In Situ Object Counting System (ISOCS) as Applied to Scan Requirements in Support of Final Status Survey at HBPP

September 26, 2012

Pacific Gas and Electric Company®

In Situ Object Counting System™ (ISOCS) as Applied to Scan Requirements in Support of the Final Status Survey at HBPP

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Dale Randall

Reviewed By: Martin C Ericsson **Date:** 4/1/13

Approved By: W A Barley **Date:** 4/1/13

1.0 SCOPE

This TBD is intended to cover the use of the Canberra ISOCS® detector system as a scanning instrument for Final Status Surveys.

2.0 DISCUSSION

The Canberra characterized High Purity Germanium (HPGe) detector will be used in conjunction with the Canberra Genie™ software suite to achieve Final Status Survey (FSS) scans of building surfaces and land areas and possibly other media as deemed appropriate (e.g. piping systems). The ISOCS® scanning technique achieves scan coverage over a defined area to set a-priori detection limits. These detection limits must be capable of detecting the investigation level to facilitate follow-up investigations where required

System Description

Two ISOCS-characterized P-type HPGe detectors, manufactured by Canberra Industries, have been procured. As the project progresses, other ISOCS® detectors (e.g. reverse electrode coaxial) may be employed. The key factor regarding the use of other ISOCS® characterized detectors is that specific efficiency calibrations will be developed and evaluated to account for each detector's unique characteristics.

The HPGe detector is mounted on a bracket designed to hold the detector / cryostat assembly and associated collimators. This bracket may be mounted in a cage-like frame. This frame permits the detector to be oriented (pointed) over a full range from a horizontal to vertical orientation while being positioned above the surface being evaluated.

The InSpector (MCA) unit that drives the signal chain and the laptop computer that runs the acquisition software (Genie-2000) are mounted either in the frame or on a wheeled cart. These components may be battery powered. Back-up power supplies (e.g. inverter) may be used to support the duty cycle. A wireless network may also be installed so that the laptop computers used to run the systems can be controlled from remote laptop, eliminating the need for a direct cable connection between the operator's station and the ISOCS unit LTP Chapter 5 Performance Criteria

In the performance of required survey unit measurements, levels of radioactivity may be identified that warrant investigation. Depending on the results of the investigation, the survey unit may require no action, remediation, and/or reclassification and resurvey. In order to satisfy the requirements of the HBPP LTP (REF 1), the scan sensitivity and coverage must be adequate to meet the dual specifications for coverage and investigation level as presented in Table 1 and Table 2.

Table 1 Scan Survey Coverage Requirements

	Class 1	Class 2	Class 3
Scan Coverage	100%	10-100 %*	Judgmental (1-10%)

* For Class 2 Survey Units, the amount of scan coverage will be proportional to the potential for finding areas of elevated activity or areas close to the release criterion in accordance with MARSSIM Section 5.5.3. Accordingly, HBPP will use historical information and the results of individual measurements collected during characterization to correlate this activity potential to scan coverage levels.

Table 2 Investigation Levels

Classification	Scan Investigation Levels	Direct Investigation Levels
Class 1	> $DCGL_{EMC}$	> $DCGL_{EMC}$ or > $DCGL_W$ and > a statistical parameter-based Value
Class 2	> $DCGL_W$ or > MDC_{SCAN} if MDC_{SCAN} is greater than $DCGL_W$	> $DCGL_W$
Class 3	Detectable over Background	> 0.5 $DCGL_W$

Traditional Scan methodologies

Traditional gamma scan surveys have been performed with handheld instruments such as NaI(Tl) scintillation detectors for gamma in potentially contaminated media or gas flow proportional probes when alpha/beta detection on surfaces is desired.

Technicians will respond to all instrument indications of elevated activity while surveying. Upon receiving an indication, the technician will stop and resurvey the last square meter of area surveyed to verify the increase. Technicians are cautioned, in training, about the importance of the verification survey and are given specific direction in the procedure as to survey extent and scan speed. If the indication is verified, the technician will mark the area with a flag or other appropriate means. Each area marked will be addressed in an investigation survey instruction prepared for the survey unit. The instruction will specify the required actions, such as a re-scan of the area, direct measurements, and collection of a soil sample (for land surveys). Each investigation will be evaluated and reported in the survey area report. (Investigation levels are shown in Table 2.)

With respect to Class 1 Survey Units, surveillance for elevated activity is performed via scan surveys using hand-held field instruments. Acceptance criteria (i.e. $DCGL_{EMC}$) is derived by multiplying the DCGLw by the area factor associated with that area bounded by the grid used to locate soil samples. Occasionally, due to either background radioactivity or the size of the sample location grid, the detection sensitivity for these hand-held instruments exceeds the $DCGL_{EMC}$. In such instances, the survey grid is reduced so that area factors yielding higher $DCGL_{EMC}$ values can be used.

ISOCS Scan methodologies

For the ISOCS scan method, the primary assumption made is that a potential one-square-meter of elevated radioactivity exists at the edge of the area being evaluated by a single in-situ measurement.

To account for detection (i.e. efficiency) radionuclide-specific investigation levels are developed. Since the investigation levels approximate the DCGLw, assay results below investigation level(s) satisfy both the DCGLw and $DCGL_{EMC}$ criteria.

The ability of ISOCS to perform radionuclide identification is also beneficial where influences from background radioactivity (e.g. ISFSI) impede survey efforts. Count times can be tailored to achieve required detection sensitivities and the detector can be collimated to minimize the influence from sources outside the detector's field of view.

Set up

The ISOCS is most commonly deployed on its cart, a tripod or a crane to accommodate the physical requirements of various measurements. Power may be supplied by battery, AC line or generator. The decision regarding the selection of collimator configuration is determined by the engineer. In some cases it may be desirable to use a 180 degree collimator, taking advantage of exposing more of the detector's sensitive volume whenever background sources are at an insignificant level.

Data collection to support FSS activities will be administered by a specific Survey Plan. Survey Plans may include an index of measurement locations with associated spectrum filenames to ensure that all the required measurements are made and results appropriately managed. Personnel specifically trained to operate the system will perform data collection activities.

Data collection activities will address environmental conditions that may impact soil moisture content. Logs shall be maintained so as to provide a mechanism to annotate such conditions to ensure that efficiency calibration files address the in-situ condition(s). In extreme cases (e.g. standing water, etc.) specific conditions will be addressed to ensure that analysis results reflect the conditions. As previously discussed with respect to water, when unique environmental conditions exist that may impact analysis results, conservative compensatory factors will be applied to the analysis of the data.

Efficiency Calibration

The central feature of the portable ISOCS technology is to support in-situ gamma spectroscopy via the application of mathematically derived efficiency calibrations. Due to the nature of the environment and surfaces being evaluated (assayed), input parameters for the ISOCS efficiency calibrations will be reviewed on a case-by-case basis to ensure the applicability of the resultant efficiency. Material densities applied

to efficiency calibrations will be documented. In practice, a single efficiency calibration file may be applied to the majority of the measurements.

The geometry most generally employed will be a circular plane assuming uniformly distributed activity. Efficiency calibrations will address a depth of 15 cm for soil and a depth up to 5 cm for concrete surfaces to account for activity embedded in cracks, etc. Other geometries (e.g. exponential circular plane, rectangular plane, etc.) will be applied if warranted by the physical attributes of the area or surface being evaluated. Efficiency calibrations are developed by radiological engineers who have received training with respect to the ISOCS software. Efficiency calibrations will be documented in accordance with the HBPP QAPP.

Attenuation by standing water will need to be modeled into the shot and carefully verified so as to not understate the depth. Experience has shown that it becomes difficult to meet detection limits with more than two inches of water in a scan shot. If there is evidence of standing water (i.e., a water sheen is visible on the soil media) then an appropriately thick layer of water attenuator will be added to the model.

Designing coverage

It is frequently desirable or required to ensure 100% scan coverage of a survey unit. This may be achieved through the use of a triangular grid pattern with positions determined using the Visual Sample Plan (VSP) software. For the purposes of this discussion, it is assumed that the 90 degree collimators are installed and that the detector face is orientated downward and is lifted to the desired height, h above the horizontal plane. The field of view of the detector is a circle of radius h. By geometric construction, the maximum horizontal distance L, between the scan shots becomes:

Equation 1

$$L = \sqrt{3} * h$$

Where,
L is the triangular grid spacing; and
h is the vertical height of the detector

To use VSP to design a triangular grid pattern for a given survey unit, we will use a random start point. The current VSP software version (v. 6.2d) requires that the number of desired samples (scan shots) N, be used to establish a triangular grid with a random start point of appropriate grid spacing. This input may be determined by using the familiar triangular grid equation from the MARSSIM:

Equation 2

$$L = \sqrt{\frac{A}{0.866N}}$$

Or, stated more purely;

Equation 3

$$L = \sqrt{\frac{A}{\sqrt{\frac{3}{2}}N}}$$

Thus Using Equations 2 and 3:

$$\sqrt{3} * h = \sqrt{\frac{A}{\sqrt{\frac{3}{2}}N}}$$

Thus,

$$3h^2 = \frac{A}{N * \sqrt{\frac{3}{2}}}$$

Solving for N,

Equation 4

$$N = \frac{A}{3h^2 * \sqrt{\frac{3}{2}}}$$

It is recommended that N+1 be input into the VSP run to ensure a slight additional overlap for conservative margin. As shown in Figures 1 and 2, once the triangular grid is constructed it will be necessary to verify that 100% of the area is covered by plotting the scan measurement locations and the field of view for each measurement in a drafting program such as AutoCAD. Additional scan shots on the periphery of the survey unit may be readily added by plotting additional measurement locations using the sample

points along the triangular grid. The manually added scan shot locations are shown in red.

Figure 1- Using VSP for plotting ISOCS scan locations

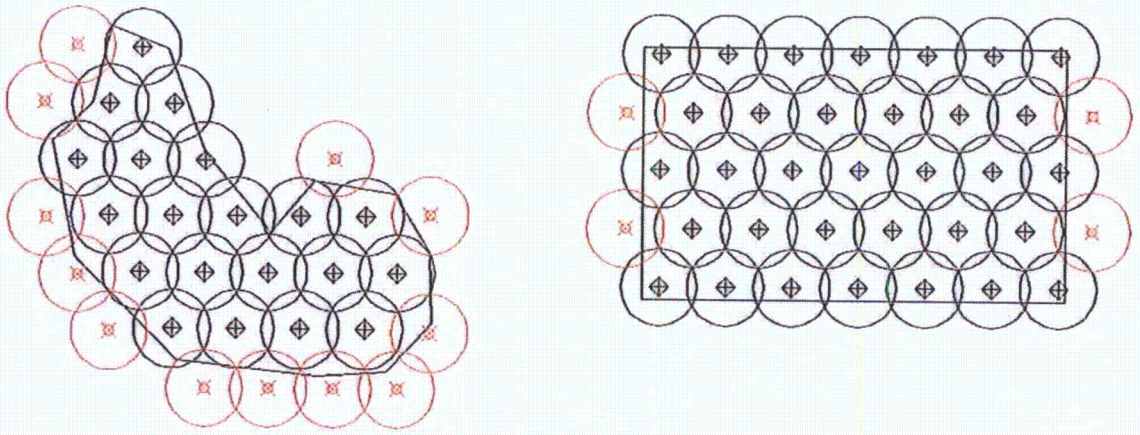
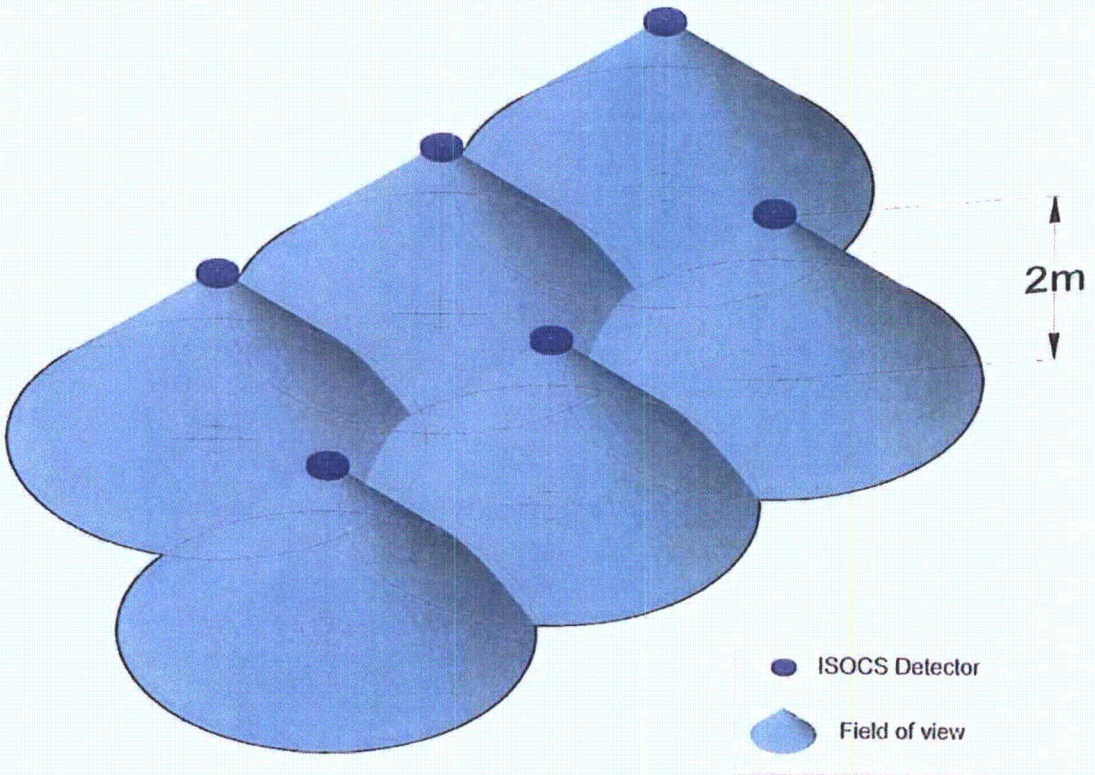


Figure 2- An array of 2m high ISOCS scans used to achieve 100% coverage



HBPP Required Detection Levels

Class 1 Survey Units

As noted earlier, the primary assumption made is that a potential one-square-meter of elevated radioactivity exists at the edge of the area being evaluated by a single in-situ measurement. In order to determine the required scan MDC one needs to determine the $DCGL_{EMC}$ for this hypothetical case. Tables 3 and 4 present the $DCGL_{EMC}$ scan requirement for Class 1 Areas for the primary nuclides of concern Cs-137 and Co-60.

Table 3 Soil Values

Nuclide	$DCGL_W$ (pCi/g)	Area Factor ($1m^2$)	$DCGL_{EMC}$ (pCi/g)
Cs-137	7.9	14	110
Co-60	3.8	10	380

Table 4 Surface Values

Nuclide	$DCGL_W$ (dpm/ 100 cm^2)	Area Factor ($1m^2$)	$DCGL_{EMC}$ (dpm/ 100 cm^2)
Cs-137	4.6 E4	15	6.90 E5
Co-60	1.3 E4	13	1.69 E5

Class 2 Survey Units

Since the investigation Level for Class 2 Survey units is given from Table 2 as:

$>DCGL_W$ or $>MDC_{SCAN}$ if MDC_{SCAN} is greater than $DCGL_W$

In order to meet this requirement we will set the detection limits such that:

$>DCGL_W$ *in a 1* m^2 *area at the edge of the field of view* may be detected.

Class 3 Survey Units

Since the investigation Level for Class 3 Survey units is given from Table 2 as:

Detectable over background.

This requirement is met by investigating any scan that positively detects activity in excess of the site assessed surface soil background of 0.4 pCi/g Cs-137.

Attachment 1 provides a site specific ISOCS run that demonstrates the nominal scan detection limits are met for soils in a 600 second count.

3.0 LIMITATIONS

The use of the in-situ techniques should be limited to characterized HPGe detectors utilizing appropriate geometries and will be used in conjunction with the Canberra Genie™ software suite. All operations should be conducted in accordance with applicable site procedures additionally; the following condition must be satisfied:

- The geometries must be reviewed by a Subject Matter Expert (SME) to ensure they are correctly developed and accurate or conservative approximations of the media being measured.

4.0 CONCLUSION

Caution needs to be used in the application of geometries for ISOCS scanning. Careful verification that the environmental conditions and geometric arrangement are appropriate to the detector geometry is pivotal to ensuring the accuracy of the results.

Field conditions may also significantly influence the practical applicability of the ISOCS as a field instrument. Experience has shown that the impact of attenuation from standing water may be particularly problematic in achieving the required detection sensitivity. Consequently, it is recommended that standing water be avoided to the extent practical and sufficient counting times are planned for where it is impractical to eliminate.

The ISOCS methodology presented has been demonstrated as an acceptable means for achieving survey scan objectives; provided that proper care is taken to ensure that the results are valid.

8.0 REFERENCES

1. NUREG- 1575, MARSSIM "Multi-Agency Radiation Site Survey and Investigation Manual", Rev 1, August, 2000.

2. HBPP License Termination Plan DRAFT (May 2012)

3. ENG-HB-003 "Humboldt Bay Soil Derived Concentration Guideline Levels", Rev 0, 2-29-12

4. ENG-HB-004 "Humboldt Bay Building Surface Derived Concentration Guideline Levels", Rev 0, 2-29-12.

5. ENG-HB-005 "Area Factors for Use with Humboldt Bay Soil DCGLs", Rev 0, 3-02-12.

6. ENG-HB-006 "Area Factors for Use with Humboldt Bay Building Surface DCGLs", Rev 0, 3-02-12.

7. C&RP B-9 Vol. 8, Rev 0, "OPERATION OF THE GENIE-2000 GAMMA SPECTROSCOPY SYSTEM"

Attachment 1

Demonstration of Achieving Required Detection Limits for Soils in a 10 minute Count Interval

Case Modeled	Case A	Case B	Case C
Time (sec)	MDA (pCi/g) Cs-137	MDA (pCi/g) Cs-137	MDA (pCi/g) Cs-137
600	0.300	3.13	2.87

Case Modeled	Case A	Case B	Case C
Time (sec)	MDA (pCi/g) Co-60	MDA (pCi/g) Co-60	MDA (pCi/g) Co-60
600	0.183	1.89	1.70

Case A	Entire field of view @ 2m height 45° collimator 1.6 g/cm^3
Case B	1m^2 circle edge field of view @ 2m height 45° collimator 1.6 g/cm^3
Case C	1m^2 circle edge field of view @ 2m height 45° collimator 1.6 g/cm^3

Geometry Composer Report

CANBERRA

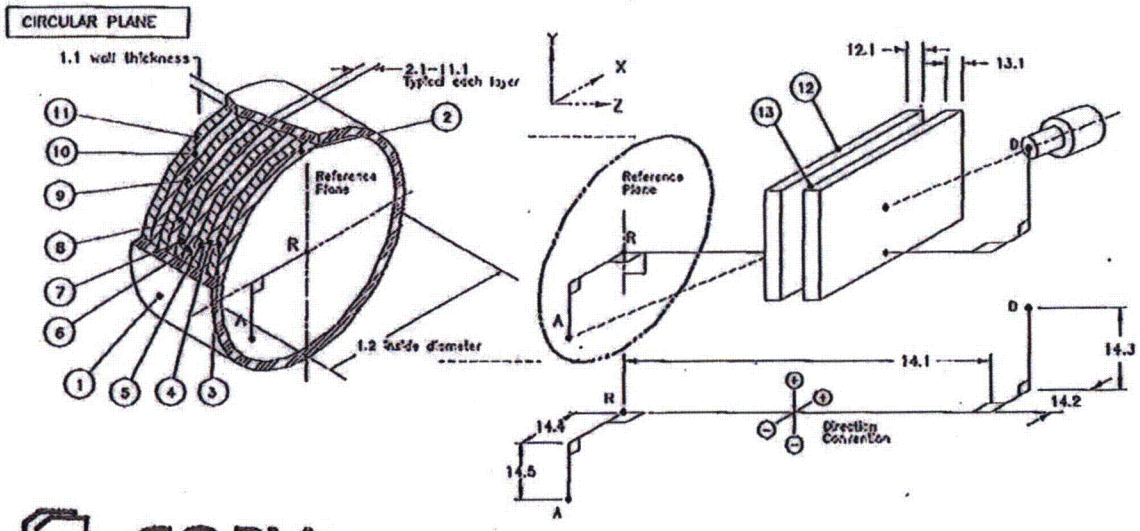
Date: Wednesday, August 17, 2011 - 09:58:45
Description: 2m Soil, Sm Collimator (12M FOV)
Comment: 2m Soil, Sm Collimator
File Name: C:\GENIE2K\Isocs\data\GEOMETRY\In-Situ\CIRCULAR_PLANE\2m Soil, Sm Collimator.geo
Software: ISOCS
Template: CIRCULAR_PLANE, Version: (default)
Detector: 3920
Collimator: 25mm-90d old (oldISOCS 25mm side 90deg collimation [large hole collimator])
Environment: Temperature = 60 °F, Pressure = 760 mm Hg, Relative Humidity = 80%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (cm)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Side Walls	0	400							
2	Layer 1	15						dirt2	1.6	1.00
3	Layer 2	0								
4	Layer 3	0								
5	Layer 4	0								
6	Layer 5	0								
7	Layer 6	0								
8	Layer 7	0								
9	Layer 8	0								
10	Layer 9	0								
11	Layer 10	0								
12	Absorber 1									
13	Absorber 2									
14	Source - Detector	200	0	0	0	0				

List of energies for efficiency curve generation

10.0	20.0	30.0	45.0	58.0	59.5	60.0	61.0
70.0	80.0	100.0	150.0	200.0	300.0	400.0	600.0
660.0	661.7	662.0	663.0	800.0	1000.0	1172.0	1173.2
1174.0	1331.0	1332.5	1333.0	1500.0	2500.0		

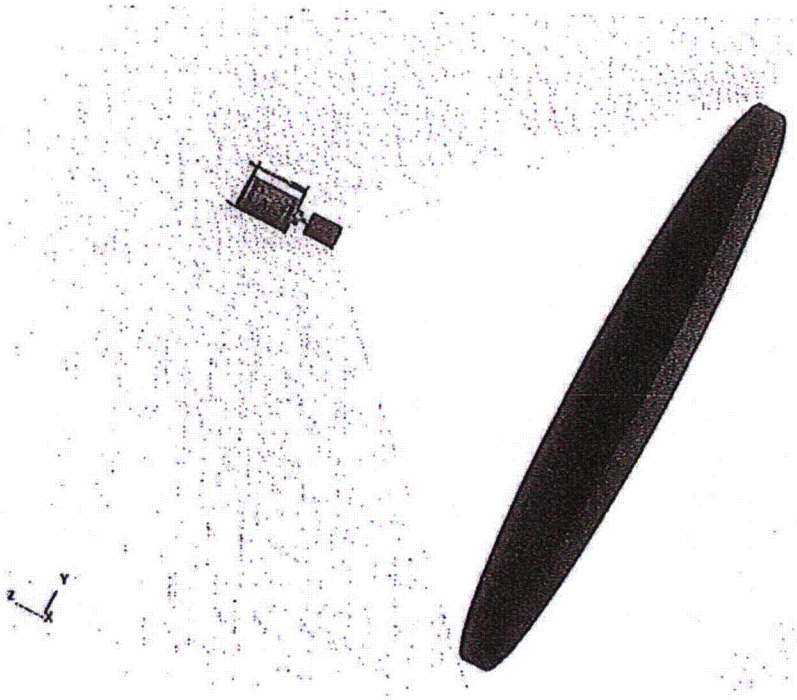


COPY

Geometry Composer Report

CANBERRA

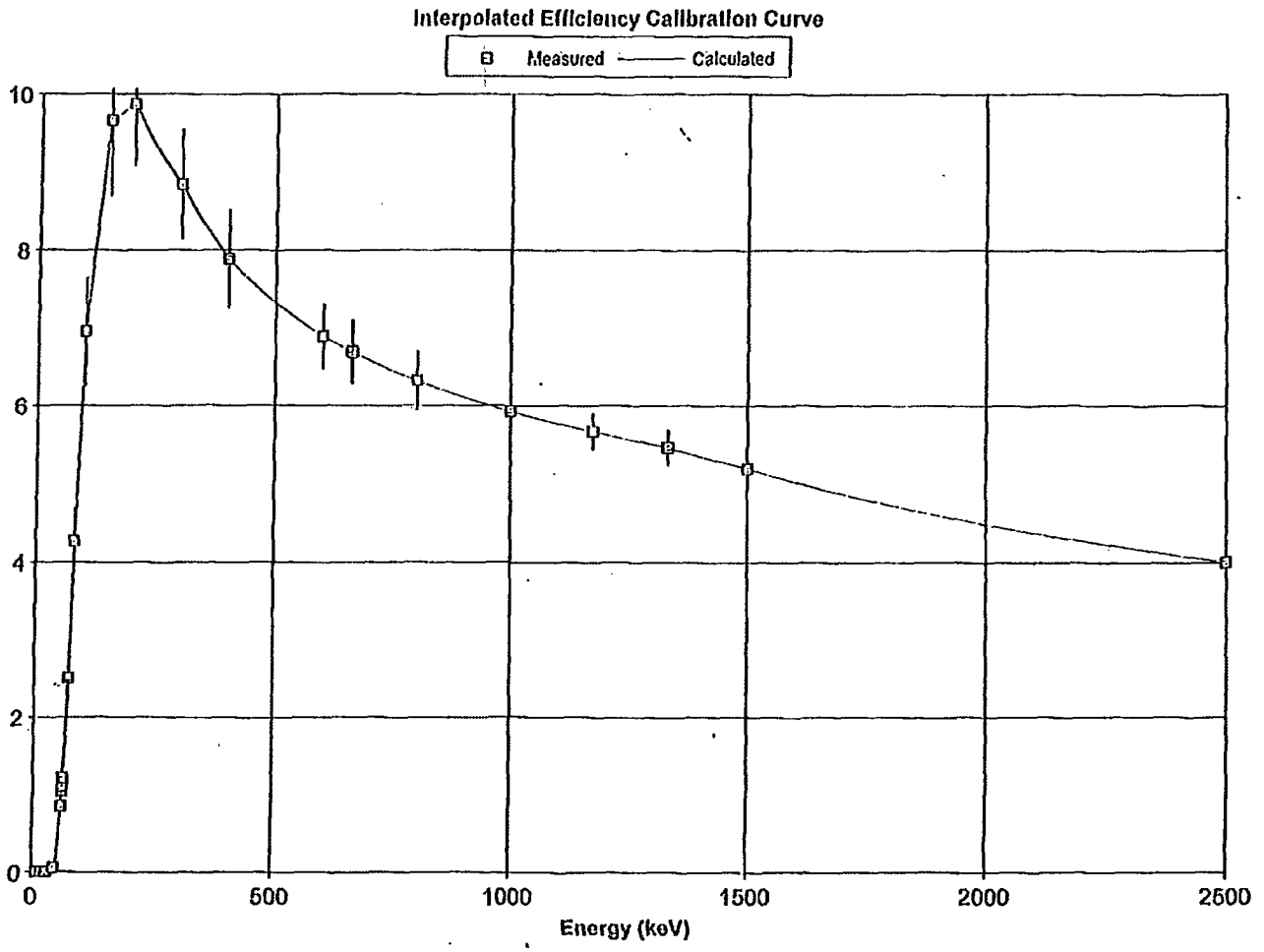
Date:	Wednesday, August 17, 2011 - 09:58:45
Description:	2m Soil, Sm Collimator
Comment:	2m Soil, Sm Collimator
File Name:	C:\GENIE2K\Isocs\data\GEOMETRY\In-Situ\CIRCULAR_PLANE\2m Soil, Sm Collimator.geo
Software:	ISOCS
Template:	CIRCULAR_PLANE, Version: (default)



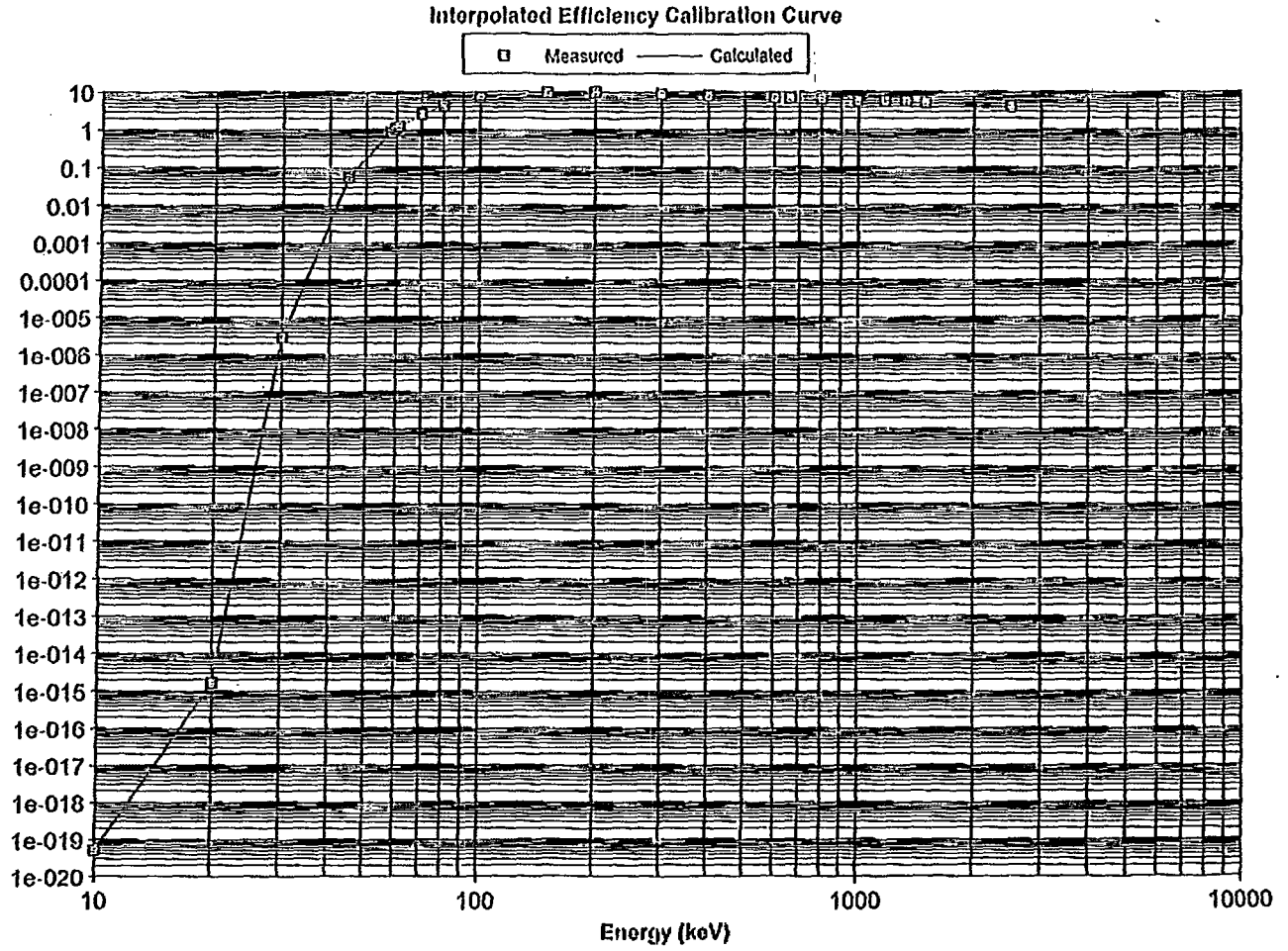
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\CIRCULAR_PLANE\2m Soil
ISOCS/LabSOCS Time: 08/17/11 09:37:46
Genie Cal File: C:\GENIE2K\CALFILES\2m_Soil_Sm .CAL
Genie Cal Time: 08/17/11 10:04:05
T plate: CIRCULAR PLANE
Geom Description: 2m Soil Sm Shld
Comment: ISOCS:UNITS=ACT/G 2M_SOIL,_SM_COLLIMATOR
Detector: 3920
Collimator: 25MM-90D_OLD
Convergence: 1.00 %
Area [Sq Meters]: 1.2566e+001 (C)
Mass [Grams]: 3.0159e+006 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency (X Mass)	%Uncertainty	%Convergence	Final # of Voxels
10.00	4.98337e-020	20.0	0.765830	27220
20.00	1.62725e-015	20.0	0.022777	872925
30.00	2.82366e-006	20.0	-0.086117	218225
45.00	5.68310e-002	15.0	0.228611	436465
58.00	8.40232e-001	10.0	-0.242875	6775
59.54	1.03257e+000	10.0	-0.298996	6775
60.00	1.09605e+000	10.0	-0.303913	6775
61.00	1.20881e+000	10.0	-0.333334	6775
70.00	2.50849e+000	10.0	-0.464690	6775
80.00	4.26787e+000	10.0	-0.556374	6775
100.00	6.95166e+000	10.0	-0.516969	6775
50.00	9.65846e+000	10.0	-0.548414	6775
00.00	9.86728e+000	8.0	-0.530546	6775
300.00	8.84319e+000	8.0	-0.350321	6775
400.00	7.88400e+000	8.0	-0.213358	6775
600.00	6.88428e+000	6.0	-0.091989	6775
660.00	6.69235e+000	6.0	-0.073433	6775
661.65	6.68068e+000	6.0	-0.071660	6775
662.00	6.69778e+000	6.0	-0.071590	6775
663.00	6.67896e+000	6.0	-0.071649	6775
800.00	6.31889e+000	6.0	-0.066937	6775
1000.00	5.91949e+000	4.0	-0.071232	6775
1172.00	5.66953e+000	4.0	-0.064342	6775
1173.22	5.66651e+000	4.0	-0.062582	6775
1174.00	5.66395e+000	4.0	-0.063173	6775
1331.00	5.46725e+000	4.0	-0.046045	6775
1332.49	5.46833e+000	4.0	-0.041743	6775
1333.00	5.46025e+000	4.0	-0.041392	6775
1500.00	5.19425e+000	4.0	-0.042582	6775
2500.00	3.99988e+000	4.0	-0.044001	6775



Datasource: SN_3920



Datasource: SN_3920

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

Detector SN_3920

Report Generated On	:	5/22/2012 11:38:36 AM
Sample Identification	:	Det 3920
Sample Title	:	2m LLD, FOV 12m
Sample Information	:	
	:	
Sample Type	:	
Sample Geometry	:	
Peak Locate Threshold	:	3.00
Peak Locate Range (in channels)	:	100 - 4096
Peak Area Range (in channels)	:	100 - 4096
Identification Energy Tolerance	:	1.000 keV
Sample Size	:	1.000E+000 g
Sample Taken On	:	5/17/2012 11:51:00 AM
Acquisition Started	:	5/17/2012 11:51:22 AM
Live Time	:	600.0 seconds
Real Time	:	601.0 seconds
Dead Time	:	0.16 %

Energy Calibration Used Done On	:	8/4/2011
Efficiency Calibration Used Done On	:	8/17/2011
Efficiency ID	:	2m Soil Sm Shld

Performed by_____ Date_____

Reviewed by _____ Date_____

****
***** P E A K L O C A T E R E P O R T *****
****

Detector Name: SN_3920
Sample Title: 2m LLD, FOV 12m
Peak Locate Performed on: 5/22/2012 11:38:36 AM
Peak Locate From Channel: 100
Peak Locate To Channel: 4096
Peak Search Sensitivity: 3.00

Peak No.	Centroid Channel	Centroid Uncertainty	Energy (keV)	Peak Significance
1	1165.13	0.3892	582.85	3.09
2	2921.16	0.2137	1460.66	7.89

? = Adjacent peak noted

Errors quoted at 1.000 sigma

****
***** P E A K A N A L Y S I S R E P O R T *****
****

Detector Name: SN_3920
Sample Title: 2m LLD, FOV 12m
Peak Analysis Performed on: 5/22/2012 11:38:36 AM
Peak Analysis From Channel: 100
Peak Analysis To Channel: 4096

Peak No.	ROI start	ROI end	Peak centroid	Energy (keV)	FWHM (keV)	Net Peak Area	Net Area Uncert.	Continuum Counts
1	1162-	1169	1165.13	582.85	1.25	1.08E+001	7.10	1.62E+001
2	2915-	2928	2921.16	1460.66	1.54	1.71E+002	13.37	3.04E+000

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet

Errors quoted at 1.000 sigma

****
***** N U C L I D E I D E N T I F I C A T I O N R E P O R T *****
****

Sample Title: 2m LLD, FOV 12m
Nuclide Library Used: C:\GENIE2K\CAMFILES\HBPP.NLB

..... IDENTIFIED NUCLIDES .....

Nuclide Name	Id Confidence	Energy (keV)	Yield (%)	Activity (pCi/g)	Activity Uncertainty
K-40	0.996	1460.81*	10.67	1.374E+001	1.207E+000
Tl-208	0.688	277.35	6.80		
		583.14*	84.20	8.342E-002	5.491E-002
		860.37	12.46		

* = Energy line found in the spectrum.
Energy Tolerance : 1.000 keV
Nuclide confidence index threshold = 0.30
Errors quoted at 1.000 sigma

********** U N I D E N T I F I E D P E A K S **********

Peak Locate Performed on: 5/22/2012 11:38:36 AM
Peak Locate From Channel: 100
Peak Locate To Channel: 4096

Peak No.	Energy (keV)	Peak Size in Counts per Second	Peak CPS % Uncertainty	Peak Type	Tol. Nuclide

All peaks were identified.

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet

Errors quoted at 1.000 sigma

****
***** NUCLIDE MDA REPORT *****
****

Detector Name: SN_3920
Sample Geometry:
Sample Title: 2m LLD, FOV 12m
Nuclide Library Used: C:\GENIE2K\CAMFILES\HBPP.NLB

	Nuclide Name	Energy (keV)	Yield (%)	Line MDA (pCi/g)	Nuclide MDA (pCi/g)	Activity (pCi/g)
+	K-40	1460.81*	10.67	9.5472E-001	9.55E-001	1.3739E+001
	Co-60	1173.22	100.00	1.8273E-001	1.83E-001	-6.5896E-002
		1332.49	100.00	1.9793E-001		4.5600E-002
	Nb-94	702.63	100.00	1.7495E-001	1.68E-001	-4.7263E-002
		871.10	100.00	1.6800E-001		-1.4617E-002
	Ag-108m	79.20	7.10	1.1801E+001	2.19E-001	-1.2975E+000
		433.93	89.90	2.2376E-001		-9.2283E-002
		614.37	90.40	2.4723E-001		-2.0506E-001
		722.95	90.50	2.1874E-001		9.1741E-002
	Cs-134	569.31	15.43	1.4419E+000	2.21E-001	-3.6585E-001
		604.70	97.60	2.2080E-001		-3.2585E-002
		795.84	85.40	2.6160E-001		-1.2721E-002
	Cs-137	661.65	85.12	2.9969E-001	3.00E-001	2.7738E-001
	Eu-152	121.78	28.40	1.3258E+000	7.10E-001	1.1491E-002
		244.69	7.49	3.3434E+000		9.8786E-001
		344.27	26.50	7.0956E-001		-6.1133E-001
		778.89	12.74	1.5412E+000		-3.6755E-001
		867.32	4.16	4.7168E+000		-1.0484E+000
		964.01	14.40	1.5175E+000		-1.3070E-001
		1085.78	10.00	2.0568E+000		-3.6315E-001
		1112.02	13.30	1.6850E+000		-9.5302E-001
		1407.95	20.70	8.4534E-001		3.5688E-001
	Eu-154	123.07	40.50	9.1728E-001	5.15E-001	3.5029E-001
		247.94	6.60	3.7264E+000		-9.5294E-001
		723.30	19.70	1.0339E+000		6.8229E-001
		873.19	11.50	1.4954E+000		-7.4302E-001
		996.32	10.30	1.5732E+000		-5.1660E-001
		1004.76	17.90	9.7848E-001		-1.1725E-001
		1274.45	35.50	5.1461E-001		2.8913E-001
	Eu-155	105.31	20.70	2.0415E+000	2.04E+000	-1.3835E-001
	Pb-206	803.10	100.00	2.1576E-001	2.16E-001	6.0968E-002
	Ac-228	338.32	11.40	1.8988E+000	8.49E-001	9.8160E-001
		911.07	27.70	8.4911E-001		5.6391E-001
		969.11	16.60	1.3370E+000		7.3501E-001
	Th-234	63.29	3.80	4.5458E+001	1.08E+001	2.9680E+001
		92.59	5.41	1.0831E+001		4.3335E+000
	U-235	143.76	10.50	3.0022E+000	4.98E-001	1.5837E-001
		163.35	4.70	6.1955E+000		5.0275E-001
		185.72	54.00	4.9762E-001		-2.0189E-001
		205.31	4.70	4.8387E+000		-5.0339E+000
	Np-237	311.98	38.60	5.9409E-001	5.94E-001	1.3611E-001
	Am-241	59.54	35.90	6.0109E+000	6.01E+000	-2.1662E+000

Nuclide Name	Energy (keV)	Yield (%)	Line MDA (pCi/g)	Nuclide MDA (pCi/g)	Activity (pCi/g)

\+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = Calculated MDA is zero due to zero counts in the region or the region is outside the spectrum
@ = Half-life too short to be able to perform the decay correction

Geometry Composer Report

CANBERRA

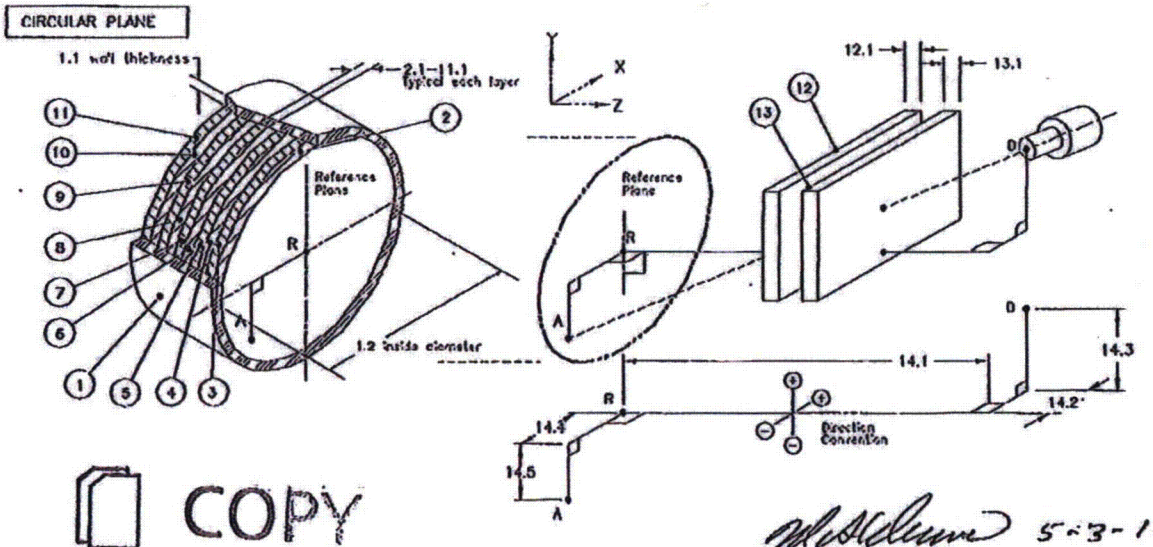
Date:	Thursday, May 03, 2012 - 08:53:52
Description:	3920 2m Soil (12mFOV) 1m on o/s edge of FOV Sm Collimator D1.6
Comment:	Calib. Date 5/3/12
File Name:	C:\GENIE2K\Isocs\data\GEOMETRY\In-Situ\CIRCULAR_PLANE\3920 12m FOV 1m Soil Sm Col.geo
Software:	ISOCS
Template:	CIRCULAR_PLANE, Version: (default)
Detector:	Det_3920
Collimator:	25mm-90d old (oldISOCS 25mm side 90deg collimation [large hole collimator])
Environment:	Temperature = 60 °F, Pressure = 760 mm Hg, Relative Humidity = 80%
Integration:	Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (cm)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Side Walls	0	113							
2	Layer 1	15						dirt2	1.6	1.00
3	Layer 2	0								
4	Layer 3	0								
5	Layer 4	0								
6	Layer 5	0								
7	Layer 6	0								
8	Layer 7	0								
9	Layer 8	0								
10	Layer 9	0								
11	Layer 10	0								
12	Absorber 1									
13	Absorber 2									
14	Source - Detector	200	0	0	144	0				

List of energies for efficiency curve generation

10.0	20.0	30.0	45.0	58.0	59.5	60.0	61.0
70.0	80.0	100.0	150.0	200.0	300.0	400.0	600.0
660.0	661.7	662.0	663.0	800.0	1000.0	1172.0	1173.2
1174.0	1331.0	1332.5	1333.0	1500.0	2500.0		



COPY

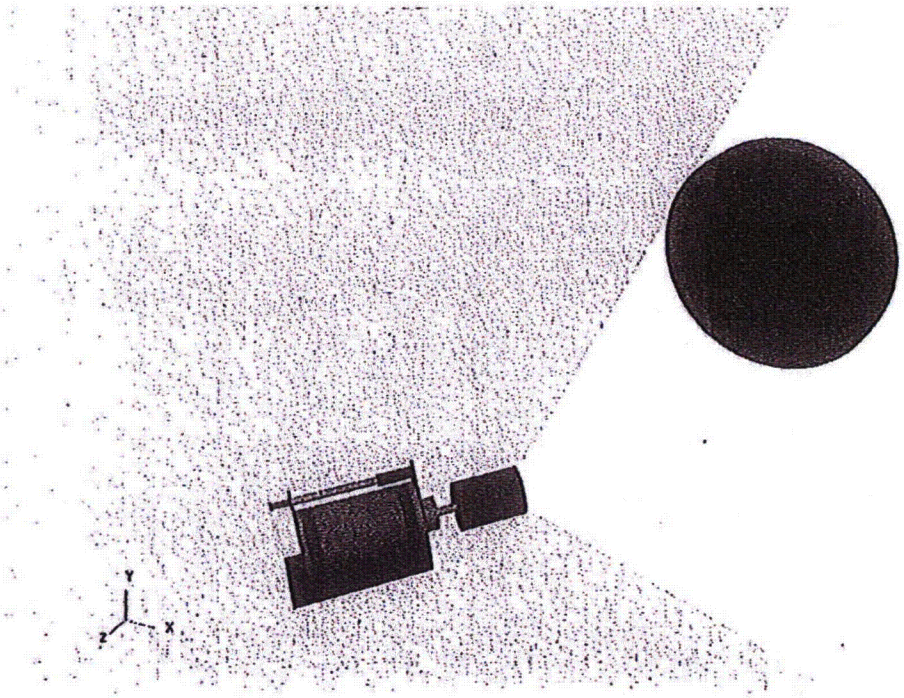
5-3-12

6/8/12.

Geometry Composer Report

CANBERRA

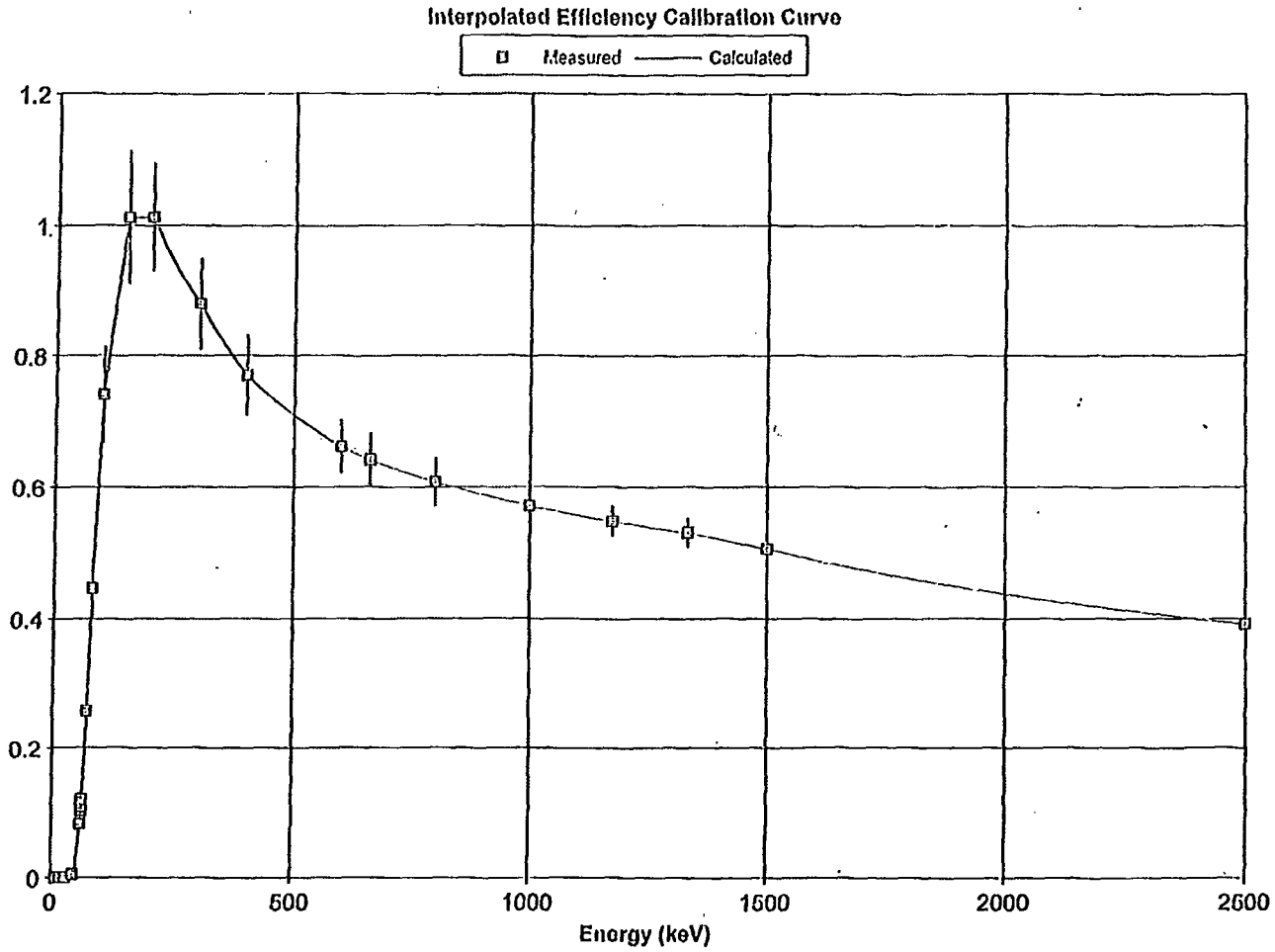
Date:	Thursday, May 03, 2012 - 08:53:52
Description:	3920 2m Soil (12mFOV) 1m on o/s edge of FOV Sm Collimator D1.6
Comment:	Calib. Date 5/3/12
File Name:	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\CIRCULAR_PLANE\3920 12m FOV 1m Soil Sm Col.geo
Software:	ISOCS
Template:	CIRCULAR_PLANE, Version: (default)



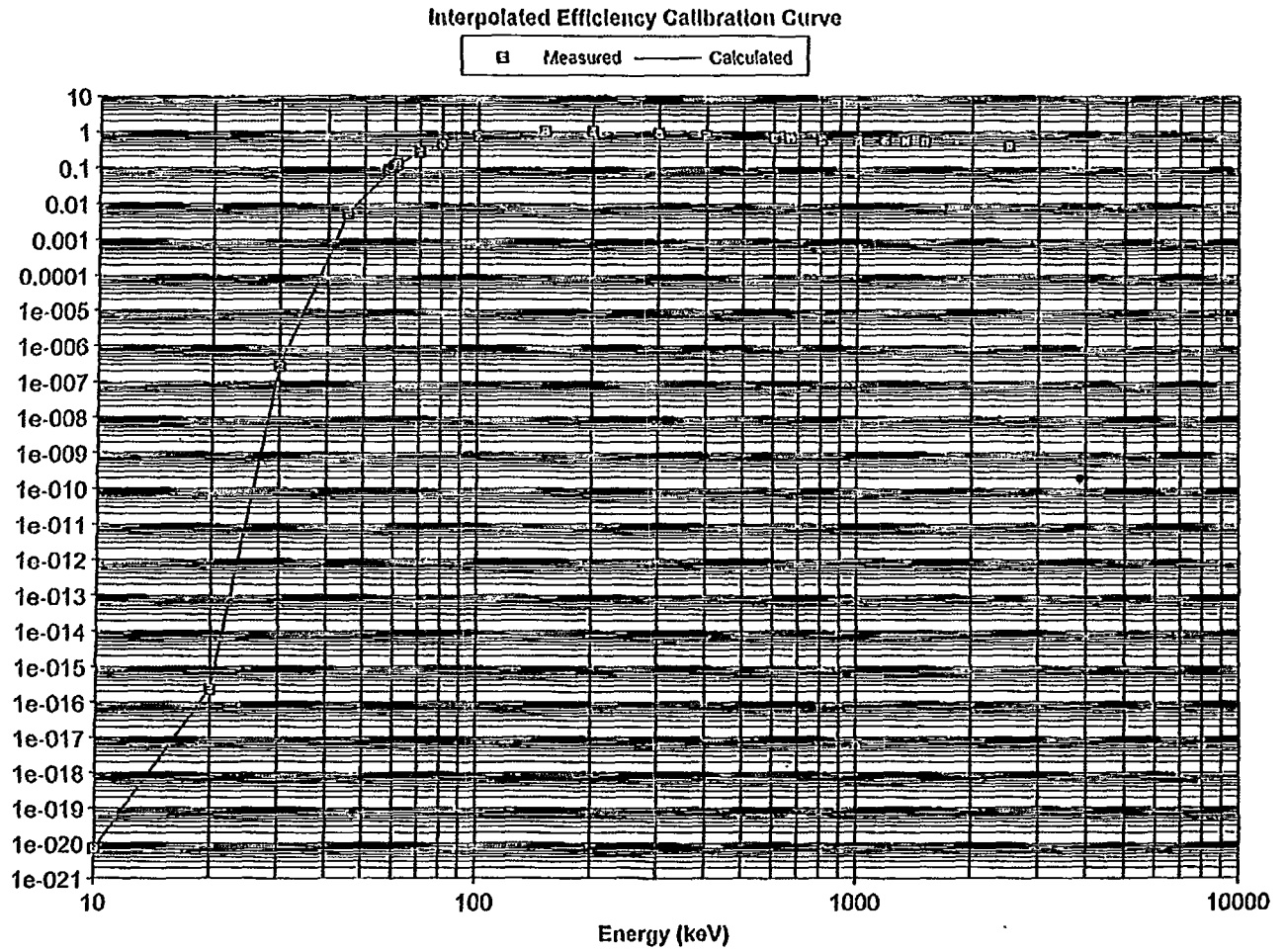
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\CIRCULAR_PLANE\3920 1
ISOCS/LabSOCS Time: 05/03/12 08:46:38
Genie Cal File: C:\GENIE2K\CALFILES\3920 12m FOV 1m SC d1.6.CAL
Genie Cal Time: 05/03/12 09:01:38
Template: CIRCULAR PLANE
Geom Description: 2m Soil 1m D1.6
Comment: ISOCS:UNITS=ACT/G CALIB._DATE_5/3/12
Detector: DET 3920
Collimator: 25MM-90D_OLD
Convergence: 1.00 %
Area [Sq Meters]: 1.0029e+000 (C)
Mass [Grams]: 2.4069e+005 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency (X Mass)	%Uncertainty	%Convergence	Final # of Voxels
10.00	7.07653e-021	20.0	-0.574994	4070
20.00	2.31320e-016	20.0	-0.683346	128670
30.00	2.56578e-007	20.0	-0.670869	128670
45.00	5.04790e-003	15.0	-0.792136	8090
58.00	8.22524e-002	10.0	-0.379550	8090
59.54	1.01969e-001	10.0	-0.366892	8090
60.00	1.08470e-001	10.0	-0.362993	8090
61.00	1.20183e-001	10.0	-0.355210	8090
70.00	2.57866e-001	10.0	-0.152227	4070
80.00	4.46745e-001	10.0	-0.188625	4070
100.00	7.39453e-001	10.0	-0.280100	4070
50.00	1.01161e+000	10.0	-0.302081	4070
200.00	1.01221e+000	8.0	-0.314004	4070
300.00	8.78829e-001	8.0	-0.319394	4070
400.00	7.69240e-001	8.0	-0.278667	4070
600.00	6.60629e-001	6.0	-0.188318	4070
660.00	6.41513e-001	6.0	-0.171501	4070
661.65	6.40543e-001	6.0	-0.171032	4070
662.00	6.42180e-001	6.0	-0.170946	4070
663.00	6.40235e-001	6.0	-0.170934	4070
800.00	6.07348e-001	6.0	-0.147361	4070
1000.00	5.70982e-001	4.0	-0.129219	4070
1172.00	5.47952e-001	4.0	-0.118688	4070
1173.22	5.48706e-001	4.0	-0.118499	4070
1174.00	5.47969e-001	4.0	-0.119254	4070
1331.00	5.29867e-001	4.0	-0.114092	4070
1332.49	5.30880e-001	4.0	-0.114327	4070
1333.00	5.30972e-001	4.0	-0.114317	4070
1500.00	5.06349e-001	4.0	-0.110963	4070
2500.00	3.91114e-001	4.0	-0.107900	4070



Datasource: SN_3920



Datasource: SN_3920

****
***** GAMMA SPECTRUM ANALYSIS *****
****

Detector SN_3920

Report Generated On	:	5/22/2012 11:26:05 AM
Sample Identification	:	Det 3920
Sample Title	:	1m on Edge-Of-View LLD
Sample Information	:	
	:	
Sample Type	:	
Sample Geometry	:	
Peak Locate Threshold	:	3.00
Peak Locate Range (in channels)	:	100 - 4096
Peak Area Range (in channels)	:	100 - 4096
Identification Energy Tolerance	:	1.000 keV
Sample Size	:	1.000E+000 g
Sample Taken On	:	5/17/2012 11:51:00 AM
Acquisition Started	:	5/17/2012 11:51:22 AM
Live Time	:	600.0 seconds
Real Time	:	601.0 seconds
Dead Time	:	0.16 %

Energy Calibration Used Done On	:	8/4/2011
Efficiency Calibration Used Done On	:	5/3/2012
Efficiency ID	:	2m Soil 1m D1.6

Performed by_____ Date_____

Reviewed by _____ Date_____

****
***** P E A K L O C A T E R E P O R T *****
****

Detector Name: SN_3920
Sample Title: 1m on Edge-Of-View LLD
Peak Locate Performed on: 5/22/2012 11:26:05 AM
Peak Locate From Channel: 100
Peak Locate To Channel: 4096
Peak Search Sensitivity: 3.00

Peak No.	Centroid Channel	Centroid Uncertainty	Energy (keV)	Peak Significance
1	1165.13	0.3892	582.85	3.09
2	2921.16	0.2137	1460.66	7.89

? = Adjacent peak noted

Errors quoted at 2.000 sigma

****
***** P E A K A N A L Y S I S R E P O R T *****
****

Detector Name: SN_3920
Sample Title: 1m on Edge-Of-View LLD
Peak Analysis Performed on: 5/22/2012 11:26:05 AM
Peak Analysis From Channel: 100
Peak Analysis To Channel: 4096

Peak No.	ROI start	ROI end	Peak centroid	Energy (keV)	FWHM (keV)	Net Peak Area	Net Area Uncert.	Continuum Counts
1	1162-	1169	1165.13	582.85	1.25	1.08E+001	14.21	1.62E+001
2	2915-	2928	2921.16	1460.66	1.54	1.71E+002	26.74	3.04E+000

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet

Errors quoted at 2.000 sigma

****
***** N U C L I D E I D E N T I F I C A T I O N R E P O R T *****
****

Sample Title: 1m on Edge-Of-View LLD
Nuclide Library Used: C:\GENIE2K\CAMFILES\HBPP.NLB

..... IDENTIFIED NUCLIDES .....

Nuclide Name	Id Confidence	Energy (keV)	Yield (%)	Activity (pCi/g)	Activity Uncertainty
K-40	0.996	1460.81*	10.67	1.41018E+002	2.47734E+001
Tl-208	0.686	277.35	6.80		
		583.14*	84.20	8.68281E-001	1.14305E+000
		860.37	12.46		

* = Energy line found in the spectrum.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 1.000 keV
Nuclide confidence index threshold = 0.30
Errors quoted at 2.000 sigma

****
***** I N T E R F E R E N C E C O R R E C T E D R E P O R T *****
****

Nuclide Name	Nuclide Id Confidence	Wt mean Activity (pCi/g)	Wt mean Activity Uncertainty
K-40	0.996	1.410184E+002	2.477343E+001
Tl-208	0.686	8.682807E-001	1.143055E+000

? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 2.000 sigma

********** U N I D E N T I F I E D P E A K S **********

Peak Locate Performed on: 5/22/2012 11:26:05 AM
Peak Locate From Channel: 100
Peak Locate To Channel: 4096

Peak No.	Energy (keV)	Peak Size in Counts per Second	Peak CPS % Uncertainty	Peak Type	Tol. Nuclide

All peaks were identified.

****
***** NUCLIDE MDA REPORT *****
****

Detector Name: SN_3920
Sample Geometry:
Sample Title: 1m on Edge-Of-View LLD
Nuclide Library Used: C:\GENIE2K\CAMFILES\HBPP.NLB

	Nuclide Name	Energy (keV)	Yield (%)	Line MDA (pCi/g)	Nuclide MDA (pCi/g)	Activity (pCi/g)
+	K-40	1460.81*	10.67	9.7992E+000	9.80E+000	1.4102E+002
	Co-60	1173.22	100.00	1.8871E+000	1.89E+000	-6.8051E-001
		1332.49	100.00	2.0387E+000		4.6970E-001
	Nb-94	702.63	100.00	1.8236E+000	1.75E+000	-4.9265E-001
		871.10	100.00	1.7455E+000		-1.5187E-001
	Ag-108m	79.20	7.10	1.1289E+002	2.28E+000	-1.2412E+001
		433.93	89.90	2.3010E+000		-9.4897E-001
		614.37	90.40	2.5770E+000		-2.1375E+000
		722.95	90.50	2.2791E+000		9.5586E-001
	Cs-134	569.31	15.43	1.4993E+001	2.30E+000	-3.8042E+000
		604.70	97.60	2.3011E+000		-3.3959E-001
		795.84	85.40	2.7219E+000		-1.3236E-001
	Cs-137	661.65	85.12	3.1257E+000	3.13E+000	2.8930E+000
	Eu-152	121.78	28.40	1.2558E+001	7.20E+000	1.0884E-001
		244.69	7.49	3.3111E+001		9.7831E+000
		344.27	26.50	7.2030E+000		-6.2058E+000
		778.89	12.74	1.6041E+001		-3.8255E+000
		867.32	4.16	4.9011E+001		-1.0894E+001
		964.01	14.40	1.5741E+001		-1.3558E+000
		1085.78	10.00	2.1301E+001		-3.7610E+000
		1112.02	13.30	1.7445E+001		-9.8671E+000
		1407.95	20.70	8.6832E+000		3.6658E+000
	Eu-154	123.07	40.50	8.6920E+000	5.31E+000	3.3192E+000
		247.94	6.60	3.6941E+001		-9.4470E+000
		723.30	19.70	1.0772E+001		7.1088E+000
		873.19	11.50	1.5537E+001		-7.7197E+000
		996.32	10.30	1.6311E+001		-5.3560E+000
		1004.76	17.90	1.0144E+001		-1.2154E+000
		1274.45	35.50	5.3131E+000		2.9851E+000
	Eu-155	105.31	20.70	1.9230E+001	1.92E+001	-1.3032E+000
	Pb-206	803.10	100.00	2.2446E+000	2.24E+000	6.3427E-001
	Ac-228	338.32	11.40	1.9254E+001	8.82E+000	9.9534E+000
		911.07	27.70	8.8159E+000		5.8548E+000
		969.11	16.60	1.3867E+001		7.6238E+000
	Th-234	63.29	3.80	4.5315E+002	1.02E+002	2.9586E+002
		92.59	5.41	1.0239E+002		4.0966E+001
	U-235	143.76	10.50	2.8618E+001	4.82E+000	1.5096E+000
		163.35	4.70	5.9518E+001		4.8298E+000
		185.72	54.00	4.8250E+000		-1.9575E+000
		205.31	4.70	4.7266E+001		-4.9172E+001
	Np-237	311.98	38.60	5.9930E+000	5.99E+000	1.3730E+000
	Am-241	59.54	35.90	6.0868E+001	6.09E+001	-2.1936E+001

Nuclide Name	Energy (keV)	Yield (%)	Line MDA (pCi/g)	Nuclide MDA (pCi/g)	Activity (pCi/g)

+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = Calculated MDA is zero due to zero counts in the region or the region is outside the spectrum
@ = Half-life too short to be able to perform the decay correction

Geometry Composer Report

CANBERRA

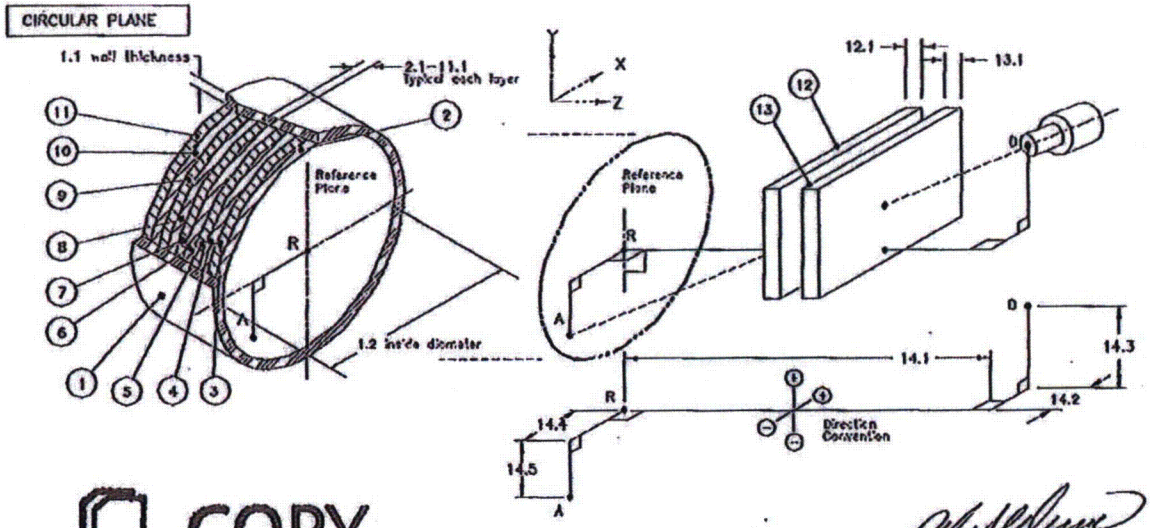
Date: Thursday, May 03, 2012 - 15:43:51
Description: 3920 2m Soil (12mFOV) 1m on o/s edge of FOV Sm Collimator D2.0
Comment: Calib. Date 5/3/12
File Name: C:\GENIE2K\Isocs\data\GEOMETRY\In-Situ\CIRCULAR_PLANE\3920 12m FOV 1m Soil Sm Col D2.geo
Software: ISOCS
Template: CIRCULAR_PLANE, Version: (default)
Detector: Det_3920
Collimator: 25mm-90d old (oldISOCS 25mm side 90deg collimation [large hole collimator])
Environment: Temperature = 60 °F, Pressure = 760 mm Hg, Relative Humidity = 80%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (cm)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Side Walls	0	113							
2	Layer 1	15						dirt5	2	1.00
3	Layer 2	0								
4	Layer 3	0								
5	Layer 4	0								
6	Layer 5	0								
7	Layer 6	0								
8	Layer 7	0								
9	Layer 8	0								
10	Layer 9	0								
11	Layer 10	0								
12	Absorber 1									
13	Absorber 2									
14	Source - Detector	200	0	0	144	0				

List of energies for efficiency curve generation

10.0	20.0	30.0	45.0	58.0	59.5	60.0	61.0
70.0	80.0	100.0	150.0	200.0	300.0	400.0	600.0
660.0	661.7	662.0	663.0	800.0	1000.0	1172.0	1173.2
1174.0	1331.0	1332.5	1333.0	1500.0	2500.0		



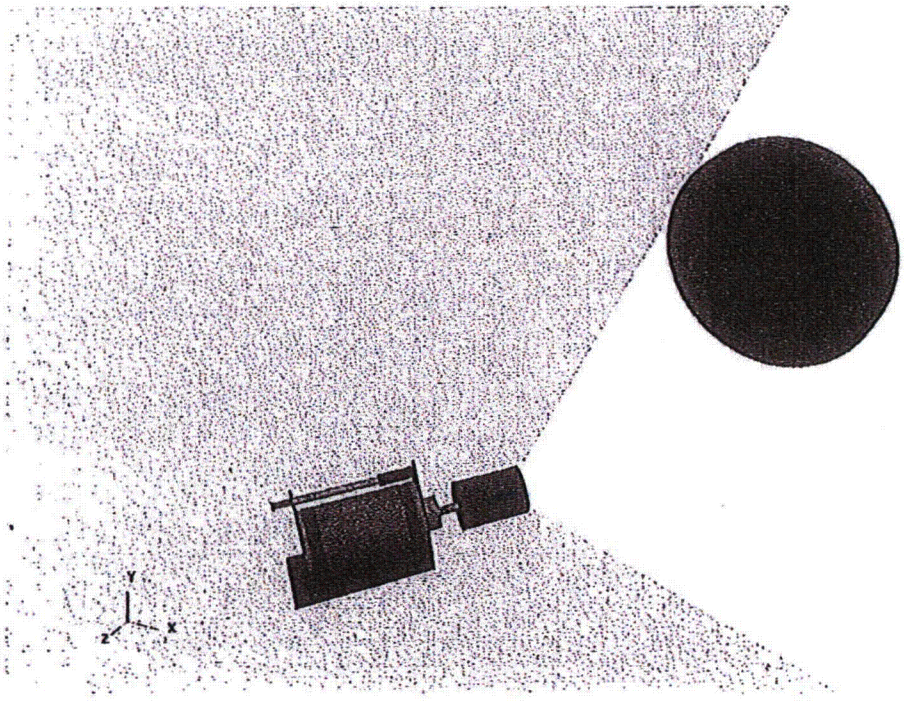
COPY

5-3-12
D. Anderson 5/3/12

Geometry Composer Report

CANBERRA

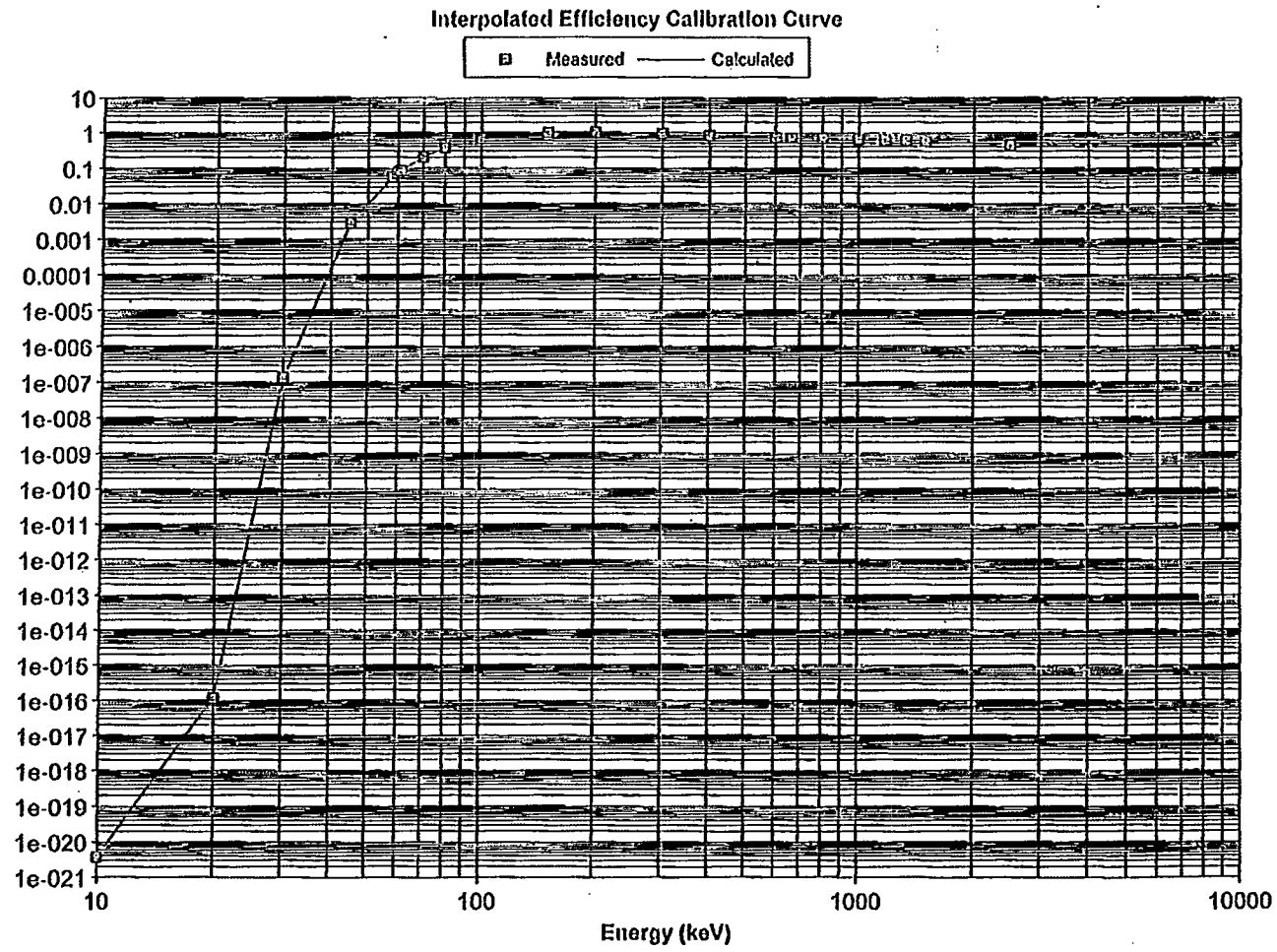
Date:	Thursday, May 03, 2012 - 15:43:51
Description:	3920 2m Soil (12mFOV) 1m on o/s edge of FOV Sm Collimator D2.0
Comment:	Calib. Date 5/3/12
File Name:	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\CIRCULAR_PLANE\3920 12m FOV 1m Soil Sm Col D2.geo
Software:	ISOCS
Template:	CIRCULAR_PLANE, Version: (default)



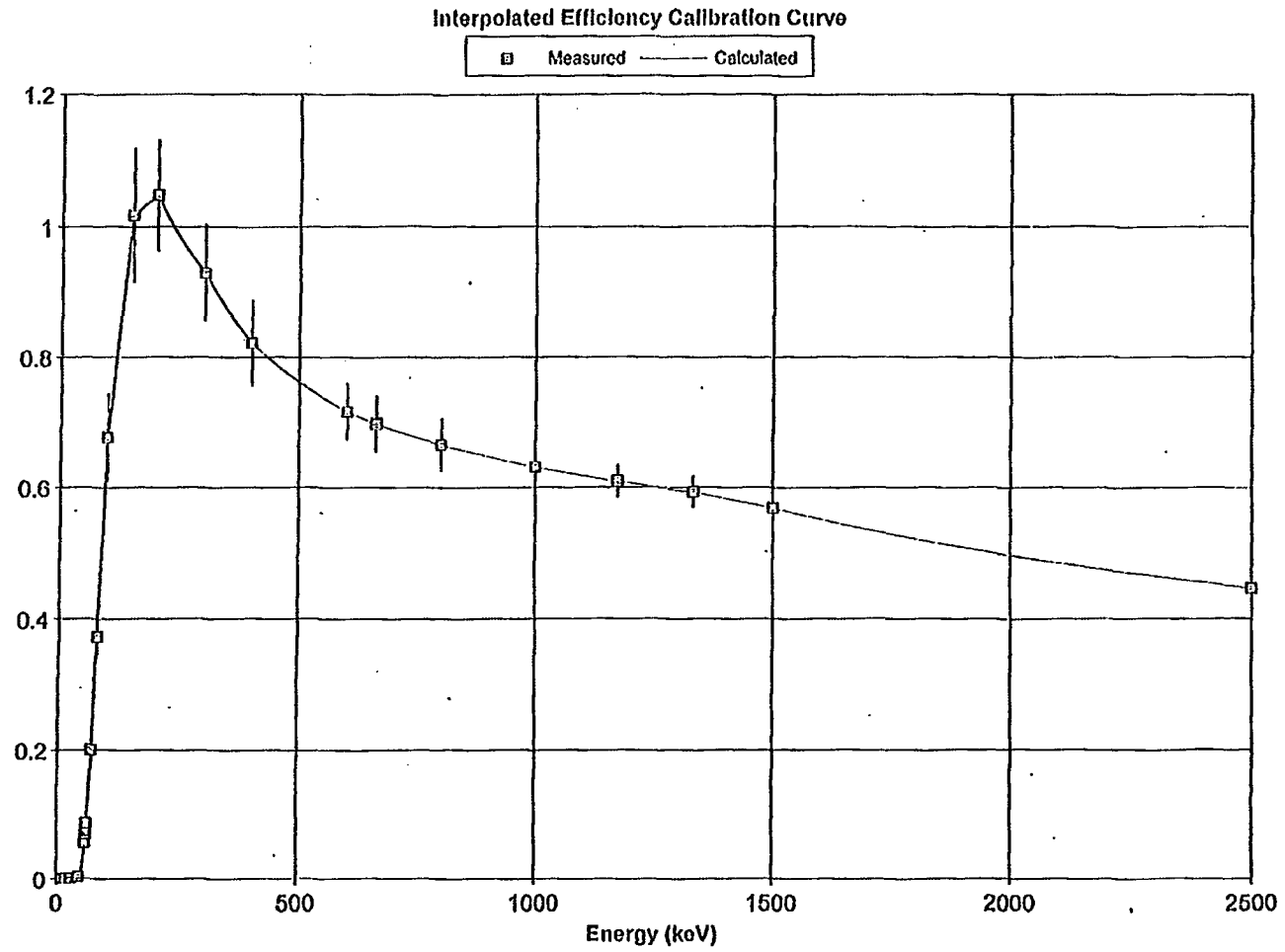
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\CIRCULAR_PLANE\3920 1:
ISOCS/LabSOCS Time: 05/03/12 08:52:44
Genie Cal File: C:\GENIE2K\CALFILES\3920 12m FOV 1m SC d2.0.CAL
Genie Cal Time: 05/03/12 09:24:51
Template: CIRCULAR PLANE
Geom Description: 2m Soil 1m D2.0
Comment: ISOCS:UNITS=ACT/G CALIB._DATE_5/3/12
Detector: DET 3920
Collimator: 25MM-90D_OLD
Convergence: 1.00 %
Area [Sq Meters]: 1.0029e+000 (C)
Mass [Grams]: 3.0086e+005 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency (X Mass)	%Uncertainty	%Convergence	Final # of Voxels
10.00	3.65168e-021	20.0	-0.249542	2030
20.00	1.13302e-016	20.0	-0.145776	514940
30.00	1.30428e-007	20.0	-0.543440	514940
45.00	2.90801e-003	15.0	-0.765265	128670
58.00	5.54817e-002	10.0	-0.422703	128670
59.54	6.99465e-002	10.0	-0.399607	128670
60.00	7.47832e-002	10.0	-0.393034	128670
61.00	8.65387e-002	10.0	-0.798743	8090
70.00	2.00474e-001	10.0	-0.609316	8090
80.00	3.72482e-001	10.0	-0.525756	8090
100.00	6.76365e-001	10.0	-0.386913	8090
50.00	1.01649e+000	10.0	-0.193214	4070
200.00	1.04683e+000	8.0	-0.242543	4070
300.00	9.28692e-001	8.0	-0.287338	4070
400.00	8.21726e-001	8.0	-0.262956	4070
600.00	7.15922e-001	6.0	-0.178655	4070
660.00	6.97567e-001	6.0	-0.162301	4070
661.65	6.96619e-001	6.0	-0.161874	4070
662.00	6.98412e-001	6.0	-0.161790	4070
663.00	6.96381e-001	6.0	-0.161834	4070
800.00	6.65188e-001	6.0	-0.139595	4070
1000.00	6.30763e-001	4.0	-0.123062	4070
1172.00	6.09146e-001	4.0	-0.113856	4070
1173.22	6.10046e-001	4.0	-0.113665	4070
1174.00	6.09176e-001	4.0	-0.114523	4070
1331.00	5.91997e-001	4.0	-0.110425	4070
1332.49	5.93125e-001	4.0	-0.110654	4070
1333.00	5.93234e-001	4.0	-0.110646	4070
1500.00	5.68268e-001	4.0	-0.108198	4070
2500.00	4.46362e-001	4.0	-0.108020	4070



Datasource: SN_3920



Datasource: SN_3920

****
***** GAMMA SPECTRUM ANALYSIS *****
****

Detector SN 3920

Report Generated On	:	5/22/2012 11:27:11 AM
Sample Identification	:	Det 3920
Sample Title	:	1m on Edge-Of-View LLD
Sample Information	:	
	:	
Sample Type	:	
Sample Geometry	:	
Peak Locate Threshold	:	3.00
Peak Locate Range (in channels)	:	100 - 4096
Peak Area Range (in channels)	:	100 - 4096
Identification Energy Tolerance	:	1.000 keV
Sample Size	:	1.000E+000 g
Sample Taken On	:	5/17/2012 11:51:00 AM
Acquisition Started	:	5/17/2012 11:51:22 AM
Live Time	:	600.0 seconds
Real Time	:	601.0 seconds
Dead Time	:	0.16 %

Energy Calibration Used Done On	:	8/4/2011
Efficiency Calibration Used Done On	:	5/3/2012
Efficiency ID	:	2m Soil 1m D2.0

Performed by_____ Date_____

Reviewed by _____ Date_____

COPY

****
***** P E A K L O C A T E R E P O R T *****
****

Detector Name: SN_3920
Sample Title: 1m on Edge-Of-View LLD
Peak Locate Performed on: 5/22/2012 11:27:11 AM
Peak Locate From Channel: 100
Peak Locate To Channel: 4096
Peak Search Sensitivity: 3.00

Peak No.	Centroid Channel	Centroid Uncertainty	Energy (keV)	Peak Significance
1	1165.13	0.3892	582.85	3.09
2	2921.16	0.2137	1460.66	7.89

? = Adjacent peak noted

Errors quoted at 2.000 sigma

****
***** P E A K A N A L Y S I S R E P O R T *****
****

Detector Name: SN_3920
Sample Title: 1m on Edge-Of-View LLD
Peak Analysis Performed on: 5/22/2012 11:27:11 AM
Peak Analysis From Channel: 100
Peak Analysis To Channel: 4096

Peak No.	ROI start	ROI end	Peak centroid	Energy (keV)	FWHM (keV)	Net Peak Area	Net Area Uncert.	Continuum Counts
1	1162-	1169	1165.13	582.85	1.25	1.08E+001	14.21	1.62E+001
2	2915-	2928	2921.16	1460.66	1.54	1.71E+002	26.74	3.04E+000

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet

Errors quoted at 2.000 sigma

****
***** N U C L I D E I D E N T I F I C A T I O N R E P O R T *****
****

Sample Title: 1m on Edge-Of-View LLD
Nuclide Library Used: C:\GENIE2K\CAMFILES\HBPP.NLB

..... IDENTIFIED NUCLIDES .....

Nuclide Name	Id Confidence	Energy (keV)	Yield (%)	Activity (pCi/g)	Activity Uncertainty
K-40	0.996	1460.81*	10.67	1.25780E+002	2.20964E+001
Tl-208	0.687	277.35	6.80		
		583.14*	84.20	8.02044E-001	1.05586E+000
		860.37	12.46		

* = Energy line found in the spectrum.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 1.000 keV
Nuclide confidence index threshold = 0.30
Errors quoted at 2.000 sigma

****
***** I N T E R F E R E N C E C O R R E C T E D R E P O R T *****
****

Nuclide Name	Nuclide Id Confidence	Wt mean Activity (pCi/g)	Wt mean Activity Uncertainty
K-40	0.996	1.257799E+002	2.209641E+001
Tl-208	0.687	8.020444E-001	1.055858E+000

? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 2.000 sigma

********** U N I D E N T I F I E D P E A K S **********

Peak Locate Performed on: 5/22/2012 11:27:11 AM
Peak Locate From Channel: 100
Peak Locate To Channel: 4096

Peak No.	Energy (keV)	Peak Size in Counts per Second	Peak CPS % Uncertainty	Peak Type	Tol. Nuclide

All peaks were identified.

****
***** NUCLIDE MDA REPORT *****
****

Detector Name: SN_3920
Sample Geometry:
Sample Title: 1m on Edge-Of-View LLD
Nuclide Library Used: C:\GENIE2K\CAMFILES\HBPP.NLB

	Nuclide Name	Energy (keV)	Yield (%)	Line MDA (pCi/g)	Nuclide MDA (pCi/g)	Activity (pCi/g)
+	K-40	1460.81*	10.67	8.7403E+000	8.74E+000	1.2578E+002
	Co-60	1173.22	100.00	1.6973E+000	1.70E+000	-6.1208E-001
		1332.49	100.00	1.8248E+000		4.2041E-001
	Nb-94	702.63	100.00	1.6730E+000	1.59E+000	-4.5196E-001
		871.10	100.00	1.5885E+000		-1.3821E-001
	Ag-108m	79.20	7.10	1.3611E+002	2.09E+000	-1.4965E+001
		433.93	89.90	2.1478E+000		-8.8580E-001
		614.37	90.40	2.3760E+000		-1.9708E+000
		722.95	90.50	2.0886E+000		8.7600E-001
	Cs-134	569.31	15.43	1.3861E+001	2.12E+000	-3.5169E+000
		604.70	97.60	2.1228E+000		-3.1327E-001
		795.84	85.40	2.4857E+000		-1.2088E-001
	Cs-137	661.65	85.12	2.8741E+000	2.87E+000	2.6601E+000
	Eu-152	121.78	28.40	1.3116E+001	6.78E+000	1.1368E-001
		244.69	7.49	3.1674E+001		9.3587E+000
		344.27	26.50	6.7810E+000		-5.8423E+000
		778.89	12.74	1.4661E+001		-3.4963E+000
		867.32	4.16	4.4610E+001		-9.9158E+000
		964.01	14.40	1.4270E+001		-1.2290E+000
		1085.78	10.00	1.9219E+001		-3.3934E+000
		1112.02	13.30	1.5725E+001		-8.8944E+000
		1407.95	20.70	7.7557E+000		3.2743E+000
	Eu-154	123.07	40.50	9.0563E+000	4.76E+000	3.4584E+000
		247.94	6.60	3.5314E+001		-9.0309E+000
		723.30	19.70	9.8721E+000		6.5148E+000
		873.19	11.50	1.4138E+001		-7.0247E+000
		996.32	10.30	1.4767E+001		-4.8491E+000
		1004.76	17.90	9.1804E+000		-1.1000E+000
		1274.45	35.50	4.7637E+000		2.6764E+000
	Eu-155	105.31	20.70	2.0773E+001	2.08E+001	-1.4078E+000
	Pb-206	803.10	100.00	2.0491E+000	2.05E+000	5.7904E-001
	Ac-228	338.32	11.40	1.8138E+001	8.01E+000	9.3765E+000
		911.07	27.70	8.0091E+000		5.3190E+000
		969.11	16.60	1.2568E+001		6.9096E+000
	Th-234	63.29	3.80	6.1653E+002	1.16E+002	4.0254E+002
		92.59	5.41	1.1557E+002		4.6241E+001
	U-235	143.76	10.50	2.8762E+001	4.70E+000	1.5172E+000
		163.35	4.70	5.8729E+001		4.7657E+000
		185.72	54.00	4.7002E+000		-1.9069E+000
		205.31	4.70	4.5639E+001		-4.7480E+001
	Np-237	311.98	38.60	5.6629E+000	5.66E+000	1.2974E+000
	Am-241	59.54	35.90	8.8734E+001	8.87E+001	-3.1979E+001

Nuclide Name	Energy (keV)	Yield (%)	Line MDA (pCi/g)	Nuclide MDA (pCi/g)	Activity (pCi/g)

+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = Calculated MDA is zero due to zero counts in the region or the region is outside the spectrum
@ = Half-life too short to be able to perform the decay correction