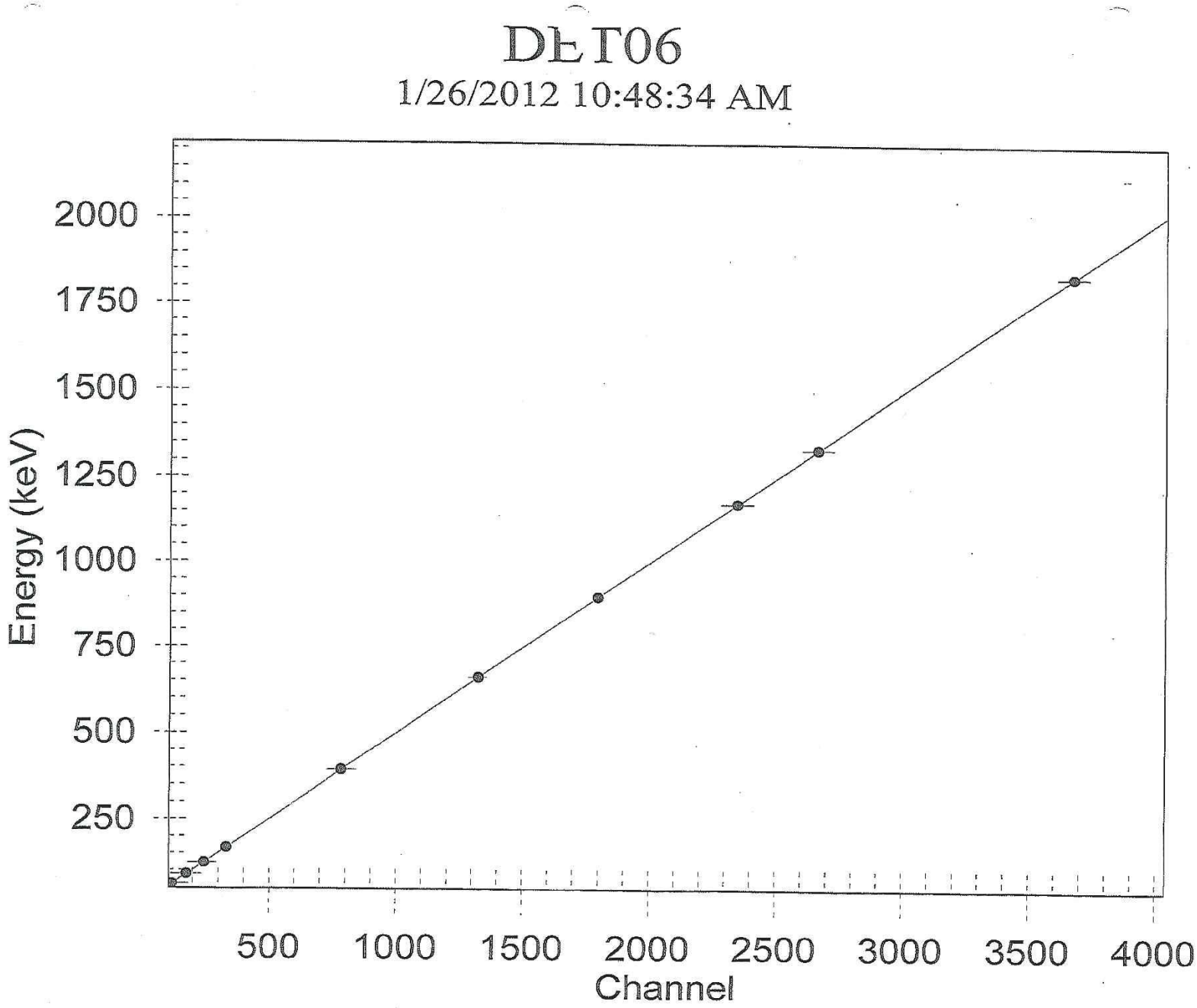
Centroid Channel	Centroid error	Energy (keV)
119.18	0.01	59.54
176.08	0.00	88.03
244.07	0.00	122.06
331.65	0.01	165.85
783.09	0.01	391.69
1323.39	0.01	661.65
1796.25	0.01	898.02
2346.37	0.01	1173.22
2664.91	0.01	1332.49
3671.34	0.02	1836.01

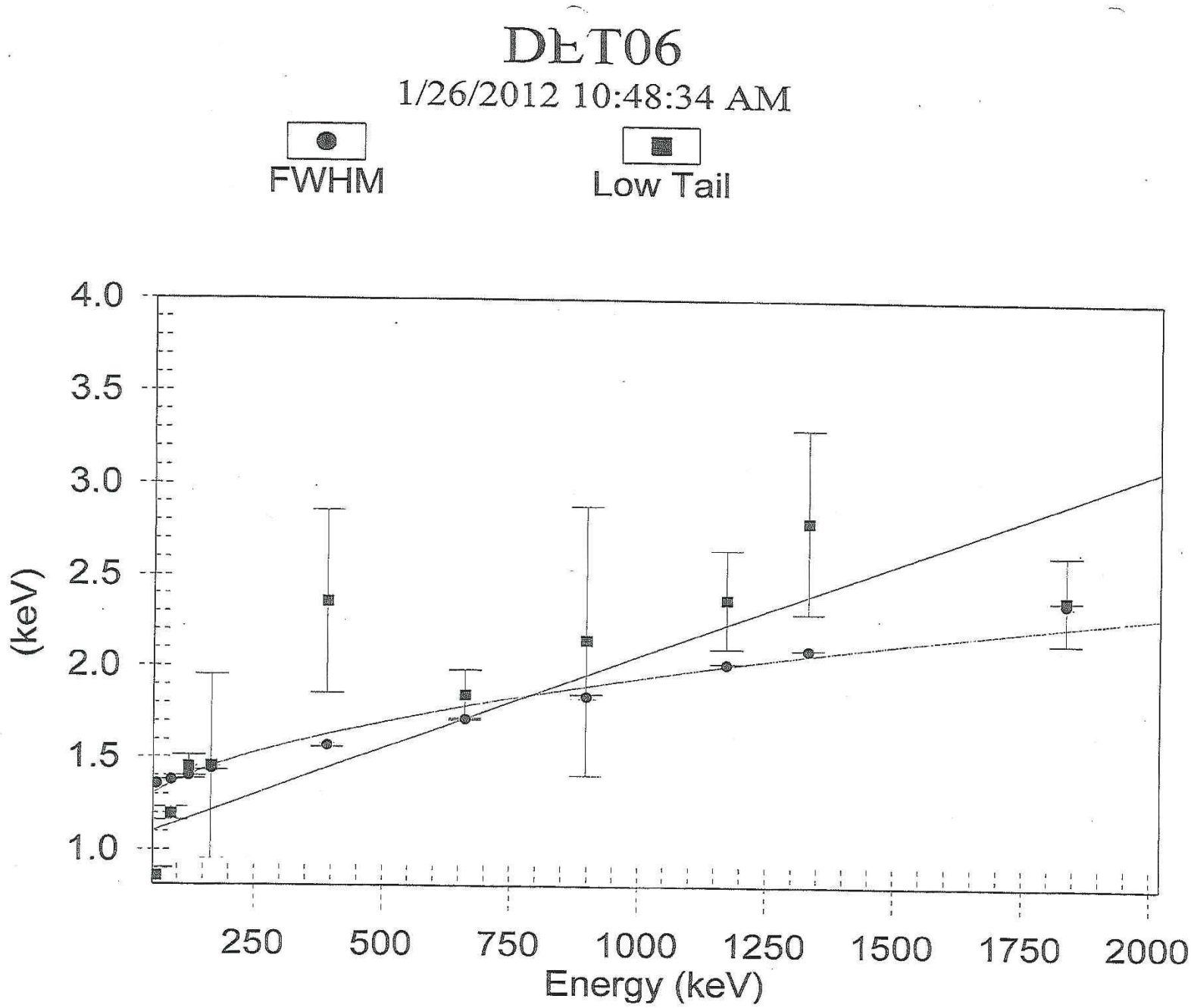
SHAPE CALIBRATION RESULTS TABLE

Energy (keV)	FWHM channels	FWHM error	TAIL channels	TAIL error
59.54	2.71	0.03	1.72	0.09
88.03	2.75	0.01	2.39	0.07
122.06	2.80	0.01	2.90	0.13
165.85	2.88	0.02	2.91	1.00

Analysis Report for Energy Calibration Sample

Energy (keV)	FWHM channels	FWHM error	TAIL channels	TAIL error
391.69	3.14	0.02	4.71	1.00
661.65	3.43	0.01	3.69	0.27
898.02	3.68	0.02	4.29	1.47
1173.22	4.03	0.01	4.75	0.54
1332.49	4.19	0.01	5.59	1.00
1836.01	4.72	0.03	4.76	0.48


DET06
1/26/2012 10:48:34 AM
Energy (keV)
2000
1750
1500
1250
1000
750
500
250
500
1000
1500
2000
2500
3000
3500
4000
Channel


DET06
1/26/2012 10:48:34 AM
FWHM
Low Tail
4.0
3.5
3.0
2.5
2.0
1.5
1.0
(keV)
250
500
750
1000
1250
1500
1750
2000
Energy (keV)

****
***** CERTIFICATE FILE REPORT *****
****

Filename: C:\GENIE2K\CAMFILES\HBS-572_1L_LD.CTF

Certificate Description:

Certificate Title: HBS-572_1L_LD

Quantity : 1.00 units

Assay date : 1/1/2011 9:00:00 AM

Original Certificate:

Nuclide Name	Half-Life (Days)	Energy (keV)	Emission Rate DPS/Unit	Emission Rate % Uncert. (+-)
Am-241	1.579E+005	59.540*	649.9	3.50
CD-109	4.640E+002	88.030*	949.5	4.90
CO-57	2.709E+002	122.060*	487.4	4.10
CE-139	1.377E+002	165.850*	697.7	3.90
HG-203	4.660E+001	279.190	1540.0	3.90
SN-113	1.151E+002	391.690*	989.8	3.90
CS-137	1.102E+004	661.650*	620.5	4.00
Y-88	1.066E+002	898.020*	2363.0	3.90
CO-60	1.925E+003	1173.220*	1198.0	4.00
CO-60	1.925E+003	1332.490*	1199.0	4.00
Y-88	1.066E+002	1836.010*	2502.0	3.90

* = Used for Calib/INIT

Apex™

Analysis Report for Efficiency Calibration Sample

EFFICIENCY CALIBRATION REPORT

Detector Name	:	DET06
Geometry Description	:	1L Marinelli LD
Efficiency Calibration Performed on	:	4/27/2011 4:02:31PM
by	:	Administrator
Efficiency Type Used	:	DUAL, NO X-OVER

Efficiency Triplets

Energy	*% Efficiency*	*Error*	*Computed*	*Error*	*% Difference*
59.54	1.40E+00	5.18E-02	1.40E+00	5.15E-02	-1.72E-03
88.03	3.25E+00	1.60E-01	3.20E+00	1.21E-01	4.60E-02
122.06	3.79E+00	1.58E-01	3.87E+00	1.07E-01	-8.49E-02
165.85	3.72E+00	1.47E-01	3.66E+00	1.01E-01	6.08E-02
279.19	2.59E+00	1.04E-01	2.60E+00	7.03E-02	-9.79E-03
391.69	1.95E+00	7.73E-02	1.96E+00	5.14E-02	-7.70E-03
661.65	1.26E+00	5.14E-02	1.25E+00	3.49E-02	1.28E-02
898.02	9.48E-01	3.75E-02	9.57E-01	2.21E-02	-8.40E-03
1173.22	7.58E-01	3.08E-02	7.59E-01	1.92E-02	-1.05E-03
1332.49	6.84E-01	2.77E-02	6.81E-01	1.83E-02	3.35E-03
1836.01	5.25E-01	2.09E-02	5.26E-01	2.06E-02	-4.23E-04

DUAL Efficiency Calibration Equation

Single Equation Terms

Offset :	-2.88E+02
Slope :	2.23E+02
Quadratic :	-6.91E+01
Cubic :	1.07E+01
4th Order :	-8.23E-01
5th Order :	2.54E-02
6th Order :	0.00E+00
7th Order :	0.00E+00
8th Order :	0.00E+00
9th Order :	0.00E+00

EMPIRICAL Efficiency Calibration Equation

Analysis Report for Efficiency Calibration Sample

Empirical Equation Terms

Scaling : 9.48E+02
Offset : -4.70E+00
Slope : 8.67E-01
Quadratic : 2.18E-03
Cubic : -2.91E-02
4th Order : 4.69E-02
5th Order : -2.54E-02

LINEAR Efficiency Calibration Equation

Linear Equation Terms

Offset : -1.45E-04
Slope : -2.16E+00
Quadratic : 2.75E+02
Cubic : -3.52E+04
4th Order : 1.94E+06
5th Order : -4.49E+07
6th Order : 0.00E+00
7th Order : 0.00E+00
8th Order : 0.00E+00
9th Order : 0.00E+00

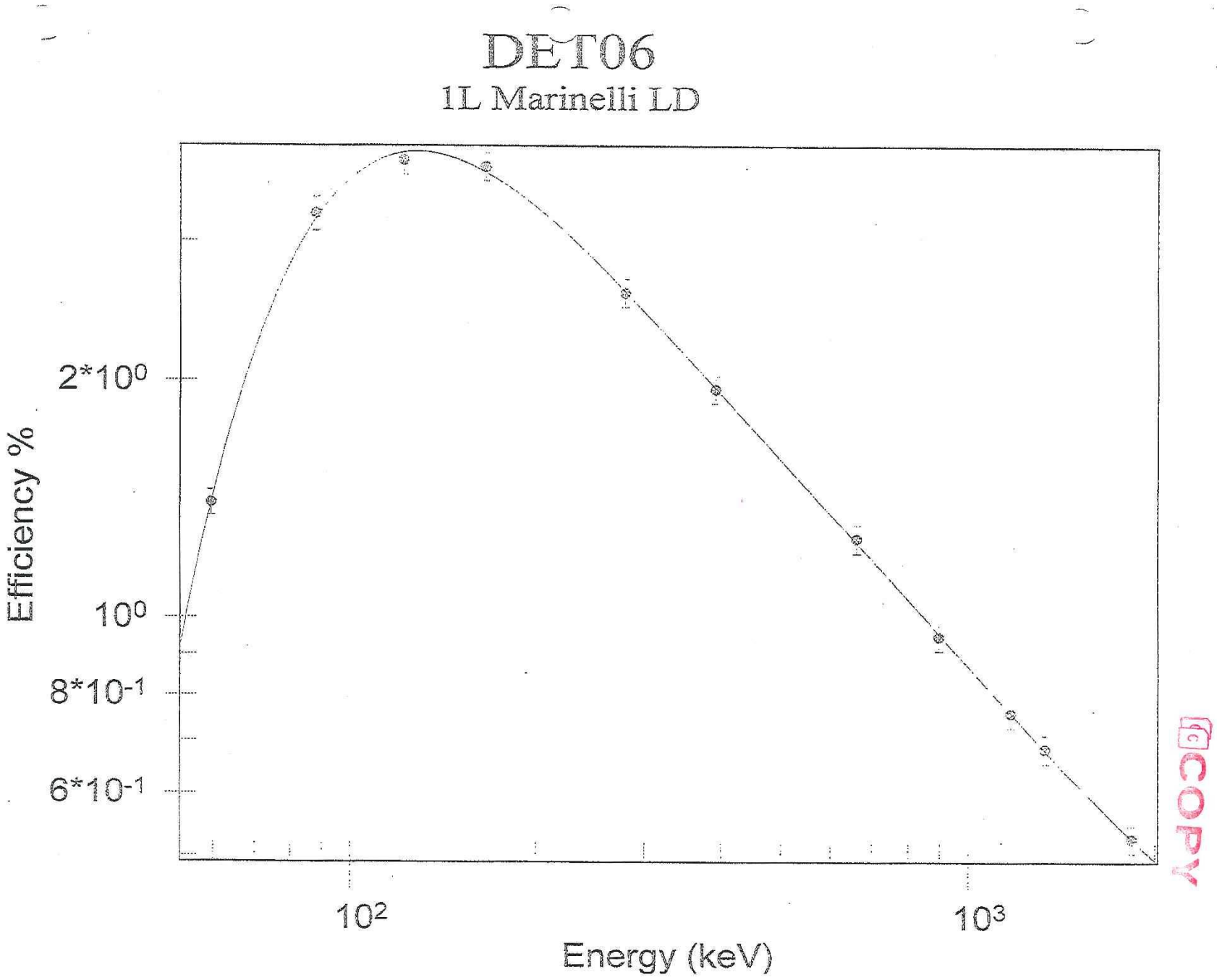
PEAK LOCATE REPORT

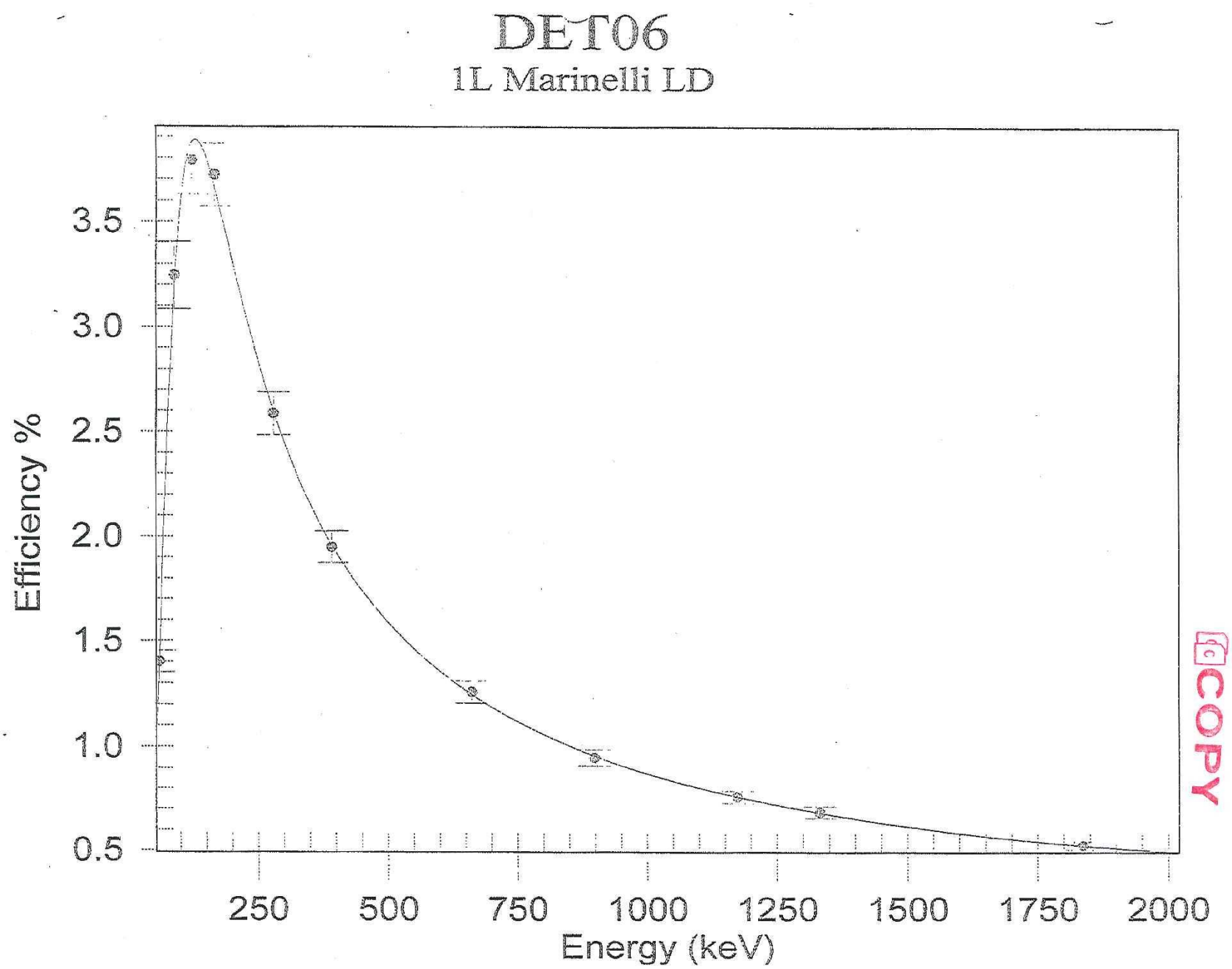
Peak Locate Performed on : 4/27/2011 3:58:02PM
Peak Locate From Channel : 1
Peak Locate To Channel : 65535
Peak Search Sensitivity : 5.00

Peak No.	*Energy (keV)*	*Centroid Channel*	*Centroid Uncertainty*	*Peak Significance*
1	41.78	84.06	0.1753	18.00
2	59.64	119.76	0.0795	75.06
3	73.04	146.55	0.3014	5.72
4	88.11	176.69	0.0597	132.72
5	122.10	244.65	0.0665	101.21
6	136.46	273.38	0.1271	27.63
7	165.83	332.12	0.0628	113.75
8	255.08	510.59	0.1852	12.26
9	279.15	558.72	0.0727	78.63
10	391.60	783.62	0.0640	93.38
11	661.68	1323.83	0.0651	89.30
12	814.38	1629.23	0.2004	9.37
13	898.07	1796.63	0.0585	99.22
14	1173.15	2346.73	0.0591	92.04
15	1324.96	2650.11	0.2076	6.31
16	1332.47	2665.29	0.0602	84.63
17	1836.03	3671.56	0.0619	72.52

Analysis Report for Efficiency Calibration Sample

? = Adjacent peak noted
Errors quoted at 1.000 sigma


DET06
1L Marinelli LD
Efficiency %
2*10^0
10^0
8*10^-1
6*10^-1
10^2
10^3
Energy (keV)


DET06
1L Marinelli LD
Efficiency %
3.5
3.0
2.5
2.0
1.5
1.0
0.5
250
500
750
1000
1250
1500
1750
2000
Energy (keV)

EFFICIENCY CONFIRMATION CHECK REPORT

Date : 4/27/2011
Time : 4:47:37PM
Facility : Default
User : Administrator
Detector : DET06
Geometry : 1L Marinelli LD
Certificate Name : HBS-572_1L_LD
Certificate Date : 1/1/2011 9:00:00AM

Nuclide Energy	Nuclide Name	Corrected Certificate Activity	Measured Activity	% Difference
59.54	Am-241	4.893E-02	5.042E-02	-3.06
88.03	CD-109	6.898E-01	6.912E-01	-0.20
122.06	CO-57	1.541E-02	1.518E-02	1.44
165.85	CE-139	2.347E-02	2.412E-02	-2.77
279.19	HG-203	5.384E-02	5.488E-02	-1.93
391.69	SN-113	4.122E-02	4.141E-02	-0.46
661.65	CS-137	1.970E-02	1.953E-02	0.86
898.02	Y-88	6.838E-02	6.763E-02	1.10
1173.22	CO-60	3.238E-02	3.233E-02	0.16
1332.49	CO-60	3.241E-02	3.248E-02	-0.22
1836.01	Y-88	6.804E-02	6.780E-02	0.36

Average Difference - 0.4

Eckert & Ziegler
Analytics

1380 Seaboard Industrial Blvd.
Atlanta, Georgia 30318
Tel 404·352·8677
Fax 404·352·2837
www.analyticsinc.com

CERTIFICATE OF CALIBRATION

Standard Radionuclide Source

HBS-572

83953-33

1.0 Liter Simulated Vegetation in 130G GA-MA Beaker

Customer: PG&E/Humboldt Bay
P.O. No.: 3500886495, Item 9
Reference Date: 01-Jan-2011 12:00 PM EST **Grams of Master Source:** 0.0055952

This standard radionuclide source was prepared using aliquots measured gravimetrically from master radionuclide solutions. Calibration and purity were checked using a germanium gamma spectrometer system. At the time of calibration no interfering gamma-ray emitting impurities were detected. The gamma ray emission rates for the most intense gamma-ray lines are given. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 1, February, 1979, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

Nuclide	Gamma-Ray Energy (keV)	Half-Life, Days	Master Source* γps/gram	This Source γps	Uncertainty, % Type u_A	u_B	U	Calibration Method
Am-241	59.5	1.580E+05	———	6.499E+02	0.1	1.7	3.5	4π LS
Cd-109	88.0	4.626E+02	1.697E+05	9.495E+02	0.8	2.3	4.9	HPGe
Co-57	122.1	2.718E+02	8.711E+04	4.874E+02	0.5	2.0	4.1	HPGe
Ce-139	165.9	1.376E+02	1.247E+05	6.977E+02	0.5	1.9	3.9	HPGe
Hg-203	279.2	4.661E+01	2.753E+05	1.540E+03	0.4	1.9	3.9	HPGe
Sn-113	391.7	1.151E+02	1.769E+05	9.898E+02	0.5	1.9	3.9	HPGe
Cs-137	661.7	1.098E+04	1.109E+05	6.205E+02	0.7	1.9	4.0	HPGe
Y-88	898.0	1.066E+02	4.224E+05	2.363E+03	0.5	1.9	3.9	HPGe
Co-60	1173.2	1.925E+03	2.142E+05	1.198E+03	0.6	1.9	4.0	HPGe
Co-60	1332.5	1.925E+03	2.143E+05	1.199E+03	0.6	1.9	4.0	HPGe
Y-88	1836.1	1.066E+02	4.472E+05	2.502E+03	0.5	1.9	3.9	HPGe

* Master Source refers to Analytics' 8-isotope mixture which is calibrated quarterly.

Calibration Methods: 4π LS - 4 pi Liquid Scintillation Counting, HPGe - High Purity Germanium Gamma-Ray Spectrometer, IC - Ionization Chamber. **Uncertainty:** U - Relative expanded uncertainty, k = 2. See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results."

(Certificate continued on reverse side)

ACCREDITED SOURCE CALIBRATION LABORATORY — HEALTH PHYSICS SOCIETY — FOUNDED 1955

Corporate Office
24937 Avenue Tibbitts Valencia, California 91355

Laboratory
1380 Seaboard Industrial Blvd. Atlanta, Georgia 30318

Apex™

Analysis Report for Efficiency Calibration Sample
1 L Marinelli MD Efficiency Calib.

EFFICIENCY CALIBRATION REPORT

Detector Name	:	DET06
Geometry Description	:	1L Marinelli MD
Efficiency Calibration Performed on	:	4/27/2011 10:59:25AM
by	:	Administrator
Efficiency Type Used	:	DUAL, No X-over

Efficiency Triplets

Energy	*% Efficiency*	*Error*	*Computed*	*Error*	*% Difference*
59.54	1.23E+00	4.62E-02	1.23E+00	4.60E-02	-2.67E-03
88.03	2.84E+00	1.40E-01	2.78E+00	1.05E-01	5.82E-02
122.06	3.28E+00	1.37E-01	3.37E+00	9.35E-02	-8.94E-02
165.85	3.26E+00	1.30E-01	3.21E+00	8.88E-02	5.09E-02
279.19	2.31E+00	9.39E-02	2.32E+00	6.34E-02	-4.56E-03
391.69	1.76E+00	7.07E-02	1.77E+00	4.69E-02	-3.30E-03
661.65	1.15E+00	4.74E-02	1.14E+00	3.22E-02	8.43E-03
898.02	8.73E-01	3.46E-02	8.83E-01	2.05E-02	-1.05E-02
1173.22	7.09E-01	2.88E-02	7.05E-01	1.79E-02	3.91E-03
1332.49	6.36E-01	2.58E-02	6.35E-01	1.71E-02	1.30E-03
1836.01	4.94E-01	1.97E-02	4.95E-01	1.94E-02	-7.61E-04

DUAL Efficiency Calibration Equation

Single Equation Terms

Offset :	-2.86E+02
Slope :	2.21E+02
Quadratic :	-6.88E+01
Cubic :	1.07E+01
4th Order :	-8.25E-01
5th Order :	2.55E-02
6th Order :	0.00E+00
7th Order :	0.00E+00
8th Order :	0.00E+00
9th Order :	0.00E+00

EMPIRICAL Efficiency Calibration Equation

Analysis Report for Efficiency Calibration Sample

1 L Marinelli MD Efficiency Calib.

Empirical Equation Terms

Scaling :	9.48E+02
Offset :	-4.78E+00
Slope :	8.44E-01
Quadratic :	2.82E-03
Cubic :	-3.69E-02
4th Order :	5.02E-02
5th Order :	-2.55E-02

LINEAR Efficiency Calibration Equation

Linear Equation Terms

Offset :	-1.36E-04
Slope :	-2.20E+00
Quadratic :	2.75E+02
Cubic :	-3.65E+04
4th Order :	2.09E+06
5th Order :	-4.97E+07
6th Order :	0.00E+00
7th Order :	0.00E+00
8th Order :	0.00E+00
9th Order :	0.00E+00

PEAK LOCATE REPORT

Peak Locate Performed on : 4/27/2011 10:58:33AM
Peak Locate From Channel : 1
Peak Locate To Channel : 65535
Peak Search Sensitivity : 5.00

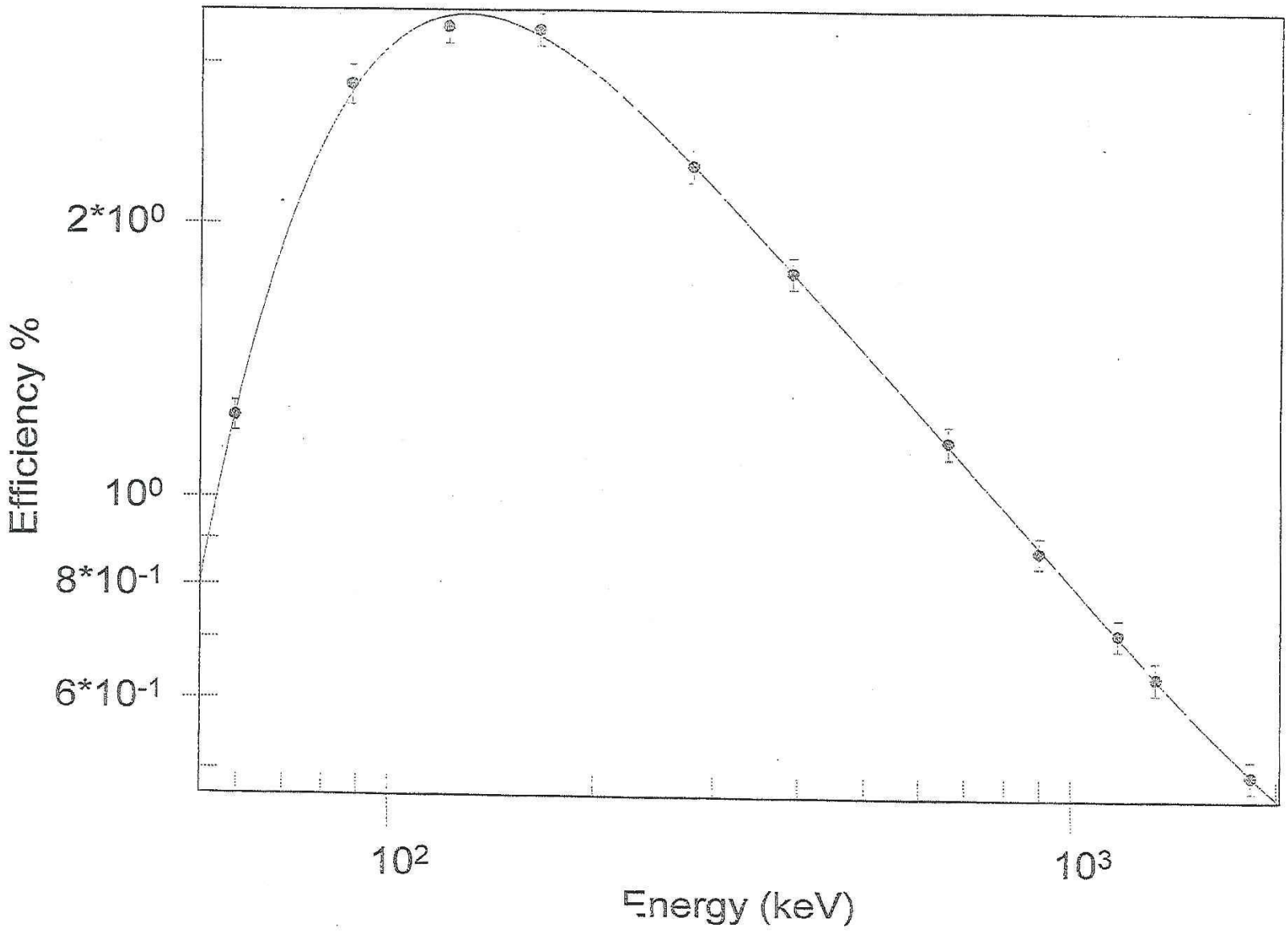
Peak No.	*Energy (keV)*	*Centroid Channel*	*Centroid Uncertainty*	*Peak Significance*
1	41.79	84.07	0.1711	16.60
2	59.64	119.76	0.0852	65.25
3	88.10	176.67	0.0631	117.35
4	122.09	244.65	0.0700	90.31
5	136.45	273.35	0.1355	24.11
6	165.84	332.12	0.0659	102.88
7	255.02	510.48	0.1966	10.15
8	279.15	558.73	0.0756	71.81
9	391.60	783.62	0.0663	86.26
10	661.67	1323.81	0.0671	83.59
11	814.18	1628.85	0.2168	8.02
12	898.07	1796.62	0.0597	95.22
13	1173.17	2346.77	0.0603	87.70
14	1324.78	2649.68	0.2076	5.51
15	1332.47	2665.27	0.0615	81.87
16	1836.06	3671.62	0.0632	69.49

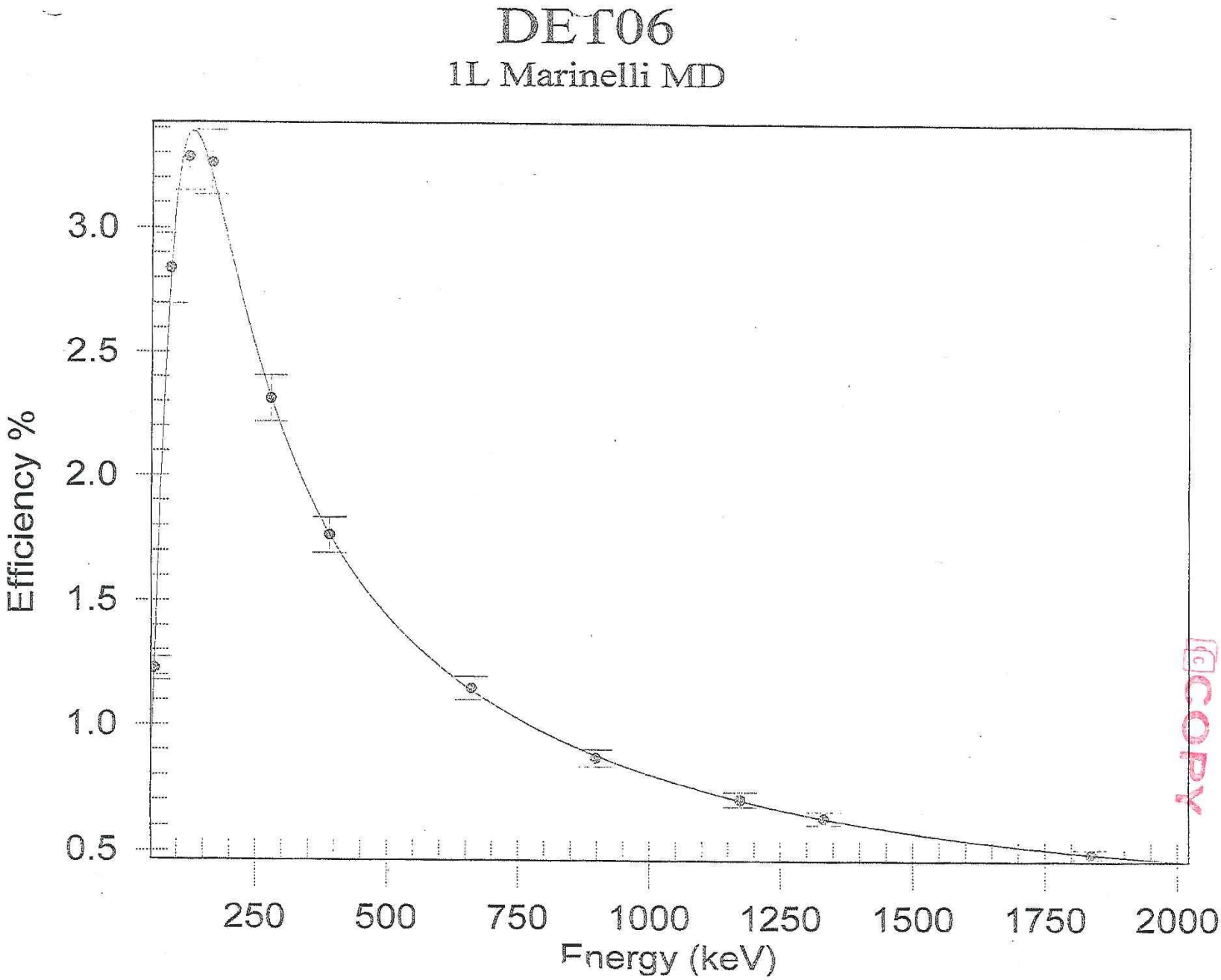
Analysis Report for Efficiency Calibration Sample

1 L Marinelli MD Efficiency Calib.

? = Adjacent peak noted
Errors quoted at 1.000 sigma

DET06
1L Marinelli MD




DET06
1L Marinelli MD
Efficiency %
3.0
2.5
2.0
1.5
1.0
0.5
250
500
750
1000
1250
1500
1750
2000
Energy (keV)
COPY

Eckert & Ziegler
Analytics

1380 Seaboard Industrial Blvd.
Atlanta, Georgia 30318
Tel 404·352·8677
Fax 404·352·2837
www.analyticsinc.com

CERTIFICATE OF CALIBRATION
Standard Radionuclide Source

HBS-569

83950-33
1.0 Liter Solid in 130G GA-MA Beaker

Customer: PG&E/Humboldt Bay
P.O. No.: 3500886495, Item 6
Reference Date: 01-Jan-2011 12:00 PM EST **Grams of Master Source:** 0.0056271

This standard radionuclide source was prepared using aliquots measured gravimetrically from master radionuclide solutions. Calibration and purity were checked using a germanium gamma spectrometer system. At the time of calibration no interfering gamma-ray emitting impurities were detected. The gamma ray emission rates for the most intense gamma-ray lines are given. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 1, February, 1979, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101. Density of solid matrix 1.15 g/cc.

Nuclide	Gamma-Ray Energy (keV)	Half-Life, Days	Master Source* γps/gram	This Source γps	Uncertainty, % Type u_A	u_B	U	Calibration Method
Am-241	59.5	1.580E+05	———	6.537E+02	0.1	1.7	3.5	4π LS
Cd-109	88.0	4.626E+02	1.697E+05	9.549E+02	0.8	2.3	4.9	HPGe
Co-57	122.1	2.718E+02	8.711E+04	4.902E+02	0.5	2.0	4.1	HPGe
Ce-139	165.9	1.376E+02	1.247E+05	7.017E+02	0.5	1.9	3.9	HPGe
Hg-203	279.2	4.661E+01	2.753E+05	1.549E+03	0.4	1.9	3.9	HPGe
Sn-113	391.7	1.151E+02	1.769E+05	9.954E+02	0.5	1.9	3.9	HPGe
Cs-137	661.7	1.098E+04	1.109E+05	6.240E+02	0.7	1.9	4.0	HPGe
Y-88	898.0	1.066E+02	4.224E+05	2.377E+03	0.5	1.9	3.9	HPGe
Co-60	1173.2	1.925E+03	2.142E+05	1.205E+03	0.6	1.9	4.0	HPGe
Co-60	1332.5	1.925E+03	2.143E+05	1.206E+03	0.6	1.9	4.0	HPGe
Y-88	1836.1	1.066E+02	4.472E+05	2.516E+03	0.5	1.9	3.9	HPGe

* Master Source refers to Analytics' 8-isotope mixture which is calibrated quarterly.

Calibration Methods: 4π LS - 4 pi Liquid Scintillation Counting, HPGe - High Purity Germanium Gamma-Ray Spectrometer, IC - Ionization Chamber. **Uncertainty:** U - Relative expanded uncertainty, k = 2. See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results."

(Certificate continued on reverse side)

ACCREDITED SOURCE CALIBRATION LABORATORY — HEALTH PHYSICS SOCIETY — FOUNDED 1958

Corporate Office
24937 Avenue Tibbitts Valencia, California 91355

Laboratory
1380 Seaboard Industrial Blvd. Atlanta, Georgia, 30318

****
***** CERTIFICATE FILE REPORT *****
****

Filename: C:\GENIE2K\CAMFILES\HBS-569_1L_MD.CTF

Certificate Description:

Certificate Title: HBS-569_1L_MD

Quantity : 1.00 units

Assay date : 1/1/2011 9:00:00 AM

Original Certificate:

Nuclide Name	Half-Life (Days)	Energy (keV)	Emission Rate DPS/Unit	Emission Rate % Uncert. (+-)
Am-241	1.579E+005	59.540*	653.7	3.50
CD-109	4.640E+002	88.030*	954.9	4.90
CO-57	2.709E+002	122.060*	490.2	4.10
CE-139	1.377E+002	165.850*	701.7	3.90
HG-203	4.660E+001	279.190	1549.0	3.90
SN-113	1.151E+002	391.690*	995.4	3.90
CS-137	1.102E+004	661.650*	624.0	4.00
Y-88	1.066E+002	898.020*	2377.0	3.90
CO-60	1.925E+003	1173.220*	1205.0	4.00
CO-60	1.925E+003	1332.490*	1206.0	4.00
Y-88	1.066E+002	1836.010*	2516.0	3.90

* = Used for Calib/INIT

Apex™

Analysis Report for Efficiency Calibration Sample
1L Marinelli HD Calibration

EFFICIENCY CALIBRATION REPORT

Detector Name	:	DET06
Geometry Description	:	1L Marinelli HD
Efficiency Calibration Performed on	:	4/27/2011 2:20:43PM
by	:	Administrator
Efficiency Type Used	:	DUAL, NO X-OVER

Efficiency Triplets

Energy	% Efficiency	Error	Computed	Error	% Difference
59.54	8.71E-01	3.42E-02	8.75E-01	3.41E-02	-4.00E-03
88.03	2.34E+00	1.16E-01	2.26E+00	8.61E-02	7.96E-02
122.06	2.83E+00	1.19E-01	2.92E+00	8.13E-02	-8.96E-02
165.85	2.89E+00	1.16E-01	2.88E+00	8.02E-02	9.58E-03
279.19	2.18E+00	9.07E-02	2.14E+00	5.92E-02	4.21E-02
391.69	1.62E+00	6.49E-02	1.65E+00	4.38E-02	-2.12E-02
661.65	1.08E+00	4.43E-02	1.07E+00	3.00E-02	1.49E-02
898.02	8.09E-01	3.22E-02	8.26E-01	1.92E-02	-1.70E-02
1173.22	6.58E-01	2.68E-02	6.61E-01	1.68E-02	-2.62E-03
1332.49	6.07E-01	2.47E-02	5.96E-01	1.61E-02	1.17E-02
1836.01	4.67E-01	1.86E-02	4.69E-01	1.84E-02	-2.42E-03

DUAL Efficiency Calibration Equation

Single Equation Terms

Offset	-3.09E+02
Slope	2.39E+02
Quadratic	-7.42E+01
Cubic	1.15E+01
4th Order	-8.90E-01
5th Order	2.76E-02
6th Order	0.00E+00
7th Order	0.00E+00
8th Order	0.00E+00
9th Order	0.00E+00

EMPIRICAL Efficiency Calibration Equation

Analysis Report for Efficiency Calibration Sample
1L Marinelli HD Calibration

Empirical Equation Terms

Scaling :	9.48E+02
Offset :	-4.84E+00
Slope :	8.40E-01
Quadratic :	1.22E-02
Cubic :	-5.32E-02
4th Order :	5.62E-02
5th Order :	-2.76E-02

LINEAR Efficiency Calibration Equation

Linear Equation Terms

Offset :	-1.20E-04
Slope :	-2.26E+00
Quadratic :	2.99E+02
Cubic :	-4.26E+04
4th Order :	2.59E+06
5th Order :	-6.40E+07
6th Order :	0.00E+00
7th Order :	0.00E+00
8th Order :	0.00E+00
9th Order :	0.00E+00

PEAK LOCATE REPORT

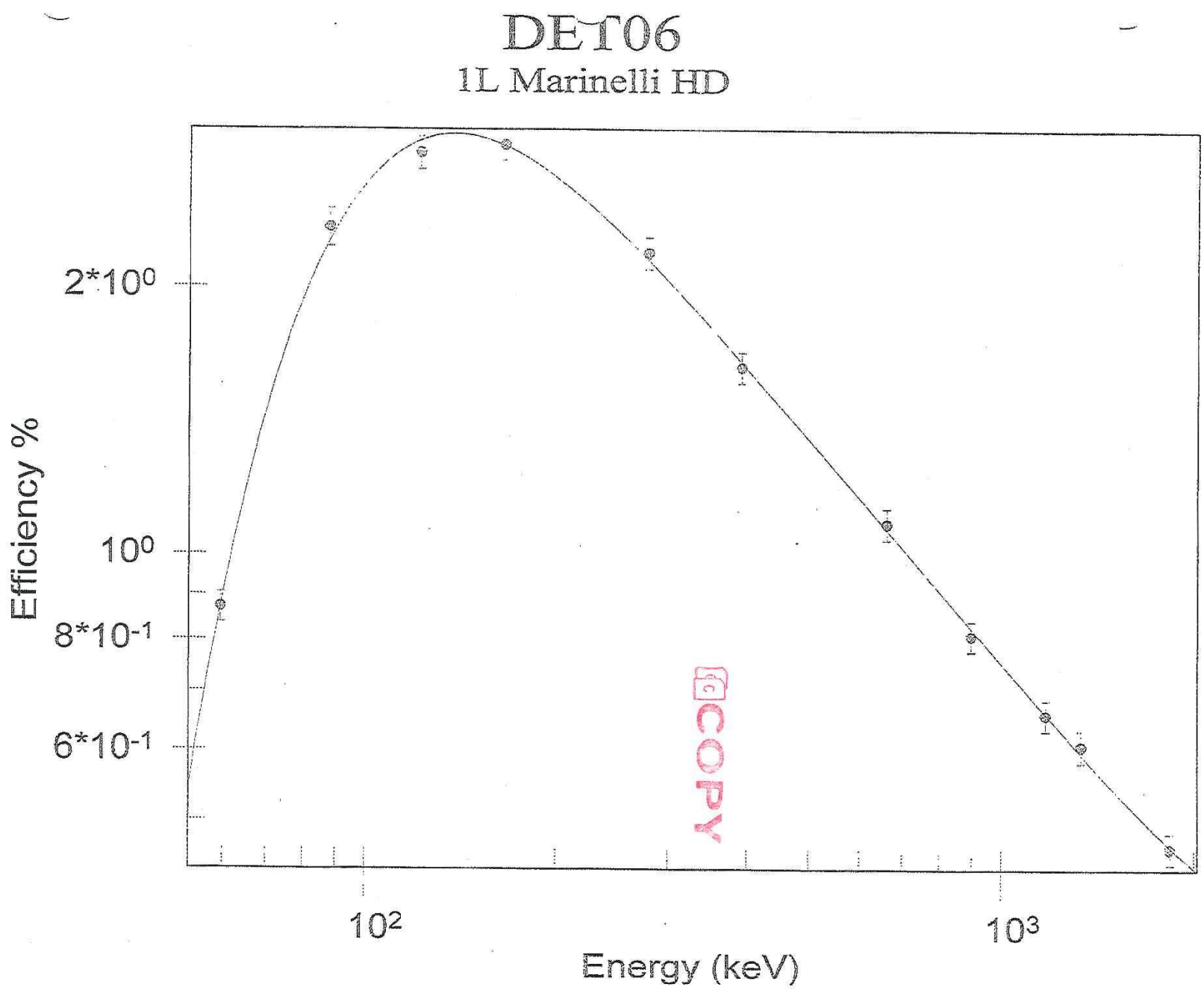
Peak Locate Performed on	: 4/27/2011 2:19:05PM
Peak Locate From Channel	: 1
Peak Locate To Channel	: 65535
Peak Search Sensitivity	: 5.00

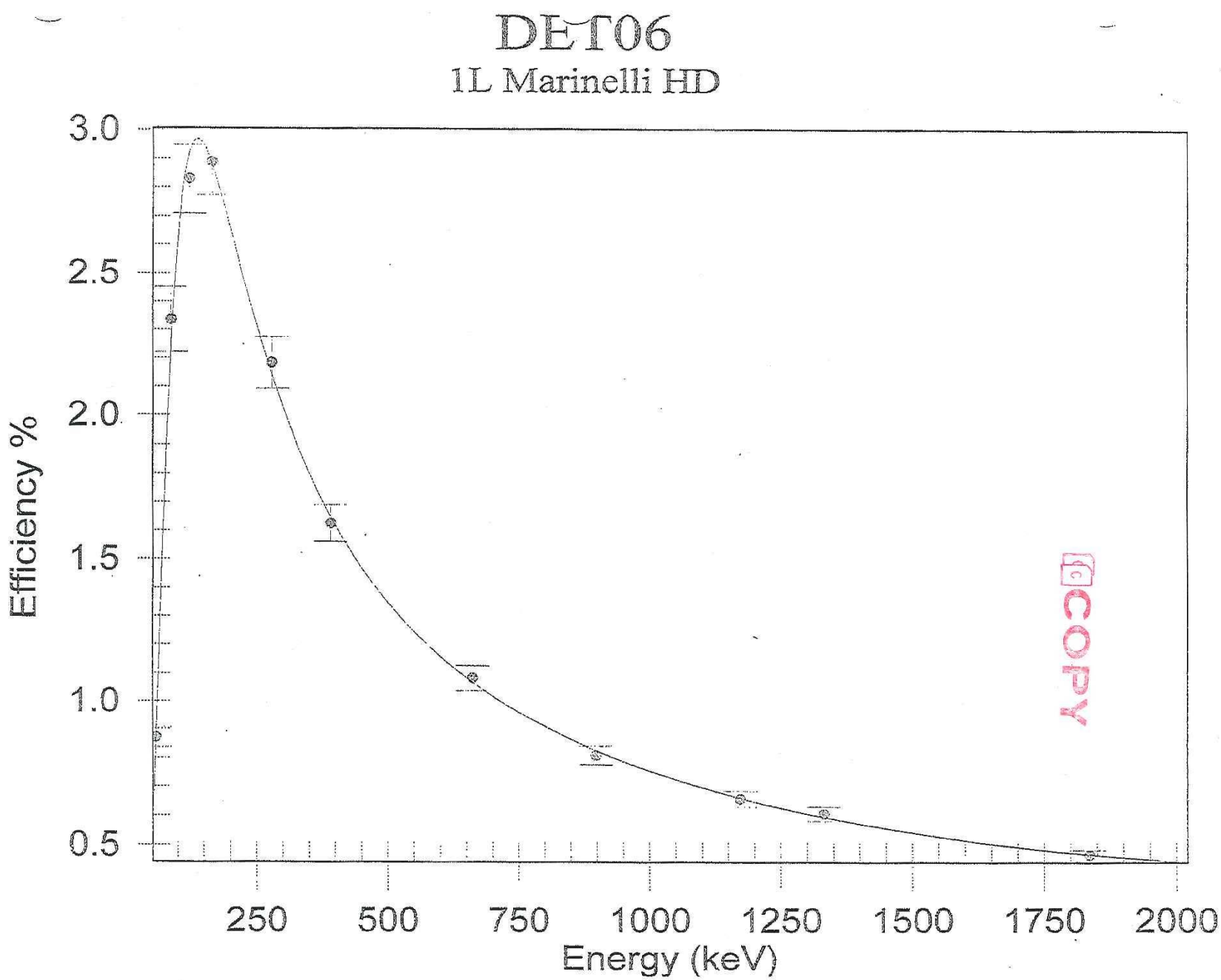
Peak No.	Energy (keV)	Centroid Channel	Centroid Uncertainty	Peak Significance
1	41.72	83.92	0.1716	18.57
2	59.63	119.75	0.0949	52.24
3	88.11	176.68	0.0668	105.27
4	122.09	244.64	0.0733	81.16
5	136.47	273.41	0.1467	19.60
6	165.83	332.12	0.0684	95.84
7	255.00	510.43	0.2139	8.14
8	279.14	558.70	0.0771	69.38
9	391.60	783.62	0.0676	83.64
10	661.66	1323.79	0.0680	80.41
11	814.36	1629.20	0.2121	8.26
12	898.07	1796.63	0.0610	91.56
13	1173.15	2346.72	0.0616	83.98
14	1324.99	2650.36	0.2117	6.41
15	1332.47	2665.26	0.0623	79.11
16	1836.08	3671.68	0.0641	68.56

Analysis Report for Efficiency Calibration Sample

1L Marinelli HD Calibration

? = Adjacent peak noted
Errors quoted at 1.000 sigma


DET06
1L Marinelli HD
2*10⁰
10⁰
8*10⁻¹
6*10⁻¹
Efficiency %
10²
10³
Energy (keV)
COPY


DET06
1L Marinelli HD
Efficiency %
3.0
2.5
2.0
1.5
1.0
0.5
250
500
750
1000
1250
1500
1750
2000
Energy (keV)
COPY

EFFICIENCY CONFIRMATION CHECK REPORT

Date : 4/27/2011
Time : 3:01:17PM
Facility : Default
User : Administrator
Detector : DET06
Geometry : 1L Marinelli HD
Certificate Name : HBS-571_1L_HD
Certificate Date : 1/1/2011 9:00:00AM

Nuclide Energy	Nuclide Name	Corrected Certificate Activity	Measured Activity	% Difference
59.54	Am-241	4.906E-02	4.943E-02	-0.76
88.03	CD-109	6.915E-01	7.209E-01	-4.25
122.06	CO-57	1.544E-02	1.473E-02	4.62
165.85	CE-139	2.353E-02	2.312E-02	1.71
279.19	HG-203	5.398E-02	5.353E-02	0.85
391.69	SN-113	4.132E-02	3.992E-02	3.40
661.65	CS-137	1.975E-02	1.957E-02	0.91
898.02	Y-88	6.855E-02	6.682E-02	2.53
1173.22	CO-60	3.246E-02	3.221E-02	0.78
1332.49	CO-60	3.249E-02	3.205E-02	1.34
1836.01	Y-88	6.821E-02	6.662E-02	2.32
			Average Difference	1.22

Eckert & Ziegler
Analytics

1380 Seaboard Industrial Blvd.
Atlanta, Georgia 30318
Tel 404·352·8677
Fax 404·352·2837
www.analyticsinc.com

CERTIFICATE OF CALIBRATION

Standard Radionuclide Source

HBS-571

83952-33

1.0 Liter High Density Solid in 130G GA-MA Beaker

Customer: PG&E/Humboldt Bay
P.O. No.: 3500886495, Item 8
Reference Date: 01-Jan-2011 12:00 PM EST **Grams of Master Source:** 0.0056090

This standard radionuclide source was prepared using aliquots measured gravimetrically from master radionuclide solutions. Calibration and purity were checked using a germanium gamma spectrometer system. At the time of calibration no interfering gamma-ray emitting impurities were detected. The gamma ray emission rates for the most intense gamma-ray lines are given. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 1, February, 1979, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

Nuclide	Gamma-Ray Energy (keV)	Half-Life, Days	Master Source* γps/gram	This Source γps	Uncertainty, % Type u_A	u_B	U	Calibration Method
Am-241	59.5	1.580E+05	———	6.516E+02	0.1	1.7	3.5	4π LS
Cd-109	88.0	4.626E+02	1.697E+05	9.518E+02	0.8	2.3	4.9	HPGe
Co-57	122.1	2.718E+02	8.711E+04	4.886E+02	0.5	2.0	4.1	HPGe
Ce-139	165.9	1.376E+02	1.247E+05	6.994E+02	0.5	1.9	3.9	HPGe
Hg-203	279.2	4.661E+01	2.753E+05	1.544E+03	0.4	1.9	3.9	HPGe
Sn-113	391.7	1.151E+02	1.769E+05	9.922E+02	0.5	1.9	3.9	HPGe
Cs-137	661.7	1.098E+04	1.109E+05	6.220E+02	0.7	1.9	4.0	HPGe
Y-88	898.0	1.066E+02	4.224E+05	2.369E+03	0.5	1.9	3.9	HPGe
Co-60	1173.2	1.925E+03	2.142E+05	1.201E+03	0.6	1.9	4.0	HPGe
Co-60	1332.5	1.925E+03	2.143E+05	1.202E+03	0.6	1.9	4.0	HPGe
Y-88	1836.1	1.066E+02	4.472E+05	2.508E+03	0.5	1.9	3.9	HPGe

* Master Source refers to Analytics' 8-isotope mixture which is calibrated quarterly.

Calibration Methods: 4π LS - 4 pi Liquid Scintillation Counting, HPGe - High Purity Germanium Gamma-Ray Spectrometer, IC - Ionization Chamber. **Uncertainty:** U - Relative expanded uncertainty, k = 2. See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results."

(Certificate continued on reverse side)

ACCREDITED SOURCE CALIBRATION LABORATORY HEALTH PHYSICS SOCIETY FOUNDED 1955

Corporate Office
24937 Avenue Tibbitts Valencia California 91355

Laboratory
1380 Seaboard Industrial Blvd. Atlanta, Georgia 30318

****
***** CERTIFICATE FILE REPORT *****
****

Filename: C:\GENIE2K\CAMFILES\HBS-571_1L_HD.CTF

Certificate Description:

Certificate Title: HBS-571_1L_HD

Quantity : 1.00 units

Assay date : 1/1/2011 9:00:00 AM

Original Certificate:

Nuclide Name	Half-Life (Days)	Energy (keV)	Emission Rate DPS/Unit	Emission Rate % Uncert. (+-)
Am-241	1.579E+005	59.540*	651.6	3.50
CD-109	4.640E+002	88.030*	951.8	4.90
CO-57	2.709E+002	122.060*	488.6	4.10
CE-139	1.377E+002	165.850*	699.4	3.90
HG-203	4.660E+001	279.190	1544.0	3.90
SN-113	1.151E+002	391.690*	992.2	3.90
CS-137	1.102E+004	661.650*	622.0	4.00
Y-88	1.066E+002	898.020*	2369.0	3.90
CO-60	1.925E+003	1173.220*	1201.0	4.00
CO-60	1.925E+003	1332.490*	1202.0	4.00
Y-88	1.066E+002	1836.010*	2508.0	3.90

* = Used for Calib/INIT

Background and
Source Check
Measurement
Quality Assurance
Last Results
Reports

****
***** G E N I E Q U A L I T Y A S S U R A N C E *****
****

Last Results Report
11/13/13 6:39:58 AM

QA File: C:\Canberra\Apex\Root\Default\QA\D00000000001B.QCK

Detector: DET06
Sample Quantity: 1.0000E+000
Sample Date: 11/13/13 6:25:57 AM
Measurement Date: 11/13/13 6:29:34 AM
Elapsed Live Time: 600.0 seconds
Elapsed Real Time: 600.0 seconds

Parameter Description [Mean +/- Std. Dev.]	Value	Deviation/Flags < LU : SD : UD : BS >
BCR	1.3100E+000	
Boundary Limits: [1.000E+000, 1.488E+000]		< : : : >

Flags Key: LU = Lower/Upper Bounds Test (Ab = Above, Be = Below)
SD = Sample Driven N-Sigma Test (In = Investigate, Ac = Action)
UD = User Driven N-Sigma Test (In = Investigate, Ac = Action)
BS = Measurement Bias Test (In = Investigate, Ac = Action)

Performed by _____ Date 11-13-13

****
***** G E N I E Q U A L I T Y A S S U R A N C E *****
****

Last Results Report
11/13/13 7:07:58 AM

QA File: C:\Canberra\Apex\Root\Default\QA\D0000000001HBS-571_1L_HD

Detector: DET06
Certificate: HBS-571 1L HD
Sample Quantity: 1.0000E+000
Sample Date: 1/1/11 9:00:00 AM
Measurement Date: 11/13/13 6:57:33 AM
Elapsed Live Time: 600.0 seconds
Elapsed Real Time: 600.8 seconds

Parameter Description [Mean +/- Std. Dev.]	Value	Deviation/Flags < LU : SD : UD : BS >
Peak energy 59.54 keV [UD: 5.9540E+001+/- 0.26600]	5.9528E+001	-4.4156E-002 < : : : >
Peak energy 1332.49 [UD: 1.3325E+003+/- 0.26600]	1.3326E+003	2.6984E-001 < : : : >
Decay corr.act.Cs-137 [UD: 1.9800E-002+/- 0.00039]	2.0220E-002	1.0792E+000 < : : : >
Peak FWHM 1332.49 keV Boundary Limits: [0.000E+000, 2.400E+000]	2.0456E+000	< : : : >
Decay corrected activity [UD: 3.2600E-002+/- 0.00050]	3.2070E-002	-1.0540E+000 < : : : >

Flags Key: LU = Lower/Upper Bounds Test (Ab = Above, Be = Below)
SD = Sample Driven N-Sigma Test (In = Investigate, Ac = Action)
UD = User Driven N-Sigma Test (In = Investigate, Ac = Action)
BS = Measurement Bias Test (In = Investigate, Ac = Action)

Performed by _____ Date 11-13-13