

## **Appendix F.4.2**

Radionuclide Identification and Characterization Survey, June 11, 2014

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# Peck Iron and Metal Radionuclide Identification and Characterization Survey

Prepared for HydroGeologic (HGL) – HGL Project Manager Brett Brodersen

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**ATTACHMENTS**

**ATTACHMENT A:** SU-1 Gamma Spectrums and Photos

**ATTACHMENT B:** SU-2 Gamma Spectrums and Photos

**ATTACHMENT C:** SU-3 Gamma Spectrums and Photos

**ATTACHMENT D:** SU-4 Gamma Spectrums and Photos

**ATTACHMENT E:** SU-5 Gamma Spectrums and Photos

**ATTACHMENT F:** Discretionary Sample Gamma Spectrums

**ATTACHMENT G:** Instrumentation Documents

**FIGURES**

**FIGURE A:** All Proposed Gamma Spectroscopy Sample Locations

**FIGURE 1-1:** Peck Iron and Metal SU 1 Gamma Spectroscopy Sample Locations

**FIGURE 1-2:** Peck Iron and Metal SU 2 Gamma Spectroscopy Sample Locations

**FIGURE 1-3:** Peck Iron and Metal SU 3 Gamma Spectroscopy Sample Locations

**FIGURE 1-4:** Peck Iron and Metal SU 4 Gamma Spectroscopy Sample Locations

**FIGURE 1-5:** Peck Iron and Metal SU 5 Gamma Spectroscopy Sample Locations

**TABLES**

**TABLE 4-1:** All Survey Units Sampling Summary.



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**LIST OF ACRONYMS**

<b>AVESI</b>	American Veteran Environmental Services INC.
<b>Nal(TI)</b>	Total Absorption Detector
<b>Pb</b>	Chemical Symbol for Lead
<b>Bi</b>	Chemical Symbol for Bismuth
<b>Cs-137</b>	Cesium
<b>keV</b>	Kiloelectron Volt
<b>MeV</b>	Megaelectron Volt
<b>GM</b>	Geiger-Muller
<b>mRem/hr</b>	Millirem per Hour
<b>NaI</b>	Sodium Iodide
<b>NIST</b>	Institute of Standards and Technology
<b>ANSI</b>	American National Standards Institute
<b>SU</b>	Survey Unit
<b>RA</b>	Radiation Protection Program
<b>Ra-226</b>	Radium
<b>μRem/hr</b>	Micro Rem per Hour
<b>RI</b>	Radionuclide Identification
<b>Rn</b>	Chemical Symbol for Radon
<b>Po-210</b>	Polonium
<b>RPP</b>	Radiation Protection Plan
<b>HP</b>	Health Physics
<b>RMSA</b>	Radioactive Materials Storage Area
<b>NaI</b>	Sodium Iodide
<b>NRC</b>	Nuclear Regulatory Commission
<b>NUREG</b>	Nuclear Regulatory

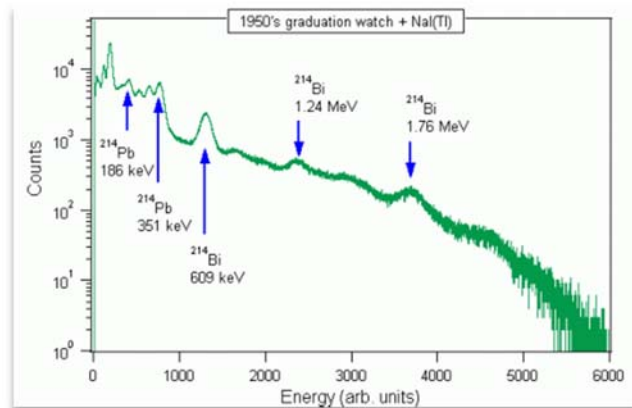
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## 1.0 SURVEY OBJECTIVES

### 1.1. Radionuclide Identification by Portable Gamma Spectroscopy

The intent of this survey was to identify existing radioactivity by radionuclide at locations recorded during the Gamma Radiation Scan Survey using a handheld radionuclide identifier such as the FLIR Systems, identiFINDER. The identiFINDER is a handheld instrument that identifies man-made and natural radionuclides and combines high sensitivity with a wide dose rate range.

Each area or object scanned by the identiFINDER will record the activity of the parent radionuclide and its decay radionuclides. Each activity recording is compared to a radionuclide library and matches the energy peaks of the recorded radionuclides to a known spectrum. Similar to the spectrum below:



**Table 1-1: Gamma Spectrum Example**

The instrument has a dual purpose design to facilitate locating missing or offending sources and then identifying the source via its gamma spectrometry and nuclide identification capability. The identiFINDER is a complete digital gamma spectroscopy and dose rate system. It integrates multi-channel analyzer, amplifier, high voltage power supply, and memory with an integral scintillation and GM detector.

### 1.2. Radionuclide Identification and Location Objectives

AVESI completed the Radionuclide Identification/characterization study and proposed to survey a minimum of 25 predetermined locations at the Peck Iron and Metal site with the identiFINDER to record gamma spectroscopy data and dose rates. Each location required:

- Physically locating and retrieving source objects or soil sample
- Gamma spectroscopy process:
  - 10 minute relative background
  - 10 minute known (Check Source)
  - 10 minute unknown (Obtained Object or Area)
- Source object returned to location



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- Personnel frisk.

The identiFINDER stores the gamma spectroscopy data for each location within the handset until post processing of the data is completed. Data was transferred to an external hard drive two times per day. Dose rates were recorded on contact at the highest activity location of each object or soil sample and entered into a Microsoft Excel spreadsheet.

AVESI completed the Radionuclide Identification/Characterization Survey by providing a final report detailing the results of the survey at each location including:

- Gamma spectrum for each location
- Dose rates up to 100 milliRem/hour (mRem/hr).
- Radionuclide(s) identification
- Depth of source object below ground surface
- Gamma activity readings
- Object Identification if possible

The pre-determined sample locations were locations that were identified as having elevated activity in excess of 2 x background during the gamma radiation scan survey. All proposed gamma spectroscopy sample locations are depicted on **Figure A: All Proposed Gamma Spectroscopy Sample Locations**. Each Survey Unit contains the following elevated areas of activity (sample locations may represent one or many anomalies):

- In Survey Unit 1, Seven (7) of the 7 anomalies were inspected and sampled. (**Figure 1-1: Peck Iron and Metal SU 1 Gamma Spectroscopy Sample Locations**)
- In Survey Unit 2, Eight (8) of the 8 anomalies were inspected and sampled. (**Figure 1-2: Peck Iron and Metal SU 2 Gamma Spectroscopy Sample Locations**)
- In Survey Unit 3, Six (6) of the 6 anomalies were inspected and sampled. (**Figure 1-3: Peck Iron and Metal SU 3 Gamma Spectroscopy Sample Locations**)
- In Survey Unit 4, Six (6) of the 6 anomalies were inspected and sampled. (**Figure 1-4: Peck Iron and Metal SU 4 Gamma Spectroscopy Sample Locations**)
- In Survey Unit 5, eleven (11) of the 31 anomalies were inspected and sampled. (**Figure 1-5: Peck Iron and Metal SU 5 Gamma Spectroscopy Sample Locations**)

There were a total of 39 potential sample locations and 2 discretionary sample locations. AVESI committed to a minimum of 25 gamma spectroscopy analyses to be performed. However, background efficiency adjustments created additional time for AVESI to complete all 39 locations as well as the 2 discretionary locations. All sampling activity to date are summarized in **Table A: All Survey Units Sampling Summary**.



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## **2.0 SURVEY METHODS**

### **2.1. Background**

Each individual sample location may have differing backgrounds due to many factors. For this reason a relative background reading was collected prior to reading each areas object or sample. In the event a natural background reading cannot be acquired by the identiFINDER, the identiFINDER will be moved to a location where a relative natural background can be achieved and soil samples and objects will be brought to the identiFINDER.

### **2.2. Source Check**

A periodic source check with a known source, such as a Cesium 137 (Cs-137) button source, shall be performed to ensure accurate response and proper function of the identiFINDER.

### **2.3. Sample Survey**

At each location AVESI performed the following tasks in this order:

1. Retrieve object or soil sample
2. Record the depth of the object or soil sample
3. Perform gamma spectroscopy (Identify Radionuclides)
4. Collect a dose rate reading of the object or soil sample (Estimate Absorbed Dose)
5. Perform a gamma survey of the location where the object or soil sample was obtained (Identifies Gamma Activity)
6. Return the object or soil sample to its original location

Each sample location yielded a radioactive object or soil sample that was subjected to gamma spectroscopy analysis which determines radionuclides present within each sample. After the object or soil sample has been obtained the depth of the object or sample was recorded. A gamma radiation survey of the sample location was completed to determine the existence of additional objects or the possibility of residual soil contamination. Each object or sample was gamma spectroscopy analyzed, on contact, at the highest established dose rate. All objects or soil samples were placed in a zip lock container or equivalent to reduce the potential for spreading contamination and reduce the risk of cross contamination of the samples.

Once the gamma spectroscopy analysis, dose rate readings and gamma radiation surveys were complete, all objects and soil samples were returned to the sample location and buried at the same depth it was removed.

### **2.4. Quality Assurance**

Radiological instrumentation and associated detectors were calibrated (annually) using National Institute of Standards and Technology (NIST) traceable sources and calibration equipment. Check Source Certificates, Instrument Calibration Certificates, Instrument Initial Check In



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paperwork, and Daily Response Check Log are in **Attachment G: Instrumentation Documents.**

Instrumentation was calibrated in accordance with guidance contained in American National Standards Institute (ANSI) N323 (ANSI, 1978) and manufacturers' instructions.



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### 3.0 SURVEY SUMMARY

The gamma spectroscopy survey was initiated at location SU-5-01-RI. The identiFINDER was not able to achieve a stable background and consequently, was relocated to a known stable natural background area (work Trailer). Therefore, all objects and samples were brought to the work trailer for gamma spectroscopy analysis. A plastic bin was dedicated to each survey unit where each object or soil sample was individually containerized prior to placing it in the bin.

#### 3.1. Survey Unit 1 (SU-1)

A total of seven (7) objects were collected from 7 sample locations and gamma spectroscopy surveyed in SU-1. All objects were small pieces of tubing or plastic coating located within the top 6 inches of soil or crushed debris. All objects were similar in shape and varied in size. Three of the objects were brown in color and 4 were light tan. The gamma spectroscopy survey resulted in the identification of the radionuclide **Radium 226 (Ra-226)** for all objects surveyed. For the full spectrum analysis and object photos refer to **Attachment A: SU-1 Gamma Spectrums and Photos**.

A gamma radiation activity survey was completed at locations where object(s) were obtained. Gamma radioactivity remaining after objects have been removed indicates the possibility of other remaining objects or soil contamination. In SU-1, none of the sample locations had gamma radioactivity remaining once the objects were removed.

**Table 3-1: SU-1 Spectrum Results and Dose Rates**

Gamma Spectrum Sample Number (RI)	Spectrum Number	Object Description	Gamma Spec Dose Rate (μRem/hr)	Identified Radionuclide	Activity Remaining Post Sampling (Y/N)
SU-1-01-RI	322	small brown tubing	450	Radium 226	N
SU-1-02-RI	324	small brown tubing	450	Radium 226	N
SU-1-03-RI	326	small brown tubing	800	Radium 226	N
SU-1-04-RI	328	small tan tubing	1,600	Radium 226	N
SU-1-05-RI	330	small tan tubing	800	Radium 226	N
SU-1-06-RI	332	small tan tubing	1,500	Radium 226	N
SU-1-07-RI	334	small tan tubing	1,000	Radium 226	N

\* Spectrum 320 is a background survey

\*\* Spectrum 336 is the Cs-137 source response check

\*\*\* Shaded rows indicate soil samples from previous event



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**3.2. Survey Unit 2 (SU-2)**

A total of five (5) objects and four (4) soil samples were collected from 8 sample locations and gamma spectroscopy surveyed in SU-2. All objects were located in the top six inches of soil or crushed debris. These objects include soil, plastic, plastic deck marker, metal and decaying pieces of metal. The gamma spectroscopy survey resulted in the identification of the radionuclide (**Ra-226**) for all objects surveyed. For the full spectrum analysis and object photos refer to **Attachment B: SU-2 Gamma Spectrums and Photos**.

A gamma radiation activity survey was completed at locations where object(s) were obtained. Gamma radioactivity remaining after objects have been removed indicates the possibility of other remaining objects or soil contamination. In SU-2, all of the sample locations had gamma radioactivity remaining once the objects were removed with the exception of SU-2-08-RI. In addition, SU-2-03-RI(1) plastic material was removed from the sample location and activity still remained at the sample origin therefore, a soil sample (SU-2-03-RI(2)) was obtained for gamma spectroscopy analysis.

**Table 3-2: SU-2 Spectrum Results and Dose Rates**

Gamma Spectrum Sample Number (RI)	Spectrum Number	Object Description	Gamma Spec Dose Rate ( $\mu$ Rem/hr)	Identified Radionuclide	Activity Remaining Post Sampling (Y/N)
SU-2-01-RI	302	soil	210	Radium 226	Y
SU-2-02-RI	304	piece of metal	500	Radium 226	Y
SU-2-03-RI(1)	306	plastic material	250	Radium 226	Y
SU-2-03-RI(2)	308	soil	80	Radium 226	Y
SU-2-04-RI	310	piece of metal	14,000	Radium 226	Y
SU-2-05-RI	312	soil	35	Radium 226	Y
SU-2-06-RI	314	soil	25	Radium 226	Y
SU-2-07-RI	316	piece of metal	130	Radium 226	Y
SU-2-08-RI	318	deck marker	6,200	Radium 226	N

\* Spectrum 298 is a background survey

\*\* Spectrum 300 is the Cs-137 source response check

\*\*\* Shaded rows indicate soil samples from previous event





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**3.3. Survey Unit 3 (SU-3)**

A total of six (5) objects and (2) soil sample were collected from 6 sample locations and gamma spectroscopy surveyed in SU-3. All objects were located in the top six inches of soil or crushed debris. These objects include soil, unknown device, eroded metal, melted metal, soil (clay), and a piece of a rock. The gamma spectroscopy survey resulted in the identification of the radionuclide **Ra-226** for all objects surveyed. For the full spectrum analysis and object photos refer to **Attachment C: SU-3 Gamma Spectrums and Photos**.

A gamma radiation activity survey was completed at locations where object(s) were obtained. Gamma radioactivity remaining after objects have been removed indicates the possibility of other remaining objects or soil contamination. In SU-3, five locations had gamma radioactivity remaining once the objects were removed. Soil sample SU-3-01-RI(1) was collected from around the unknown device in object SU-3-01-RI(2).

**Table 3-3: SU-3 Spectrum Results and Dose Rates**

Gamma Spectrum Sample Number (RI)	Spectrum Number	Object Description	Gamma Spec Dose Rate (μRem/hr)	Identified Radionuclide	Activity Remaining Post Sampling (Y/N)
SU-3-01-RI(1)	281	soil	8	Non Detect	N
SU-3-01-RI(2)	283	unknown device	3,800	Radium 226	Y
SU-3-02-RI	285	corroded metal	1,700	Radium 226	Y
SU-3-03-RI	287	unknown device	3,600	Radium 226	Y
SU-3-04-RI	289	chunk	9,000	Radium 226	Y
SU-3-05-RI	291	clay like soil	430	Radium 226	Y
SU-3-06-RI	293	chunk of rock	1,000	Radium 226	N

\*\* Spectrum 295 is the Cs-137 source response check

\*\*\* Shaded rows indicate soil samples from previous event



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**3.4. Survey Unit 4 (SU-4)**

A total of six (6) objects were collected from 6 sample locations and gamma spectroscopy surveyed in SU-4. All objects were located in the top six inches of soil or crushed debris. These objects include a liquid filled gauge, four (4) small button type objects and one piece of corroded metal. The gamma spectroscopy survey resulted in the identification of the radionuclide **Ra-226** for all objects surveyed. For the full spectrum analysis and object photos refer to **Attachment D: SU-4 Gamma Spectrums and Photos**.

A gamma radiation activity survey was completed at locations where object(s) were obtained. Gamma radioactivity remaining after objects have been removed indicates the possibility of other remaining objects or soil contamination. In SU-4, none of the sample locations had gamma radioactivity remaining once the objects were removed.

**Table 3-4: Spectrum Results and Dose Rates**

Gamma Spectrum Sample Number (RI)	Spectrum Number	Object Description	Gamma Spec Dose Rate (mRem/hr)	Identified Radionuclide	Activity Remaining Post Sampling (Y/N)
SU-4-01-RI	267	large gauge	100	Radium 226	N
SU-4-02-RI	269	small button	1,700	Radium 226	N
SU-4-03-RI	271	small button	1,350	Radium 226	N
SU-4-04-RI	273	small button	1,150	Radium 226	N
SU-4-05-RI	275	small button	3,600	Radium 226	N
SU-4-06-RI	277	corroded metal	260	Radium 226	N

\* Spectrum 265 is a background survey

\*\* Spectrum 279 is the Cs-137 source response check

\*\*\* Shaded rows indicate soil samples from previous event



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**3.5. Survey Unit 5 (SU-5)**

A total of eleven (11) objects were collected from 12 sample locations and gamma spectroscopy surveyed in SU-5. All objects were located in the top six inches of soil or crushed debris with the exception of SU-5-12-RI and SU-5-06-RI. Sample SU-5-12-RI was obtained below a drain or sewer pipe and SU-5-06-RI was under water and not accessible. Objects in this survey unit include deck markers, small button type objects, a glass bulb or light fixture, soil, plastic, wood, and metal. The gamma spectroscopy survey resulted in the identification of the radionuclide **Ra-226** for all objects surveyed. For the full spectrum analysis and object photos refer to **Attachment E: SU-5 Gamma Spectrums and Photos**.

A gamma radiation activity survey was completed at locations where object(s) were obtained. Gamma radioactivity remaining after objects have been removed indicates the possibility of other remaining objects or soil contamination. In SU-5, three of the sample locations had gamma radioactivity remaining once the objects were removed.

**Table 3-5: SU-5 Spectrum Results and Dose Rates**

Gamma Spectrum Number (RI)	Spectrum Number	Object Description	Gamma Spec Dose Rate (mRem/hr)	Identified Radionuclide	Activity Remaining Post Sampling (Y/N)
SU-5-01-RI	238	glass bulb	3,000	Radium 226	Y
SU-5-02-RI	242	deck marker badge	220	Radium 226	N
SU-5-03-RI	244	small button	1,100	Radium 226	N
SU-5-04-RI	246	soil	130	Radium 226	Y
SU-5-05-RI	248	deck marker	6,700	Radium 226	N
SU-5-06-RI	N/A	N/A	N/A	N/A	N/A
SU-5-07-RI	250	small button	1,850	Radium 226	N
SU-5-08-RI	252	small piece of plastic	50,000	Radium 226	N
SU-5-09-RI	254	small button	2,400	Radium 226	N
SU-5-10-RI	256	deck marker	6,500	Radium 226	N
SU-5-11-RI	258	small button	2,500	Radium 226	N
SU-5-12-RI	260	wood and metal	800	Radium 226	Y

\* Spectrum 236 is a background survey

\*\* Spectrum 240 and 262 are the Cs-137 source response checks

\*\*\* Shaded rows indicate soil samples from previous event



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**3.6. Discretionary Sample Locations**

Two (2) discretionary sample locations were gamma spectroscopy surveyed. Both samples were located in close proximity to Elizabeth River. These gamma spectroscopy samples were completed via in-situ. Both locations were negative for gamma emitting radionuclides. For the full spectrum analysis refer to **Attachment E: Discretionary Sample Location Gamma Spectrums**.

**Table 3-6: Discretionary Spectrum Results and Dose Rates**

<b>Gamma Spectrum Number (RI)</b>	<b>Spectru m Number</b>	<b>Object Description</b>	<b>Gamma Spec Dose Rate (mRem/hr)</b>	<b>Identified Radionuclide</b>	<b>Activity Remaining Post Sampling (Y/N)</b>
Desc-01-RI	341	soil (in situ)	8	Non Detect	N/A
Desc-02-RI	344	soil (in situ)	8	Non Detect	N/A



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#### **4.0 SURVEY RESULTS**

Gamma spectroscopy sample results in this section are summarized and discussed in two sections, the “Gamma Spectroscopy Results and Dose Rates” section summarizes the results of each survey unit and identifies radionuclide(s) and reports a range for exposure dose rates in  $\mu\text{Rem/hr}$ . The “Gamma Radioactivity Survey Results” section summarizes the radioactivity at each location in the survey unit ultimately recording areas of possible residual soil contamination or the presence of additional radioactive objects.

##### **4.1. Survey Unit 1**

4.1.1. In SU-1 a total of seven locations were identified for gamma spectroscopy analysis. All seven locations contained objects that were removed from the sample locations. The sample locations were then surveyed for gamma radioactivity and the objects were subjected to gamma spectroscopy analysis and dose rate surveys.

###### **4.1.1.1. Gamma Spectroscopy Results and Dose Rates**

Of the seven objects that were gamma spectroscopy surveyed, all seven objects had radioactivity consistent with *Ra-226*. The dose rates of these objects ranged from *450  $\mu\text{Rem/hr}$  to 1,600  $\mu\text{Rem/hr}$* .

###### **4.1.1.2. Gamma Radioactivity Survey Results**

All seven sample locations were gamma radiation surveyed after objects with radioactivity were removed. All seven locations had no radioactivity remaining suggesting that there were *no additional radioactive objects or residual soil containing radioactivity* at these locations.

##### **4.2. Survey Unit 2**

4.2.1. In SU-2 a total of eight locations were identified for gamma spectroscopy analysis. Only five locations contained objects that were removed from the sample locations. Soil samples were obtained at three locations where objects were not present. All sample locations were then surveyed for gamma radioactivity and the objects and soil samples were subjected to gamma spectroscopy analysis and dose rate surveys.

###### **4.2.1.1. Gamma Spectroscopy Results and Dose Rates**

Of the five objects and three soil samples that were gamma spectroscopy surveyed, all objects and soil samples had radioactivity consistent with *Ra-226*. The dose rates of these objects ranged from *25  $\mu\text{Rem/hr}$  to 14,000  $\mu\text{Rem/hr}$* .

###### **4.2.1.2. Gamma Radioactivity Survey Results**

All eight sample locations were gamma radiation surveyed after objects with radioactivity were removed. One location had no radioactivity remaining



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suggesting that there were *no additional radioactive objects or residual soil containing radioactivity* were present at this location. Seven locations had activity remaining suggesting that there are *additional radioactive objects or residual soil containing radioactivity* at these locations.

**4.3. Survey Unit 3**

4.3.1. In SU-3 a total of six locations were identified for gamma spectroscopy analysis. Five locations contained objects that were removed from the sample locations. A soil sample was obtained at one location where an object was not present. One additional soil sample (SU-3-01-RI(1)) was collected from around an unknown device (SU-3-01-RI(2)). All sample locations were then surveyed for gamma radioactivity and the objects and soil samples were subjected to gamma spectroscopy analysis and dose rate surveys.

**4.3.1.1. Gamma Spectroscopy Results and Dose Rates**

Of the five objects and two soil samples that were gamma spectroscopy surveyed, five objects and one soil sample had radioactivity consistent with *Ra-226*. The dose rates of these objects and soil samples ranged from 430  $\mu\text{Rem/hr}$  to 9,000  $\mu\text{Rem/hr}$ .

One soil sample, SU-3-01-RI(1), collected around the unknown device, contained no radioactivity and a dose rate consistent with background of 8  $\mu\text{Rem/hr}$ .

**4.3.1.2. Gamma Radioactivity Survey Results**

All six sample locations were gamma radiation surveyed after objects and soils samples with radioactivity were removed. One location had no radioactivity remaining suggesting that there is *no additional radioactive objects or residual soil containing radioactivity* at this location. Six locations had radioactivity remaining suggesting that there were *additional radioactive objects or residual soil containing radioactivity* at these locations.

**4.4. Survey Unit 4**

4.4.1. In SU-4 a total of six locations were identified for gamma spectroscopy analysis. All six locations contained objects that were removed from the sample locations. All sample locations were then surveyed for gamma radioactivity and the objects were subjected to gamma spectroscopy analysis and dose rate surveys.

**4.4.1.1. Gamma Spectroscopy Results and Dose Rates**

Of the six objects that were gamma spectroscopy surveyed, all six objects had radioactivity consistent with *Ra-226*. The dose rates of these objects and soil samples ranged from 100  $\mu\text{Rem/hr}$  to 3,600  $\mu\text{Rem/hr}$ .



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**4.4.1.2. Gamma Radioactivity Survey Results**

All six sample locations were gamma radiation surveyed after objects with radioactivity were removed. All six locations had no radioactivity remaining suggesting that *no additional radioactive objects or residual soil containing radioactivity remains.*

**4.5. Survey Unit 5**

4.5.1. In SU-5 a total of twelve locations were identified for gamma spectroscopy analysis. Ten locations contained objects that were removed from the sample locations. A soil sample was obtained at one location where an object was not present. One location (SU-5-06-RI) was under water and not accessible and therefore not sampled. All sample locations were then surveyed for gamma radioactivity and the objects were subjected to gamma spectroscopy analysis and dose rate surveys.

**4.5.1.1. Gamma Spectroscopy Results and Dose Rates**

Of the 11 objects and soil samples that were gamma spectroscopy surveyed, all eleven objects had radioactivity consistent with *Ra-226*. The dose rates of these objects and soil samples ranged from *130  $\mu$ Rem/hr to 50,000  $\mu$ Rem/hr.*

**4.5.1.2. Gamma Radioactivity Survey Results**

All eleven sample locations were gamma radiation surveyed after objects with radioactivity were removed. Eight locations had no radioactivity remaining suggesting that *no additional objects or residual soil containing radioactivity remains.* Three locations had radioactivity remaining suggesting that there were *additional radioactive objects or residual soil containing radioactivity.*

**4.6. Discretionary Sample Locations**

4.6.1. Two discretionary sample locations were identified for gamma spectroscopy analysis. These two sample locations were near the Elizabeth River. No objects were removed and no soil was sampled. A gamma spectroscopy analysis was completed via in-situ.

**4.6.1.1. Gamma Spectroscopy Results and Dose Rates**

Two locations were analyzed by gamma spectroscopy via in situ survey. No soil was removed and no objects were obtained. The gamma spectroscopy instrument was not able to detect any radioactivity present at either discretionary location. The dose rates obtained at each location was *8  $\mu$ Rem/hr* which is consistent with background.



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**4.6.1.2. Gamma Radioactivity Survey Results**

Due to these samples being analyzed via in situ, no gamma radioactivity survey data was obtained.





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## **5.0 CONCLUSION**

### **5.1. Gamma Spectroscopy**

The discretionary locations where the gamma spectroscopy was performed via in situ, near the Elizabeth River were excluded from this conclusion. The discretionary sample locations were generated randomly without any indication of radioactivity. All other locations were selected due to radioactivity present and the need for radionuclide identification.

AVESI committed to a minimum of 25 gamma spectroscopy analyses to be performed. There was a total of 39 potential sample locations and 2 discretionary sample locations. The decision to bring the objects and soil samples to the work trailer, as discussed in section 3.0, was a more efficient way to complete the gamma spectroscopy analyses. Therefore, of the 39 potential gamma spectroscopy sample locations, AVESI was able to complete 38. Two discretionary samples were also completed bringing the total gamma spectroscopy analysis to 40.

A total of 40 gamma spectroscopy analyses were performed at 39 predetermined locations across 5 survey units. One sample (SU-5-06-RI) was not accessible due to standing water. Two additional soil samples were obtained, one on SU-2 and one on SU-3. Object sample (SU-2-03-RI(1)) was removed and radioactivity remained at the sample location. Soil sample (SU-2-03-RI(2)) was obtained to confirm the soil contamination. Object (SU-3-01-RI(2)) was removed. The interior of the device contained a large amount of soil. The soil was collected as sample (SU3-01-RI(1)) and gamma spectroscopy was performed.

Of the 40 gamma spectroscopy analyses completed, 39 displayed radioactive energies consistent with Ra-226. One sample (SU3-01-RI(1)) contained no detectable radioactivity.

Of the 40 gamma spectroscopy analyses, 33 were objects and 7 were soil samples and of the 38 locations where objects or soil samples were removed 16 locations had radioactivity remaining in the sample location suggesting additional objects or soil contamination.

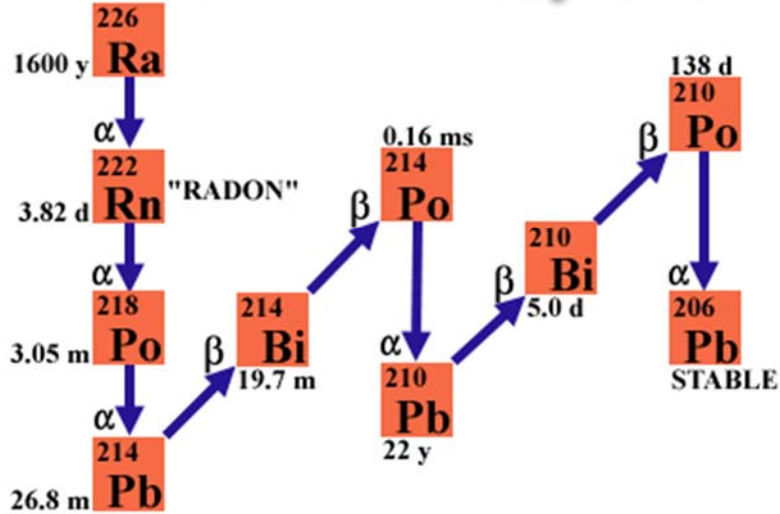
### **5.2. Dose Rates**

The dose rates for each object or soil sample were attained at the highest gamma activity point reading possible. Of the 38 locations, the highest dose rate was obtained on an object in SU-5 at 50,000  $\mu\text{Rem/hr}$ . The lowest dose rate, other than non-detect samples, was attained in SU-2 at 25  $\mu\text{Rem/hr}$ .

### **5.3. Radium 226**

In the past Radium has been used to produce neutron sources, luminous paints, luminous dials and medical radioisotopes, etc... Ra-226 has a half-life of approximately 1600 years and gamma X-ray energy of 186 keV. Ra-226 undergoes decay by alpha to Radon 222 (Rn-222) then Polonium 218 (Po-218) and so on. As seen below:

## Radium-226 Decay Chain



The Gamma Spectroscopy analysis identified Radium 226 by its gamma energy of 186.1 keV and correlating daughter product energies as well. Gamma energy peaks that identify Radium 226 are:

- Ra 226 → 186.1 keV
- Pb 214 → 352 keV
- Bi 214 → 609 keV
- Bi 214 → 1120 keV
- Bi 214 → 1764 keV



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## **6.0 RECOMMENDATIONS**

### **6.1.1. *Radiation Protection Program***

It is recommended that a Radiation Protection Program (RA) with a site Radiation Protection Plan (RPP) be developed and implemented to assist and protect the public and site personnel during future intrusive soil activities. The RPP at a minimum should include sections addressing radiological hazards, radiological controls, training, dosimetry, monitoring, and posting and labeling.

### **6.1.2. *Dose Assessment***

It is recommended that a dose assessment be conducted based on current survey data for the reasonable maximally exposed scenario group (critical group). For example, what is the dose to a transient who accesses uncontrolled areas of the property? This dose assessment can be refined using data identified during further surveys.

### **6.1.3. *Health Physics Support***

It is recommended that all future soil intrusion work is supported by the radiation protection plan and health physicists (HP).

### **6.1.4. *Radioactive Materials Storage Area***

It is recommended that a temporary Radioactive Materials Storage Area (RMSA) be established in the rear of the property.

### **6.1.5. *Radioactive Materials Control***

It is recommended that all known areas of elevated activity that are not controlled (SU-2) within the fenced area of Peck Iron and Metal be removed and stored within the fenced area.



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## **7.0 REFERENCES**

ANSI (American National Standards Institute) 1997. *American National Standards Radiation Protection Instrumentation Test and Calibration*, ANSI N323A-1997.

NRC (United States Nuclear Regulatory Commission) 1974, *Termination of Operating Licenses for Nuclear Reactors*, NUREG-1.86, June.

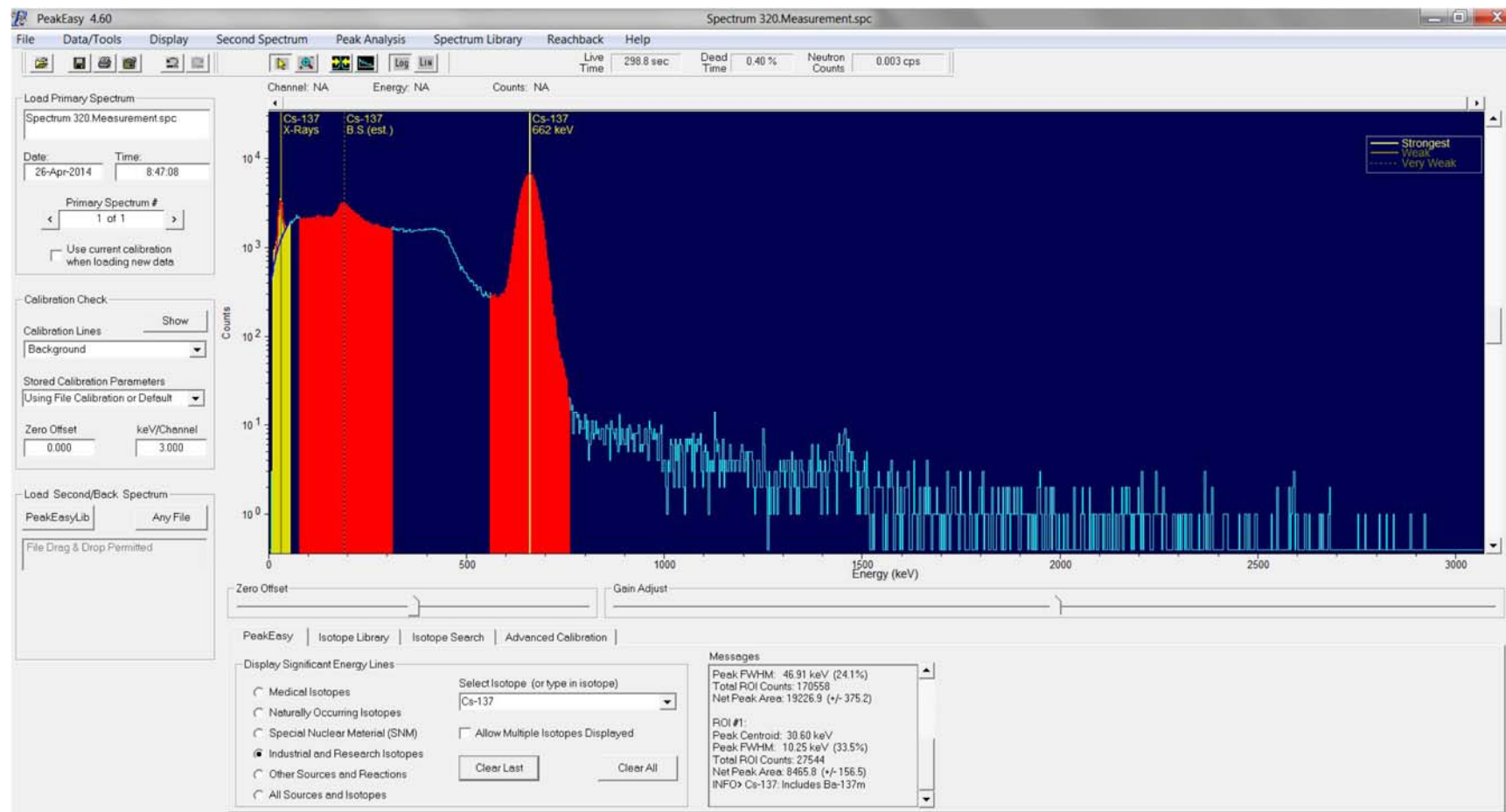


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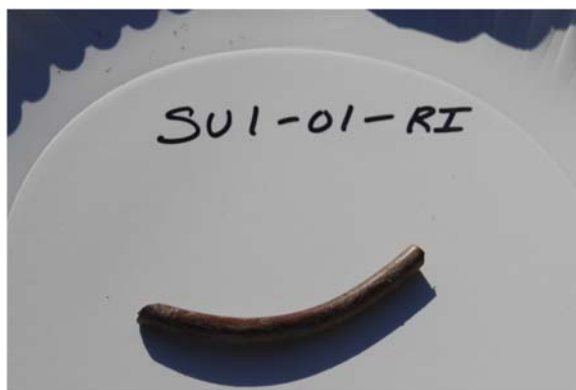
**ATTACHMENT A: SU-1 GAMMA SPECTRUMS AND PHOTOS**

## Survey Unit 1

### Spectrum 320: Cs-137 Source Check



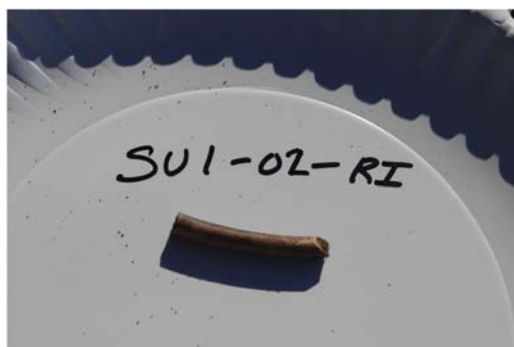
## Spectrum 322: SU-01-01-RI



Peck Iron and Metal  
Radionuclide Identification Survey  
Gamma Spectroscopy SU-1

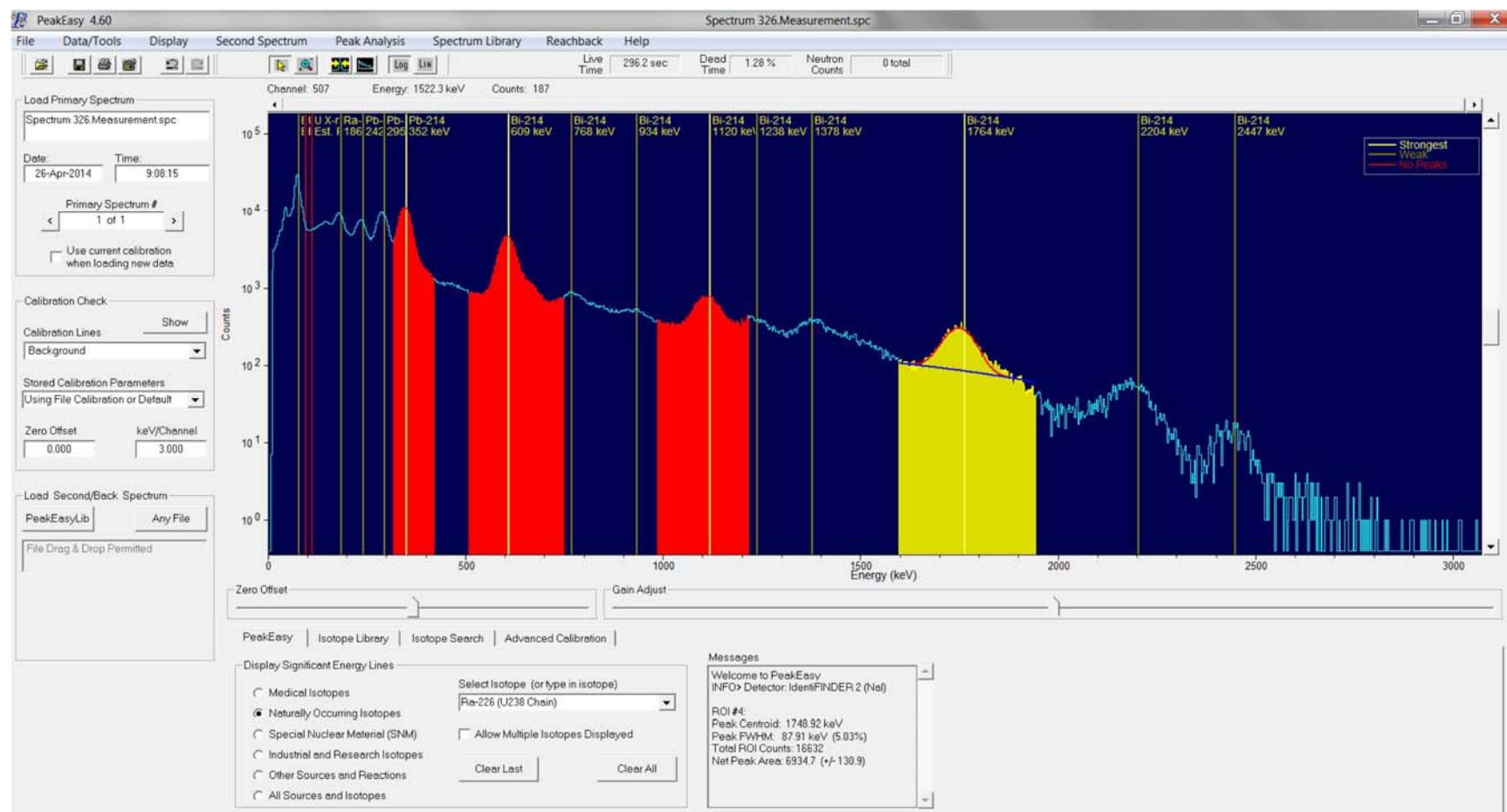
Thursday, May 22, 2014

## Spectrum 324: SU-01-02-RI





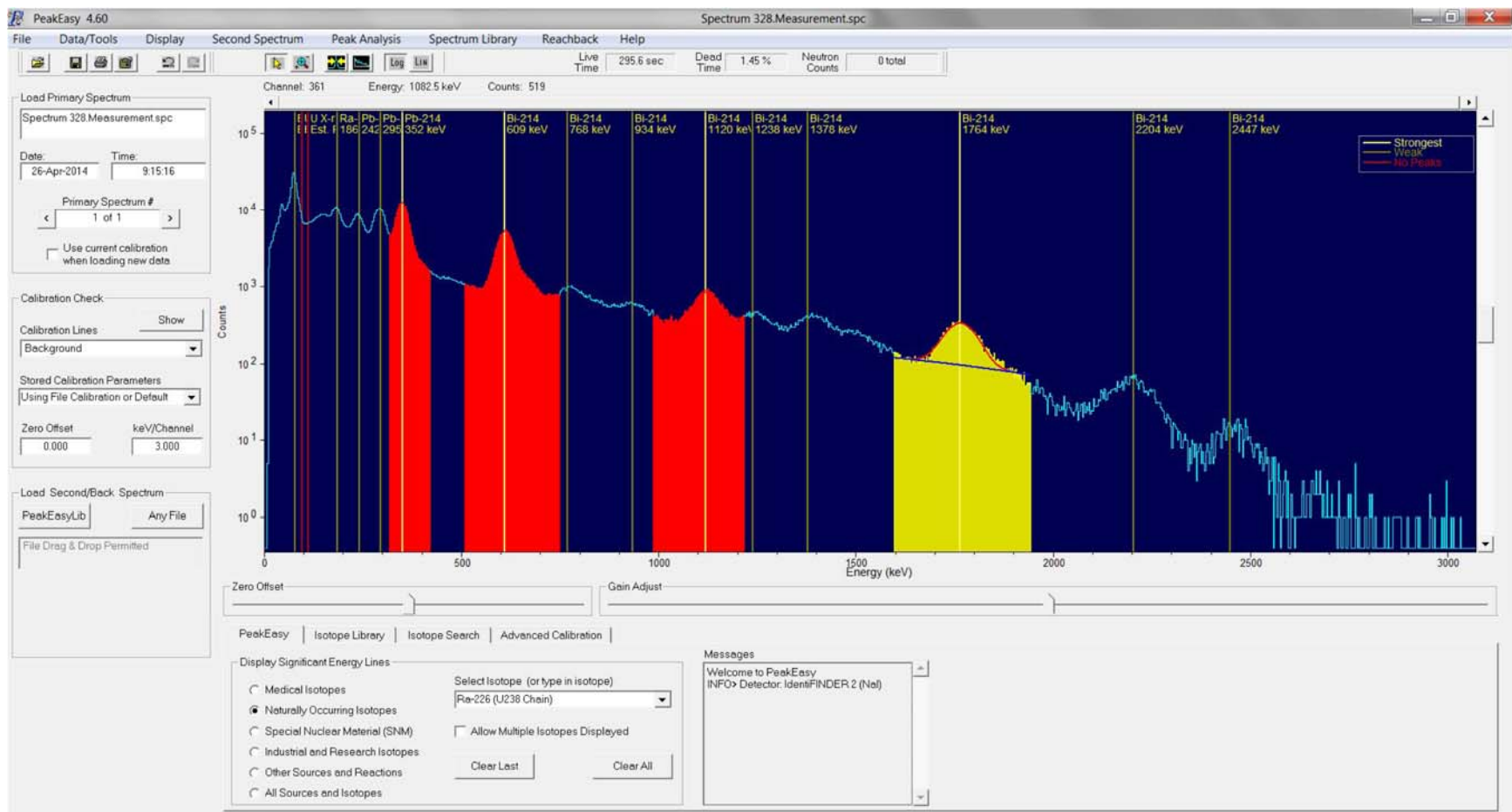
## Spectrum 326: SU-01-03-RI



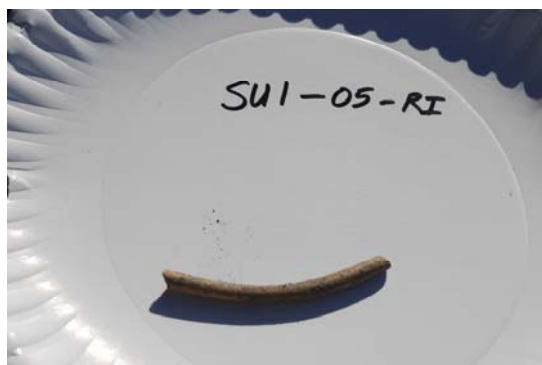
Peck Iron and Metal  
Radionuclide Identification Survey  
Gamma Spectroscopy SU-1

Thursday, May 22, 2014

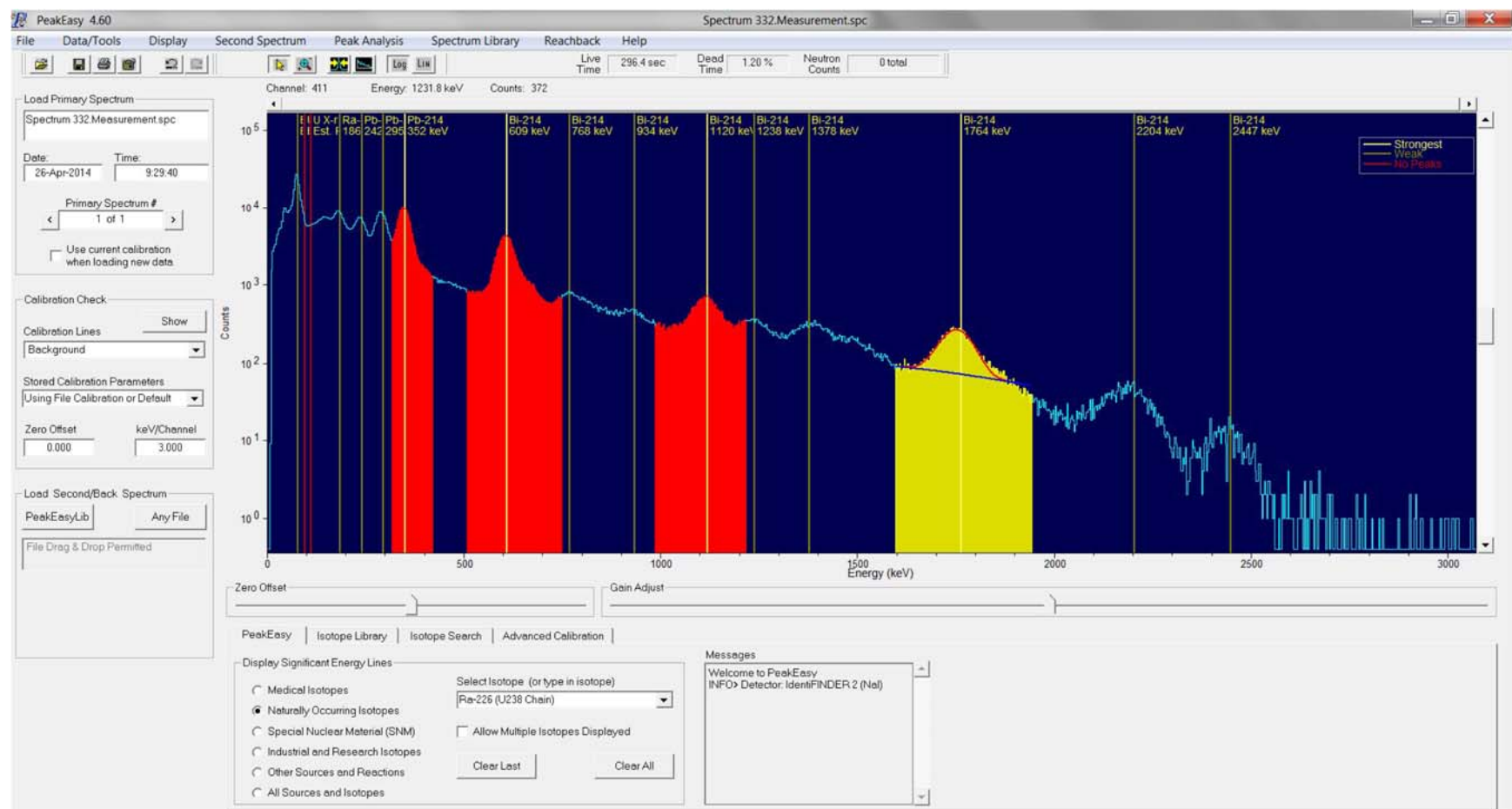
## Spectrum 328: SU-01-04-RI



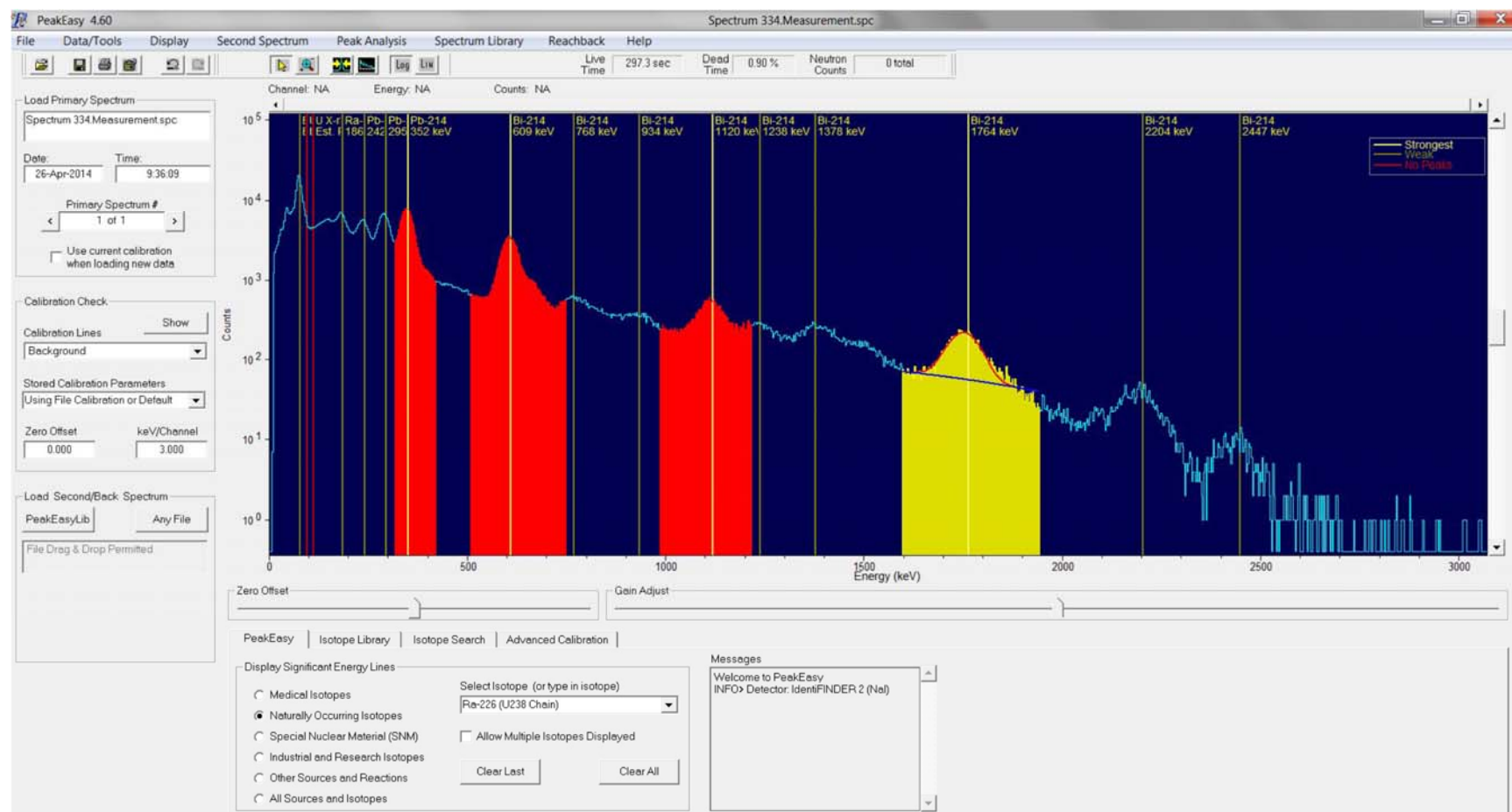
The screenshot displays the PeakEasy 4.60 software interface. The main window shows a gamma spectrum plot titled "Spectrum 330.Measurement.spc". The plot has a logarithmic y-axis labeled "Counts" ranging from  $10^0$  to  $10^5$  and a linear x-axis labeled "Energy (keV)" ranging from 0 to 3000. The spectrum shows a blue line for the "Strongest" peak and a red line for "Weak" peaks. Several peaks are labeled with their energy values: Bi-214 (609 keV, 768 keV, 934 keV, 1120 keV, 1238 keV, 1378 keV, 1764 keV, 2204 keV, 2447 keV) and Pb-214 (242 keV, 295 keV, 352 keV). The interface includes a menu bar (File, Data/Tools, Display, Second Spectrum, Peak Analysis, Spectrum Library, Reachback, Help) and a toolbar. On the left, there are panels for "Load Primary Spectrum" (Spectrum 330.Measurement.spc, Date: 26-Apr-2014, Time: 9:22:11, Primary Spectrum # 1 of 1, Use current calibration when loading new data), "Calibration Check" (Calibration Lines: Show, Background, Stored Calibration Parameters: Using File Calibration or Default, Zero Offset: 0.000 keV/Channel, 3.000), and "Load Second/Back Spectrum" (PeakEasyLib, Any File, File Drag & Drop Permitted). At the bottom, there is a "Display Significant Energy Lines" panel with radio buttons for Medical Isotopes, Naturally Occurring Isotopes (selected), Special Nuclear Material (SNM), Industrial and Research Isotopes, Other Sources and Reactions, and All Sources and Isotopes. A "Select Isotope (or type in isotope)" dropdown menu shows "Ra-226 (U238 Chain)". There are also "Clear Last" and "Clear All" buttons. A "Messages" panel at the bottom right displays the text: "Welcome to PeakEasy INFO> Detector: IdentIFINDER 2 (NaI)".



## Spectrum 332: SU-01-06-RI



## Spectrum 334: SU-01-07-RI

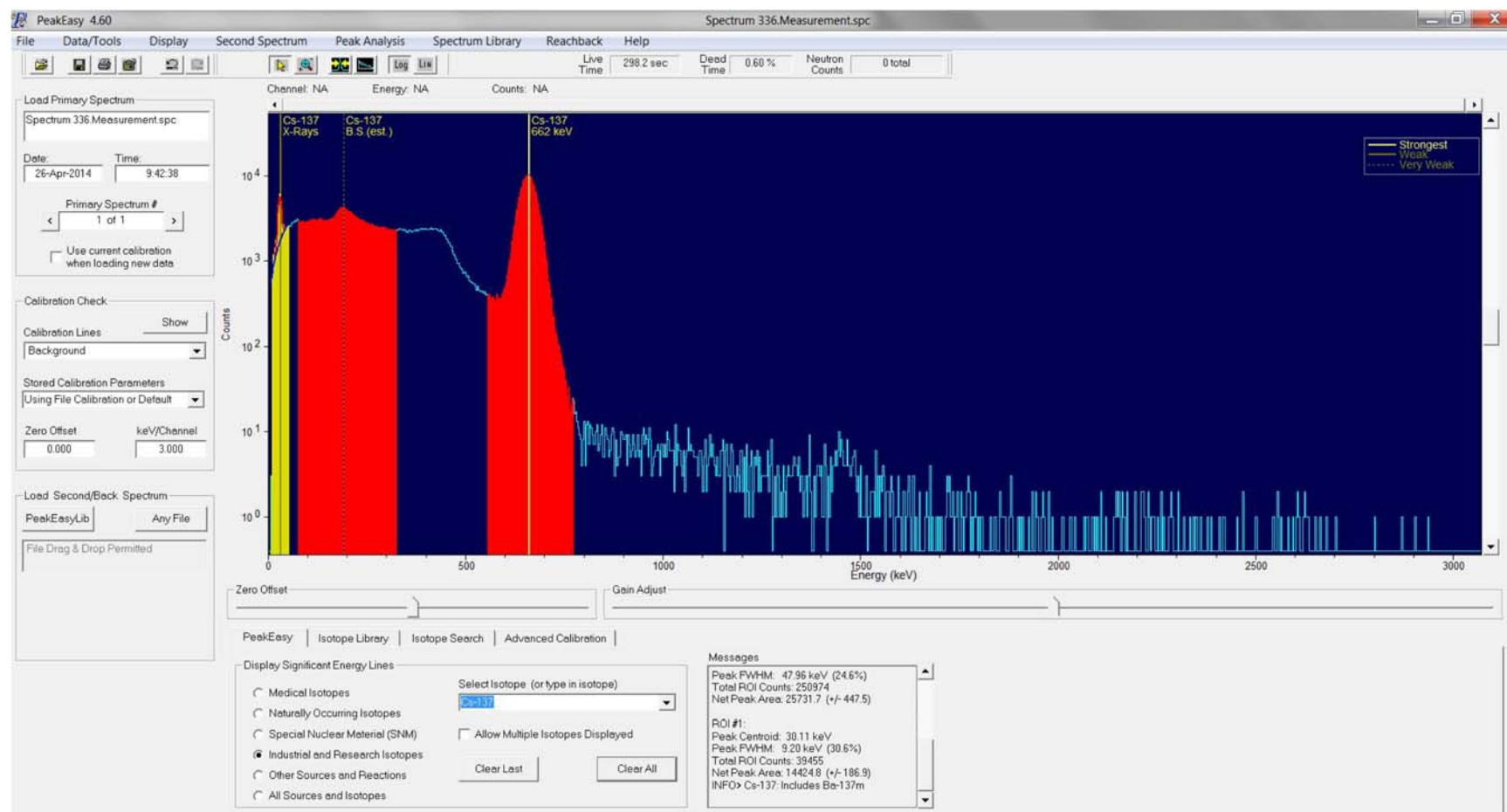


Peck Iron and Metal  
Radionuclide Identification Survey  
Gamma Spectroscopy SU-1

Thursday, May 22, 2014



## Spectrum 336: Cs-137 Source Check



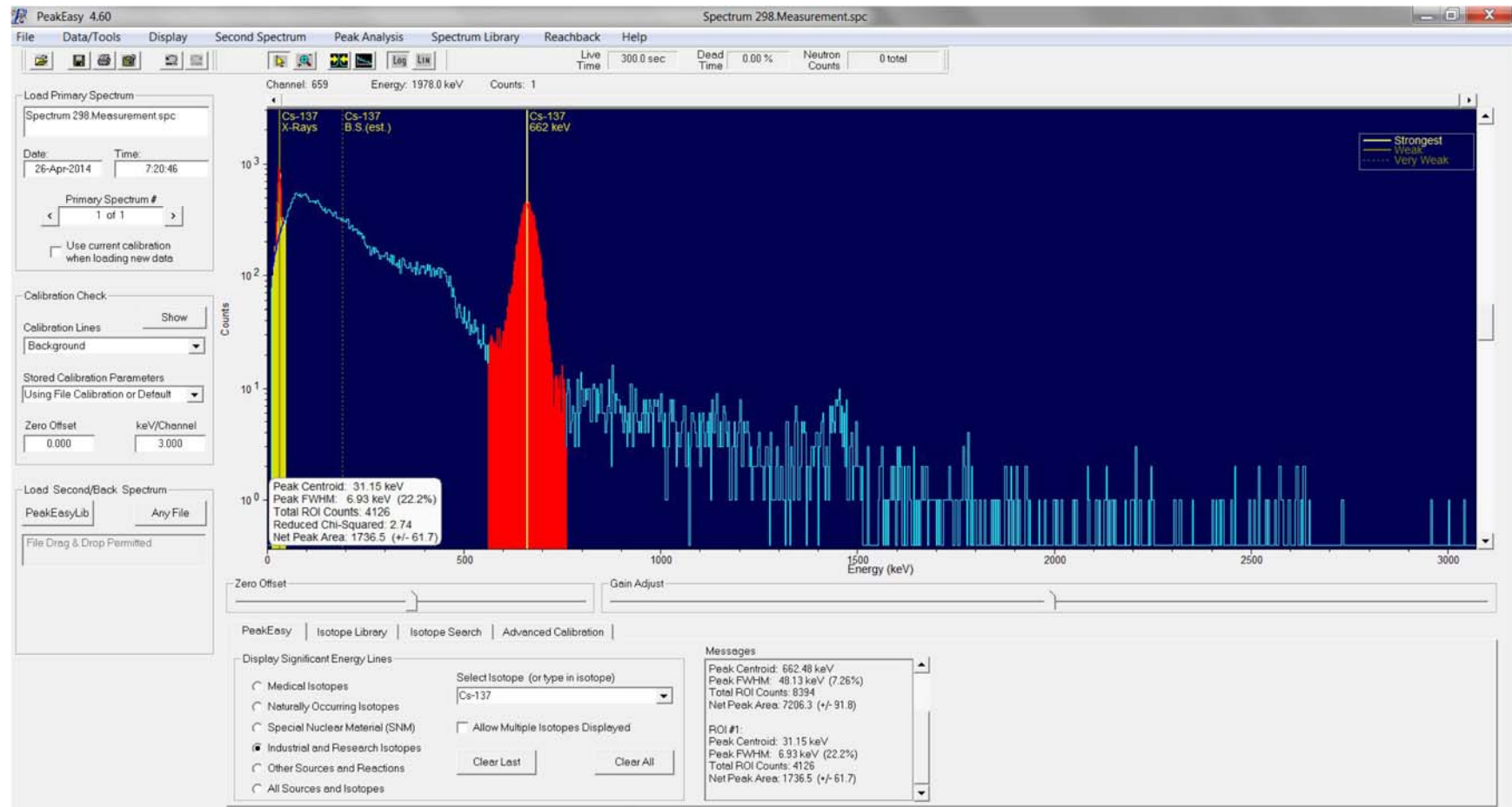


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**ATTACHMENT B: SU-2 GAMMA SPECTRUMS AND PHOTOS**

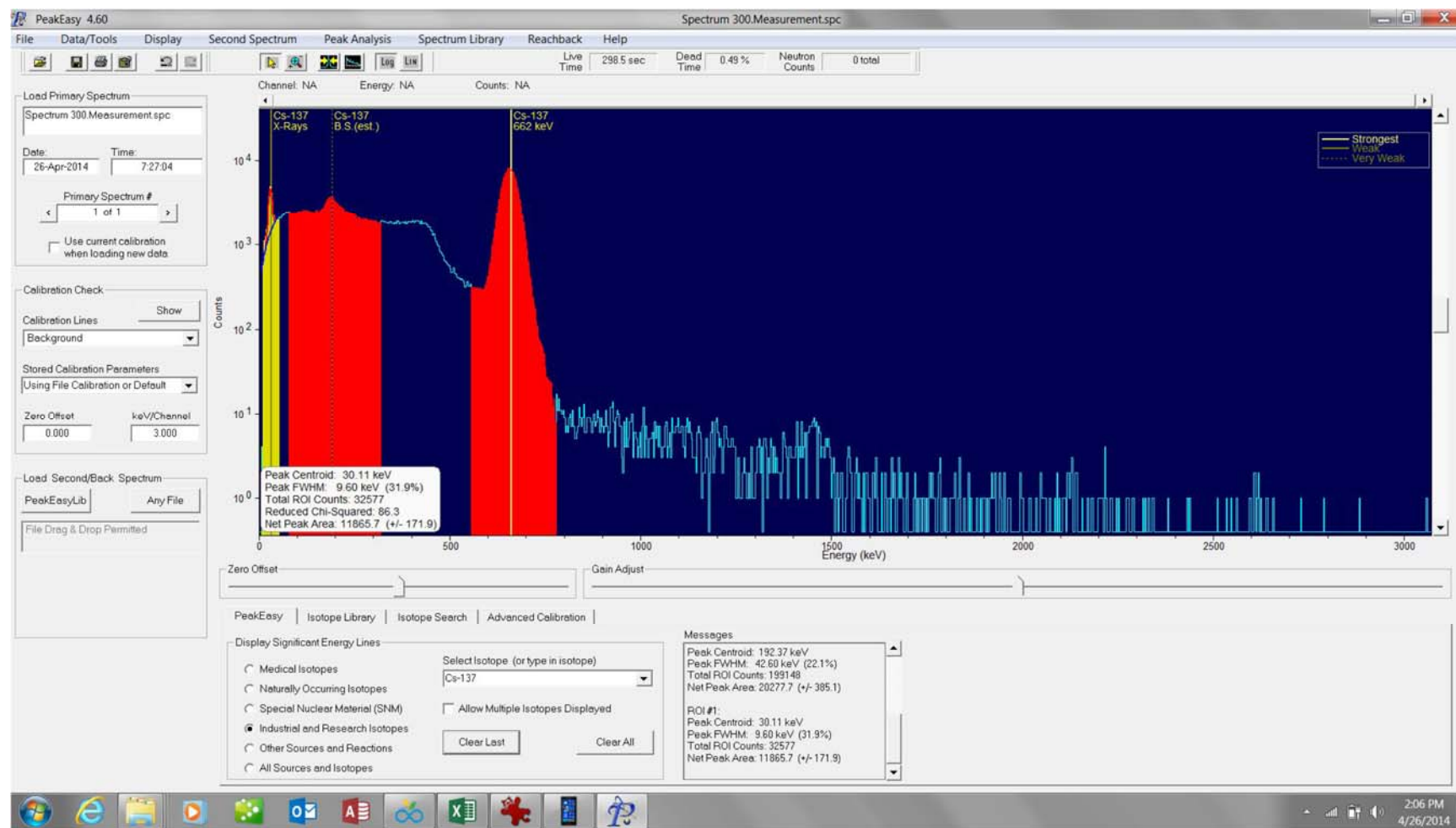
## Survey Unit 2

### Spectrum 298: Background

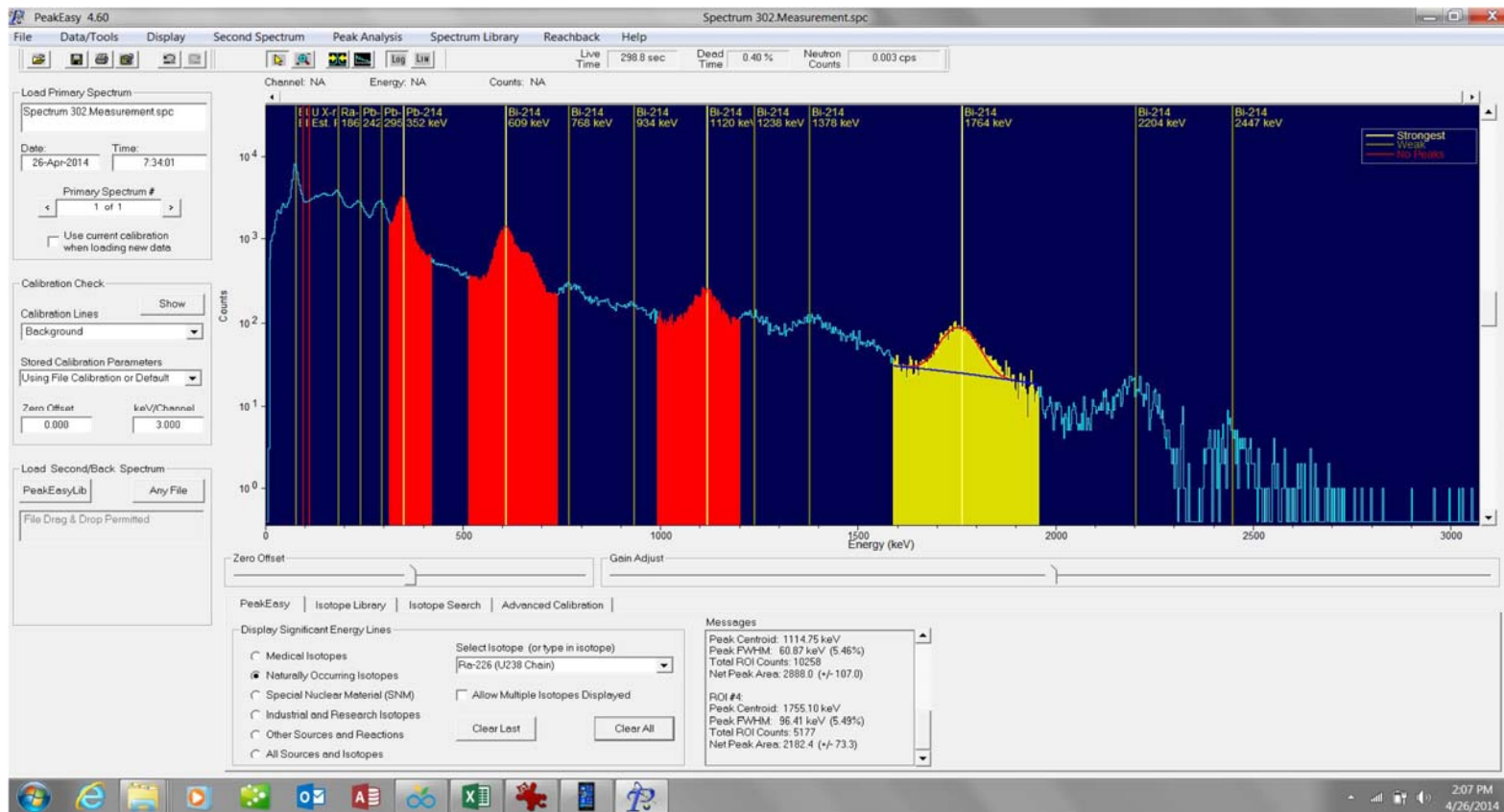




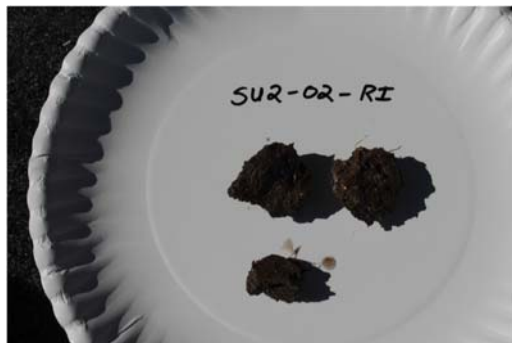
## Spectrum 300: Cs-137 Source Check



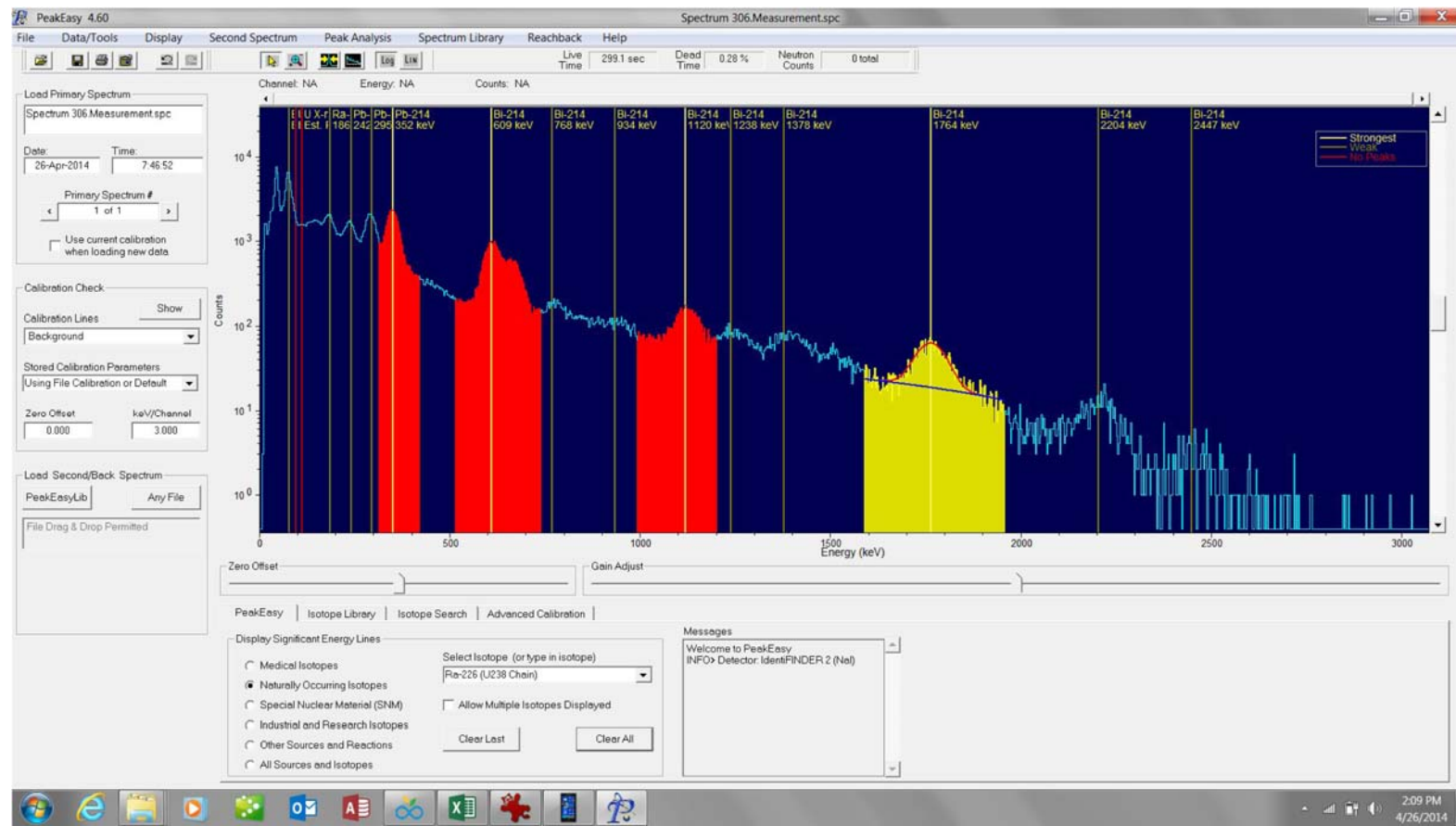
# Spectrum 302: SU 02-01-RI (210 $\mu$ Rem/hr.)



# Spectrum 304: SU 02-02-RI (500 $\mu$ Rem/hr.)



# Spectrum 306: SU 02-03-RI(1) (250 $\mu$ Rem/hr.)



# Spectrum 308: SU 02-03-RI(2) (80 $\mu$ Rem/hr.)

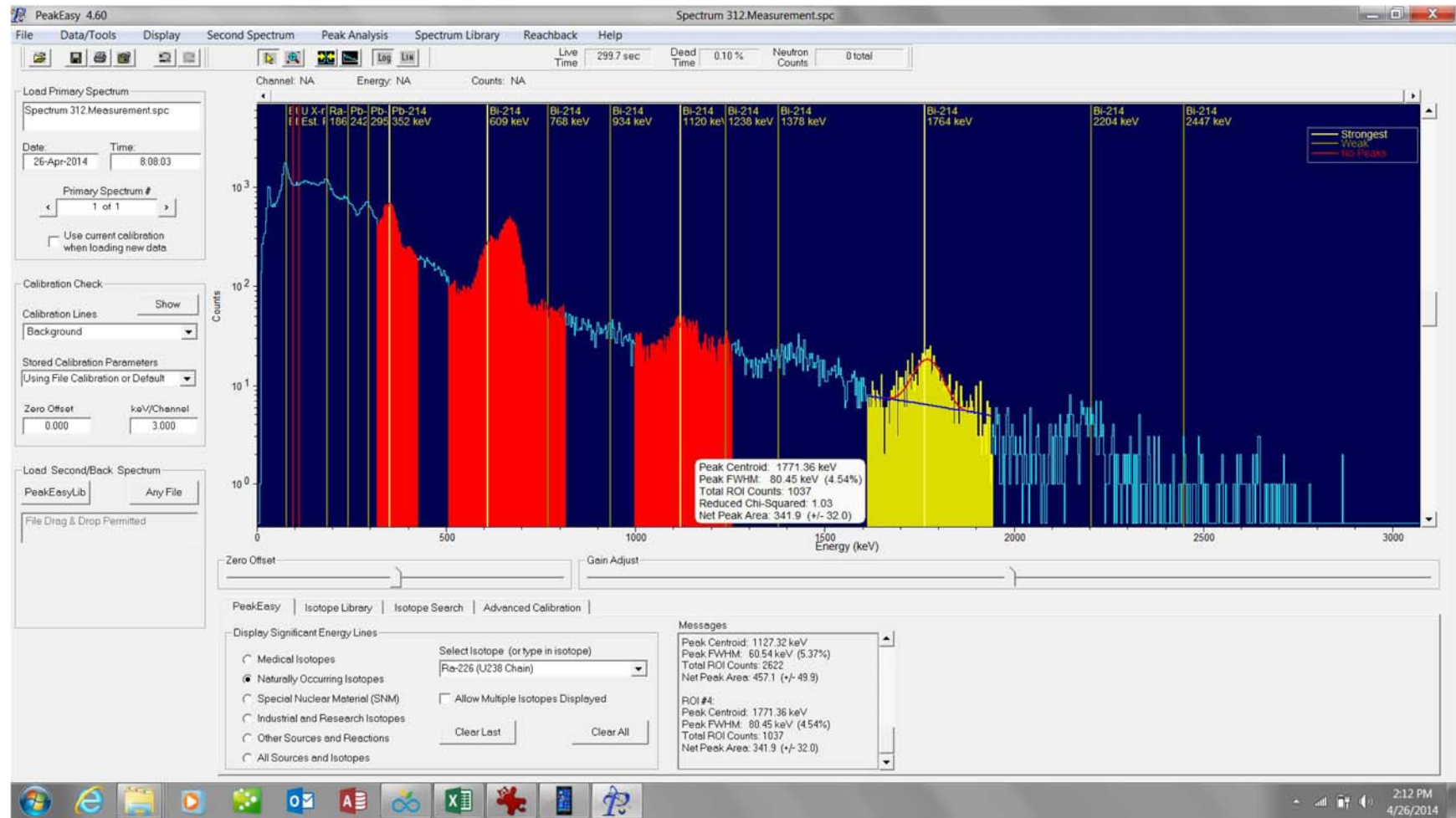




# Spectrum 310: SU 02-04-RI (14,000 $\mu$ Rem/hr. or 14mRem/hr.)

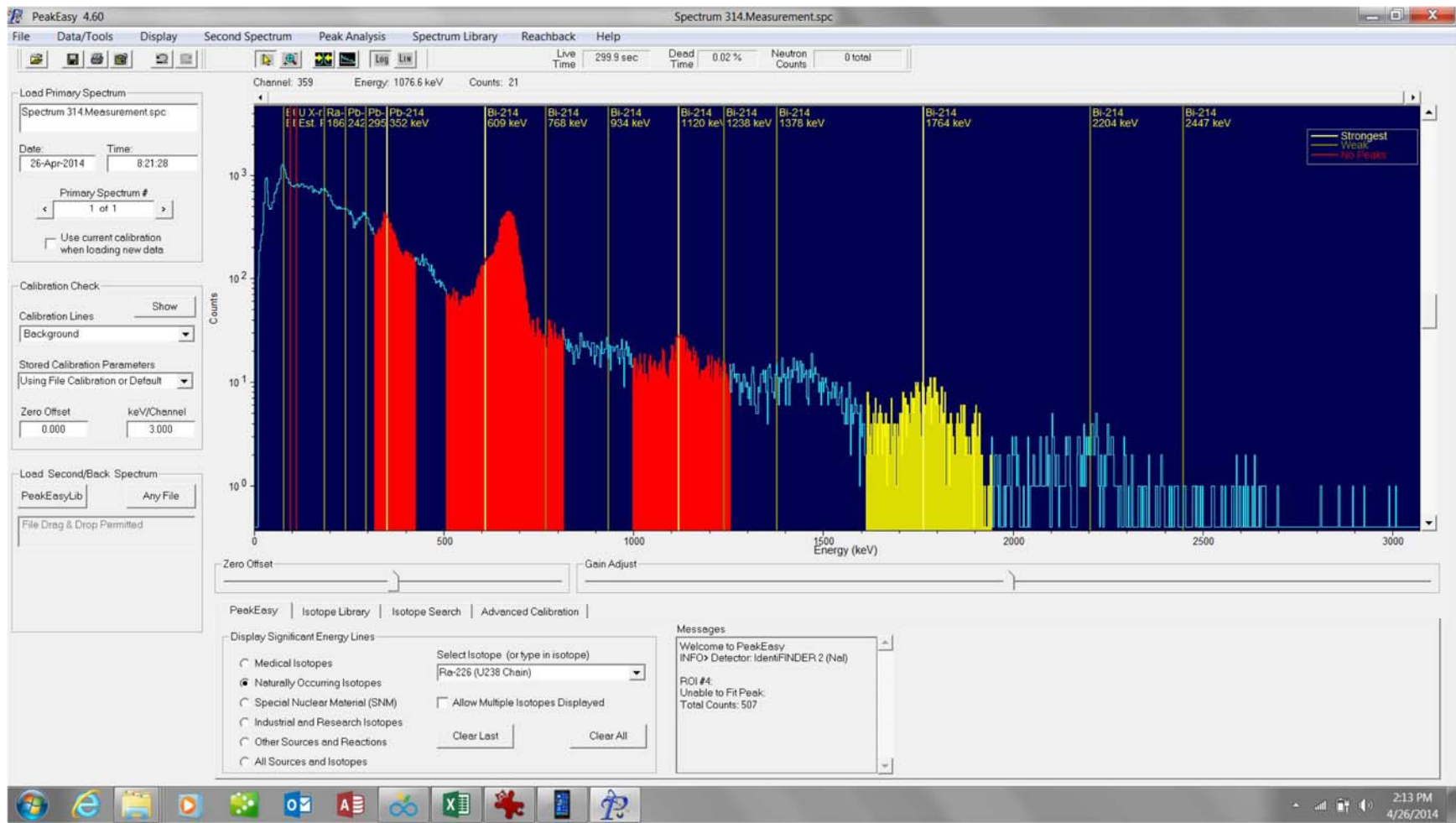


# Spectrum 312: SU 02-05-RI (35 $\mu$ Rem/hr.)



**No Picture Available**

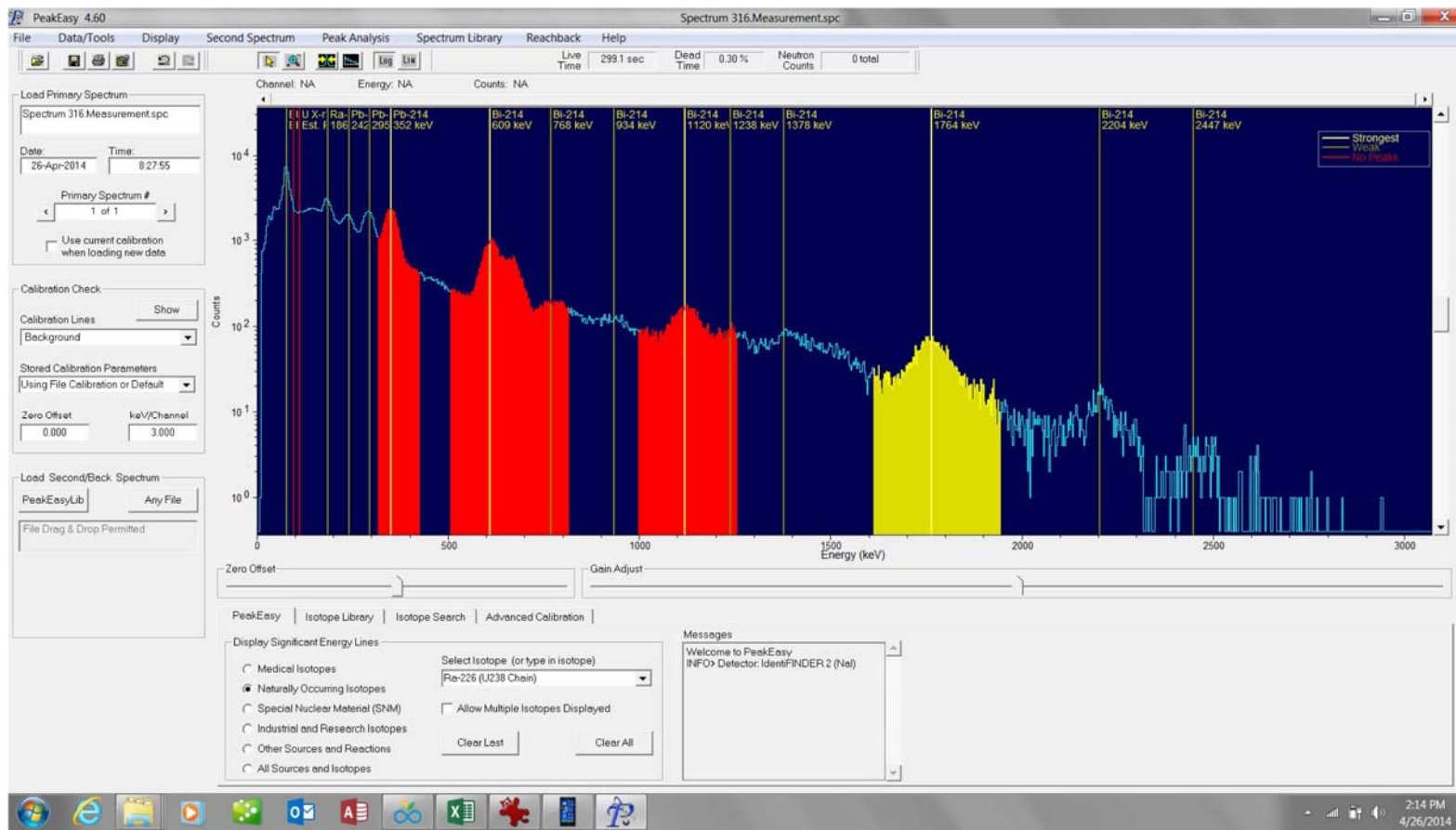
# Spectrum 314: SU 02-06-RI (25 $\mu$ Rem/hr.)



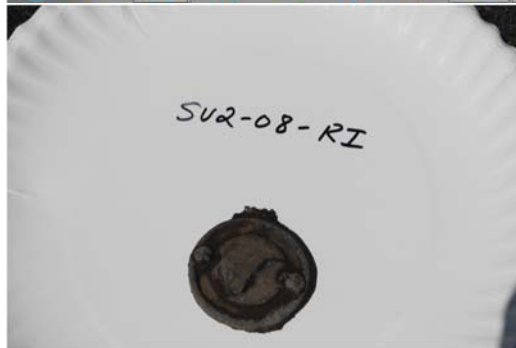
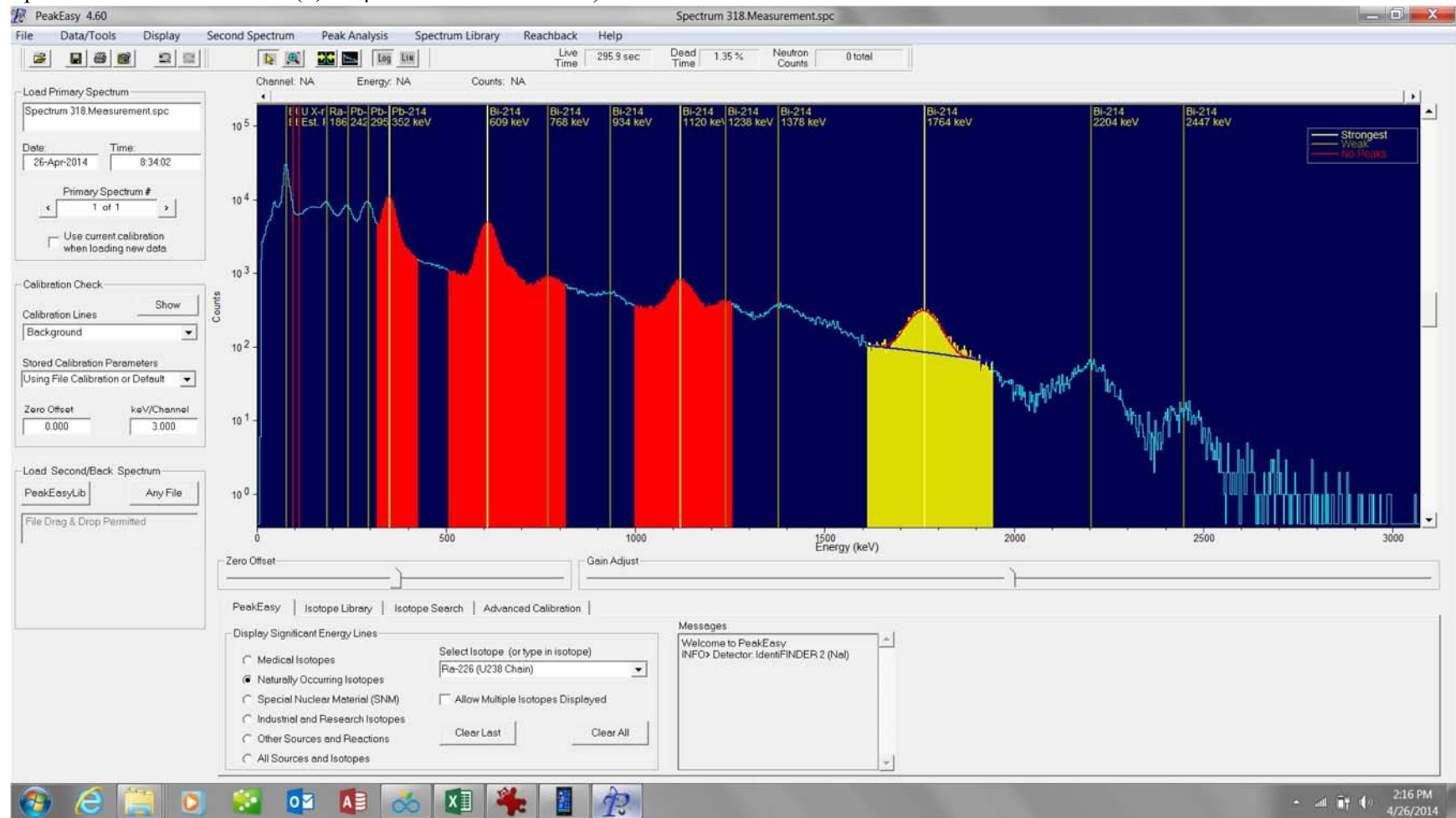
**No Picture Available**



# Spectrum 316: SU 02-07-RI (130 $\mu$ Rem/hr.)



# Spectrum 318: SU 02-08-RI (6,200 $\mu$ Rem/hr. or 6.2 mRem)



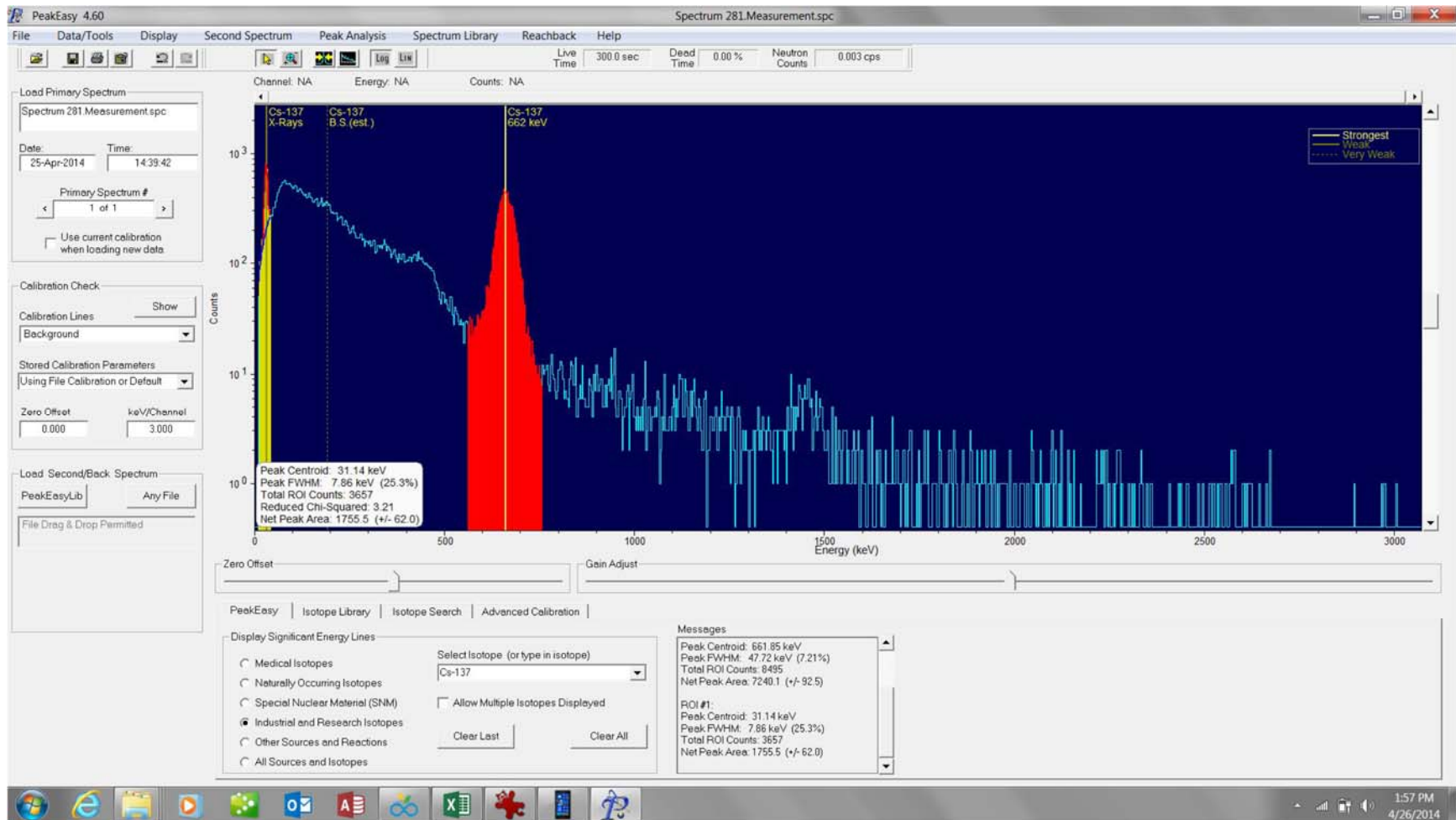


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**ATTACHMENT C: SU-3 GAMMA SPECTRUMS AND PHOTOS**

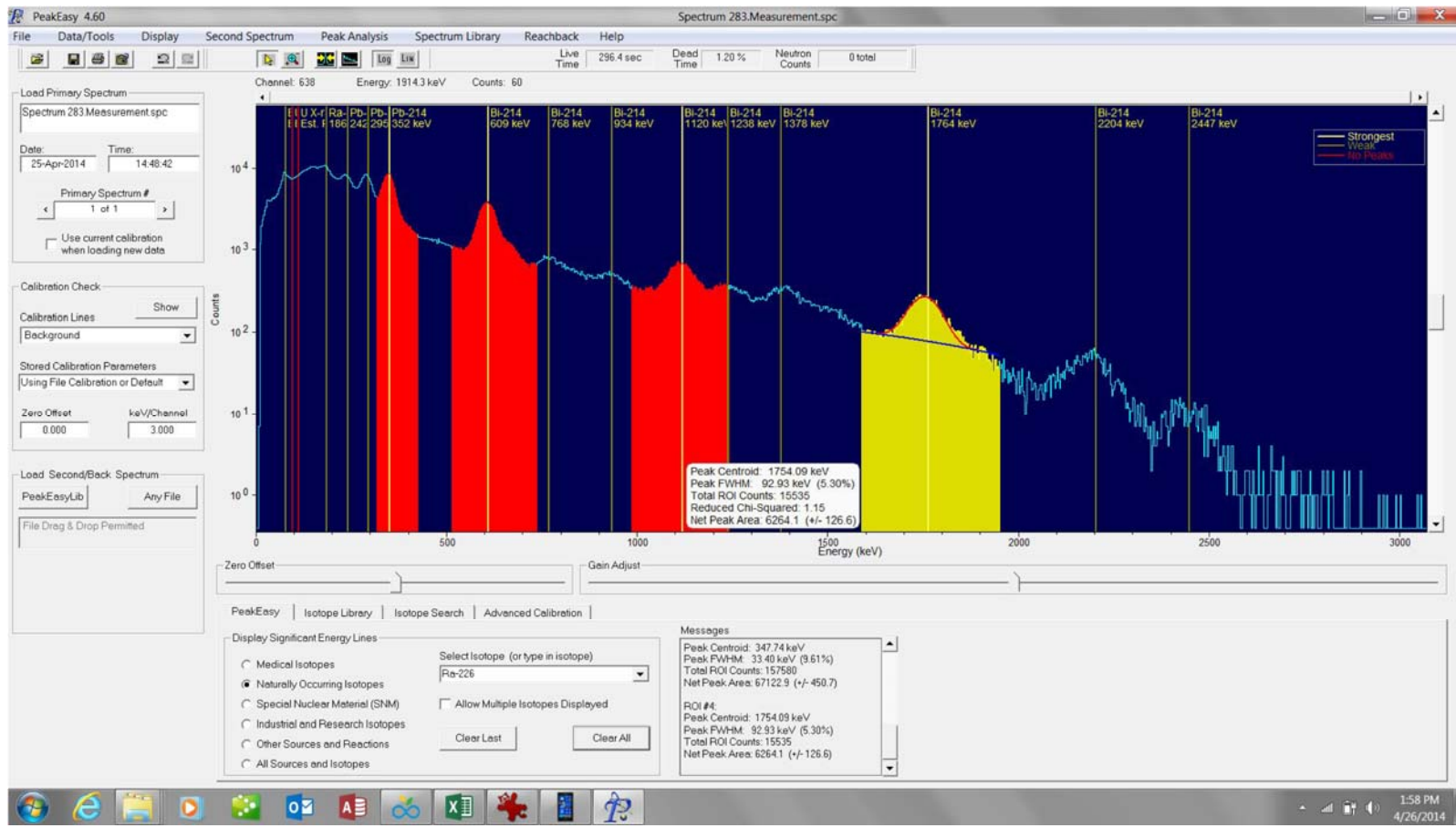
### Survey Unit 3

Spectrum 281: SU-03-01-RI(1) (8  $\mu$ Rem/hr.)



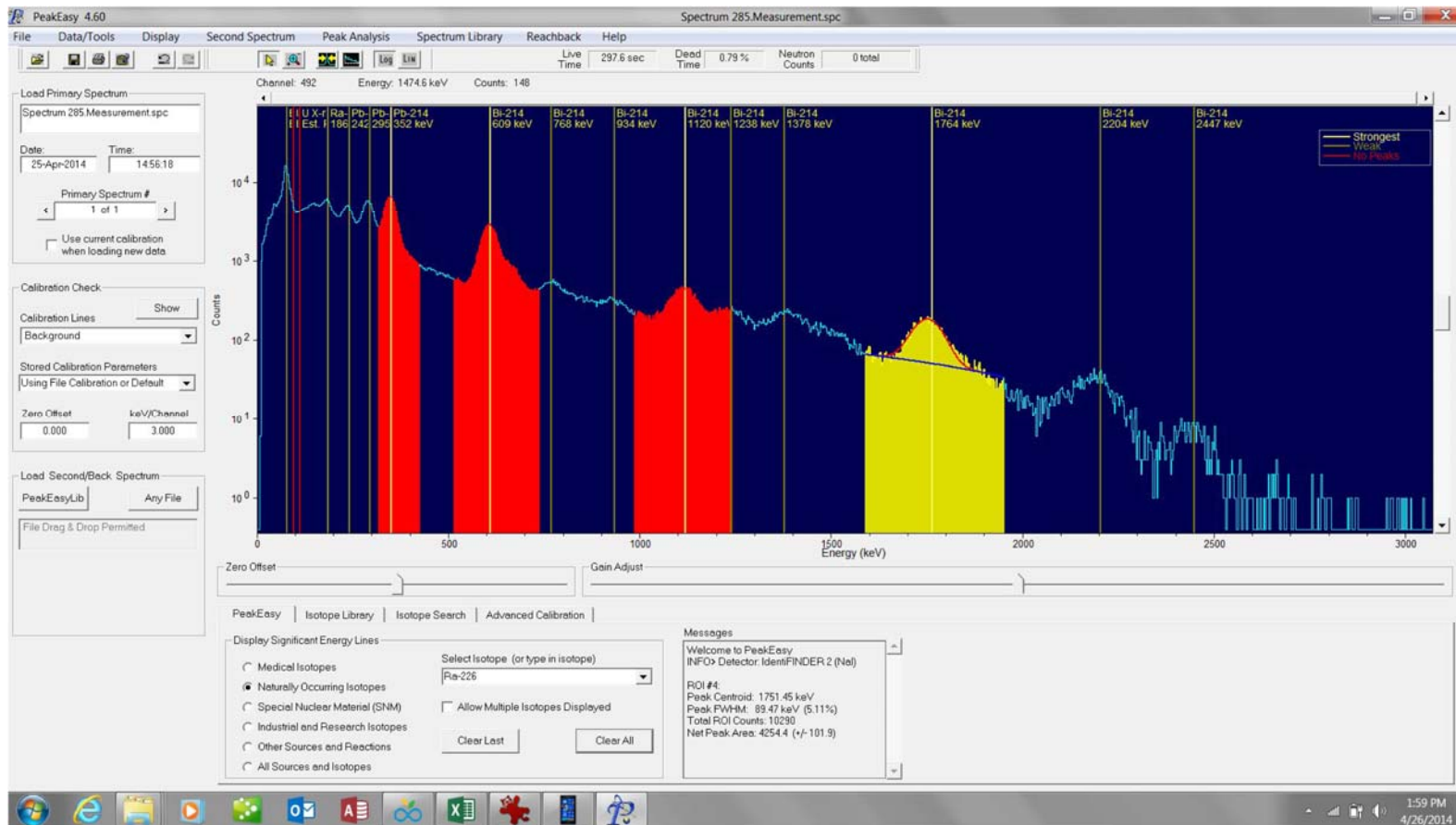
No Photo Available

Spectrum 283: SU-03-01-RI(2) (3,800  $\mu$ Rem/hr. or 3.8 mRem/hr.)





# Spectrum 285: SU-03-02-RI (1,700 $\mu$ Rem/hr. or 1.7 mRem/hr.)



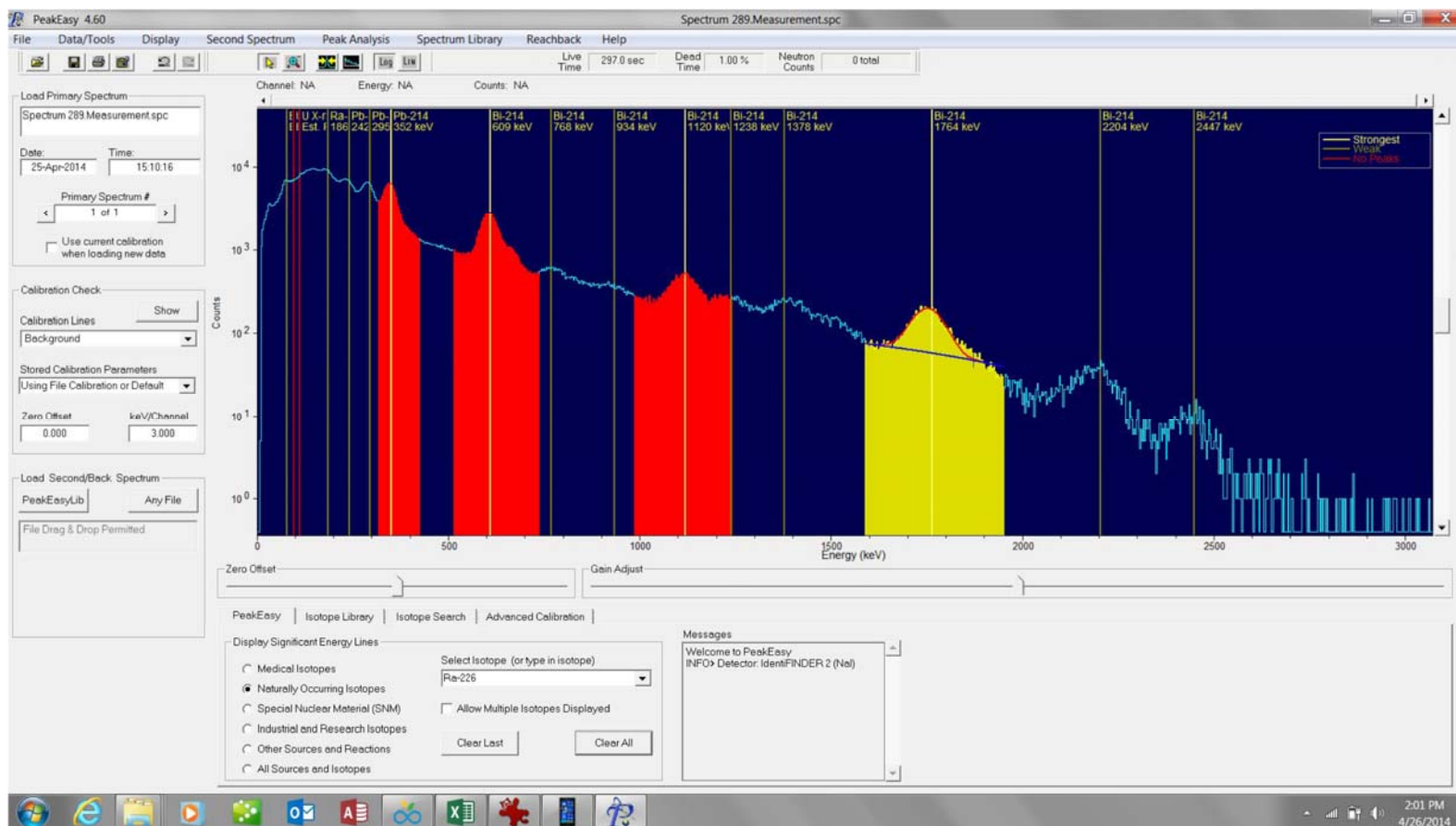
Spectrum 287: SU-03-03-RI (3,600  $\mu$ Rem/hr. or 3.6 mRem/hr.)



Peck Iron and Metal  
Radionuclide Identification Survey  
Gamma Spectroscopy SU-3

Thursday, May 22, 2014

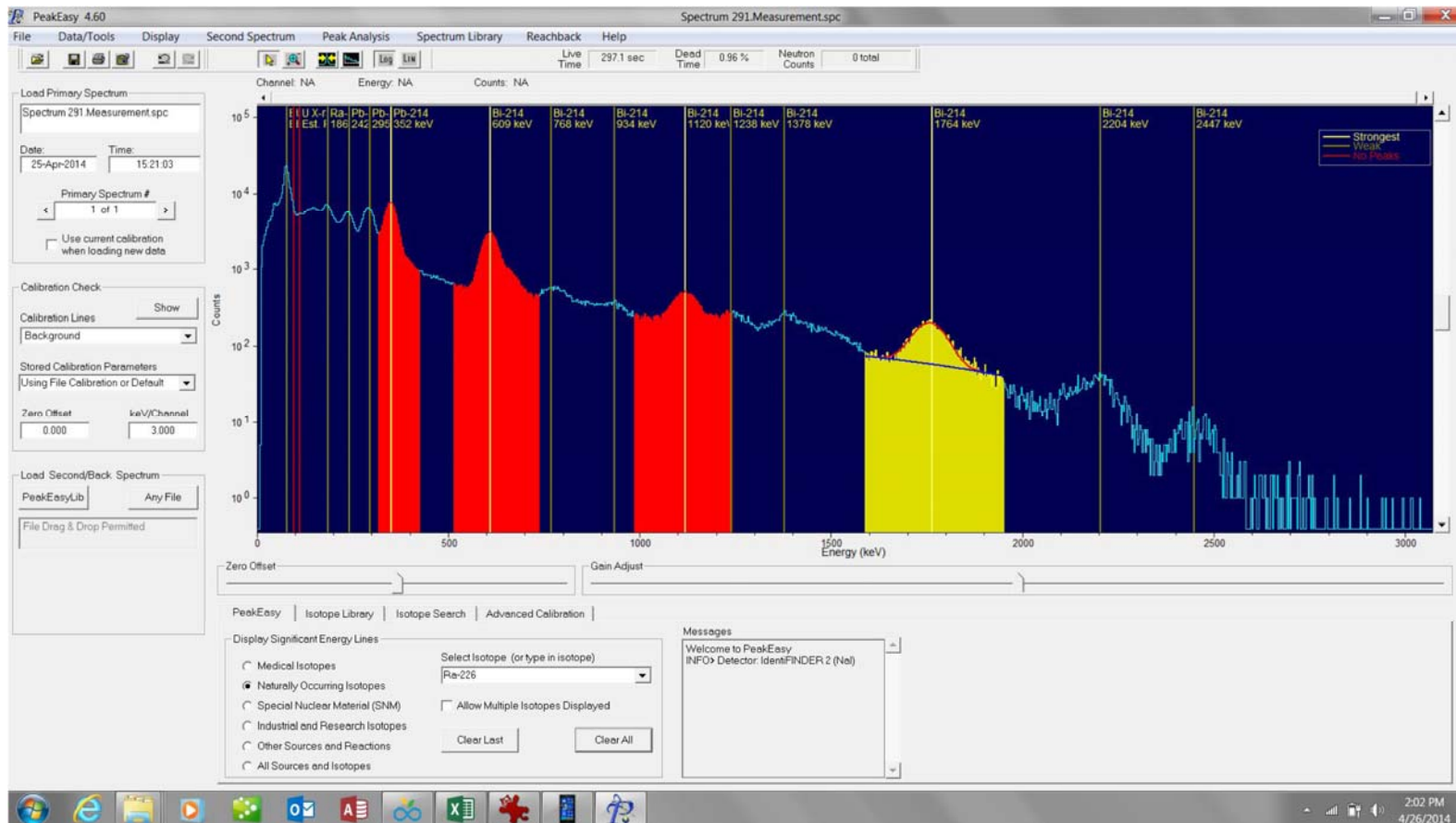
Spectrum 289: SU-03-04-RI (9,000  $\mu$ Rem/hr. or 9 mRem/hr.)



**No Photo Available**



# Spectrum 291: SU-03-05-RI (430 $\mu$ Rem/hr.)

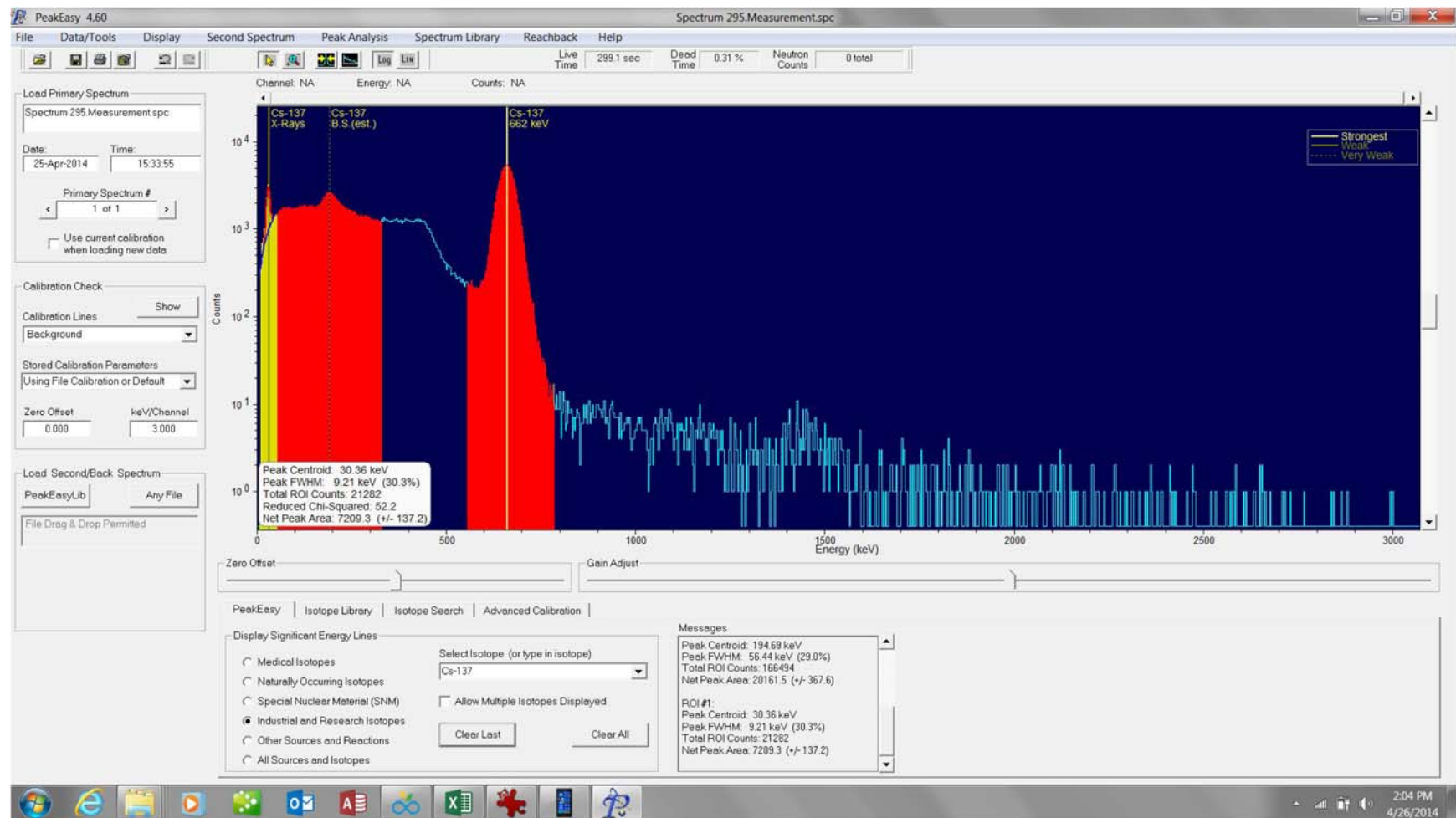


## Spectrum 293: SU-03-06-RI (1,000 $\mu$ Rem/hr. or 1 mRem/hr.)



**No Photo Available**

# Spectrum 295: Cs-137 Check Source (440 $\mu$ Rem/hr.)



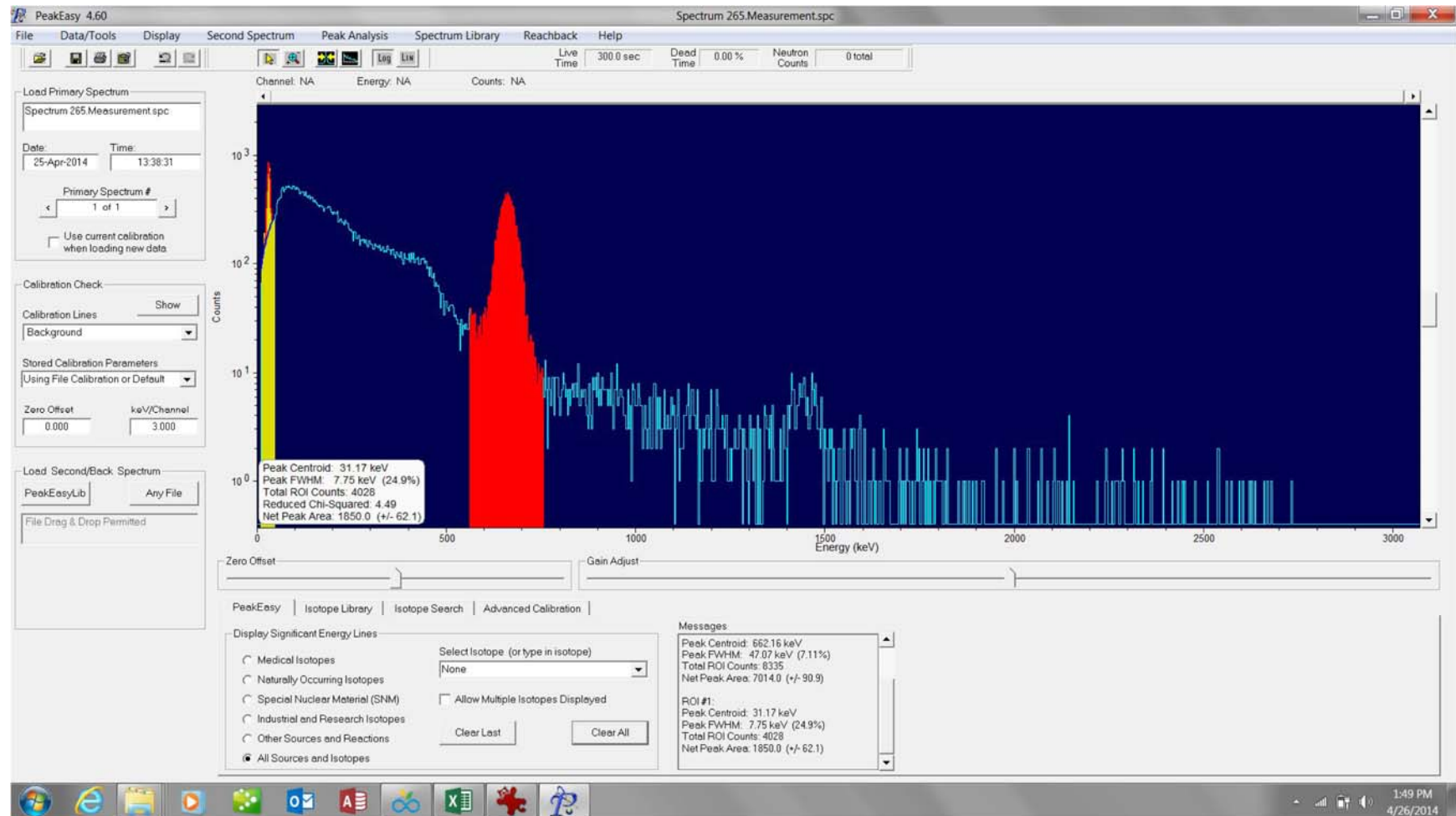


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**ATTACHMENT D: SU-4 GAMMA SPECTRUMS AND PHOTOS**

## Survey Unit 4

Spectrum 265: Background (8  $\mu$ Rem/hr.)



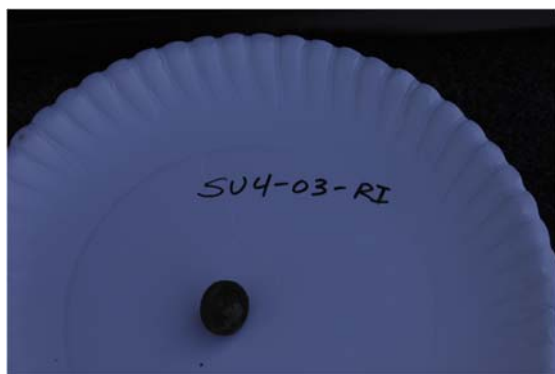


# Spectrum 267: SU-04-01-RI (100 $\mu$ Rem/hr.)





# Spectrum 271: SU-04-03-RI (1,350 $\mu$ Rem/hr.)





PeakEasy 4.60

Spectrum 273.Measurement.spc

File Data/Tools Display Second Spectrum Peak Analysis Spectrum Library Rebackback Help

Live Time 298.7 sec Dead Time 0.45 % Neutron Counts 0.003 cps

Channel: NA Energy: NA Counts: NA

Load Primary Spectrum

Spectrum 273.Measurement.spc

Date: 25-Apr-2014 Time: 14:12:06

Primary Spectrum # 1 of 1

Use current calibration when loading new data

Calibration Check

Calibration Lines Show

Background

Stored Calibration Parameters

Using File Calibration or Default

Zero Offset 0.000 keV/Channel

Load Second/Back Spectrum

PeakEasyLib Any File

File Drag & Drop Permitted

Counts

Energy (keV)

Zero Offset

Gain Adjust

PeakEasy | Isotope Library | Isotope Search | Advanced Calibration |

Display Significant Energy Lines

Medical Isotopes

Naturally Occurring Isotopes

Special Nuclear Material (SNM)

Industrial and Research Isotopes

Other Sources and Reactions

All Sources and Isotopes

Select Isotope (or type in isotope)

Ra-226

Allow Multiple Isotopes Displayed

Clear Last

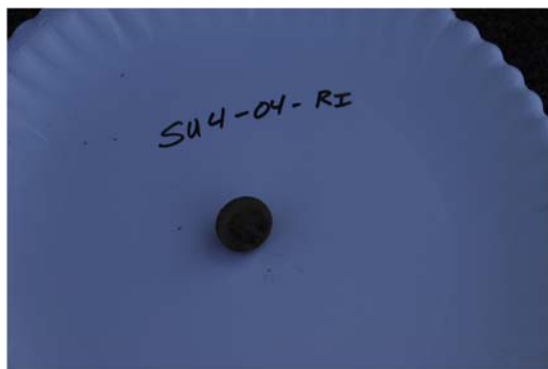
Clear All

Messages

Welcome to PeakEasy

INFO> Detector: IdentIFINDER 2 (NaI)

1:54 PM 4/26/2014



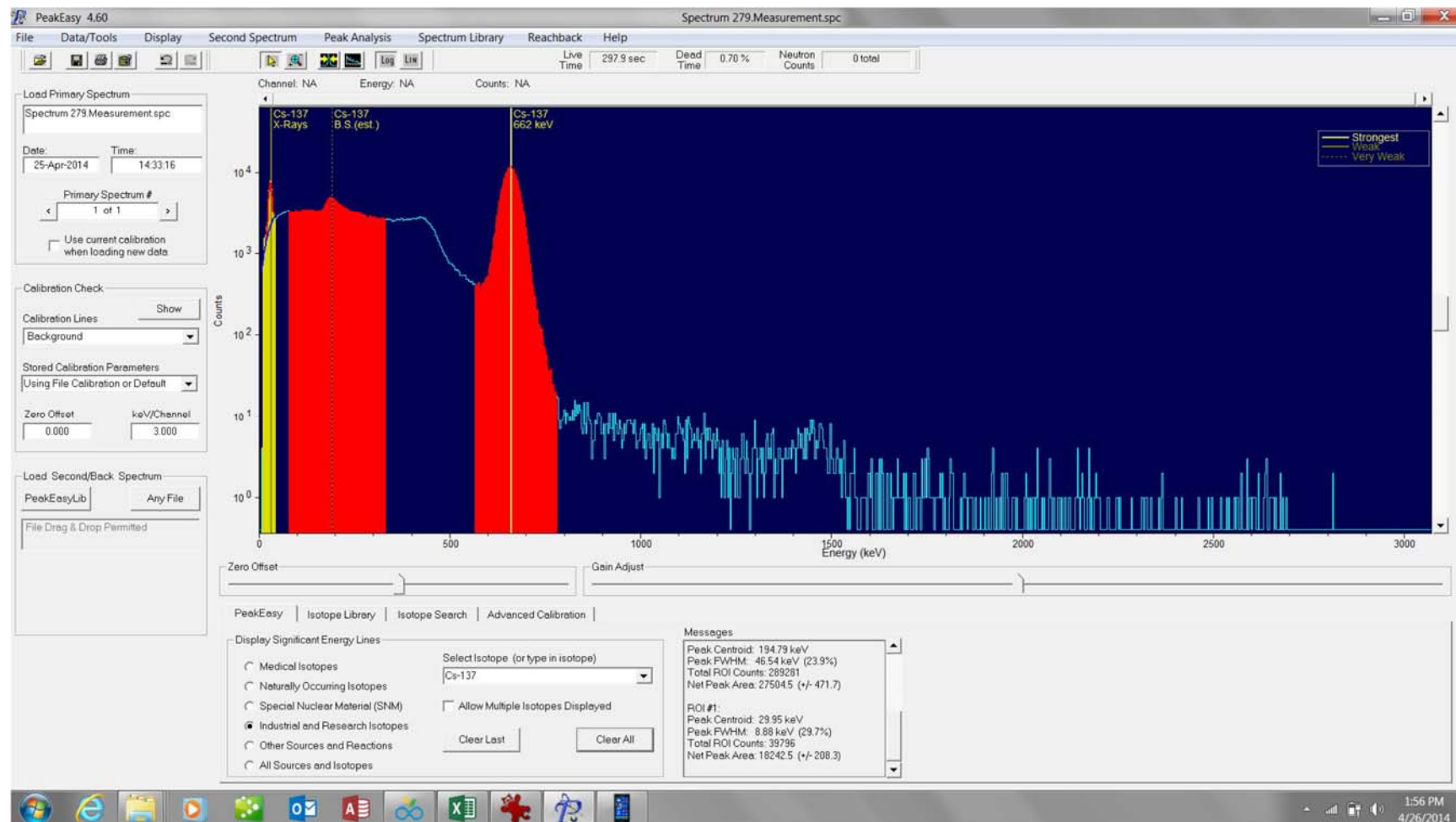
Spectrum 275: SU-04-05-RI (3,600  $\mu$ Rem/hr. or 3.6 mRem/hr.)



# Spectrum 277: SU-04-06-RI (260 $\mu$ Rem/hr.)



# Spectrum 279: Cs-137 Check Source (440 $\mu$ Rem/hr.)



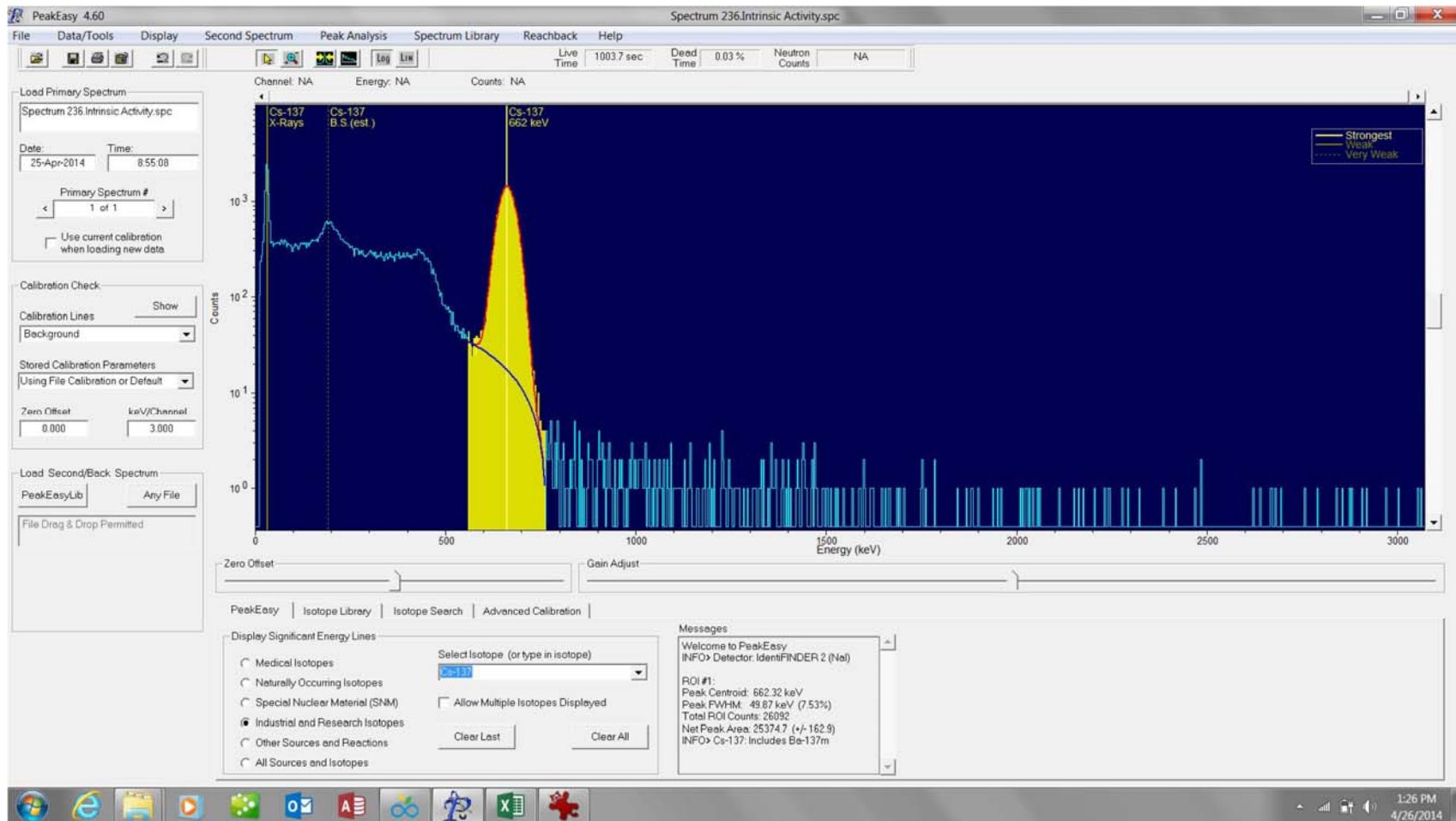


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**ATTACHMENT E: SU-5 GAMMA SPECTRUMS AND PHOTOS**

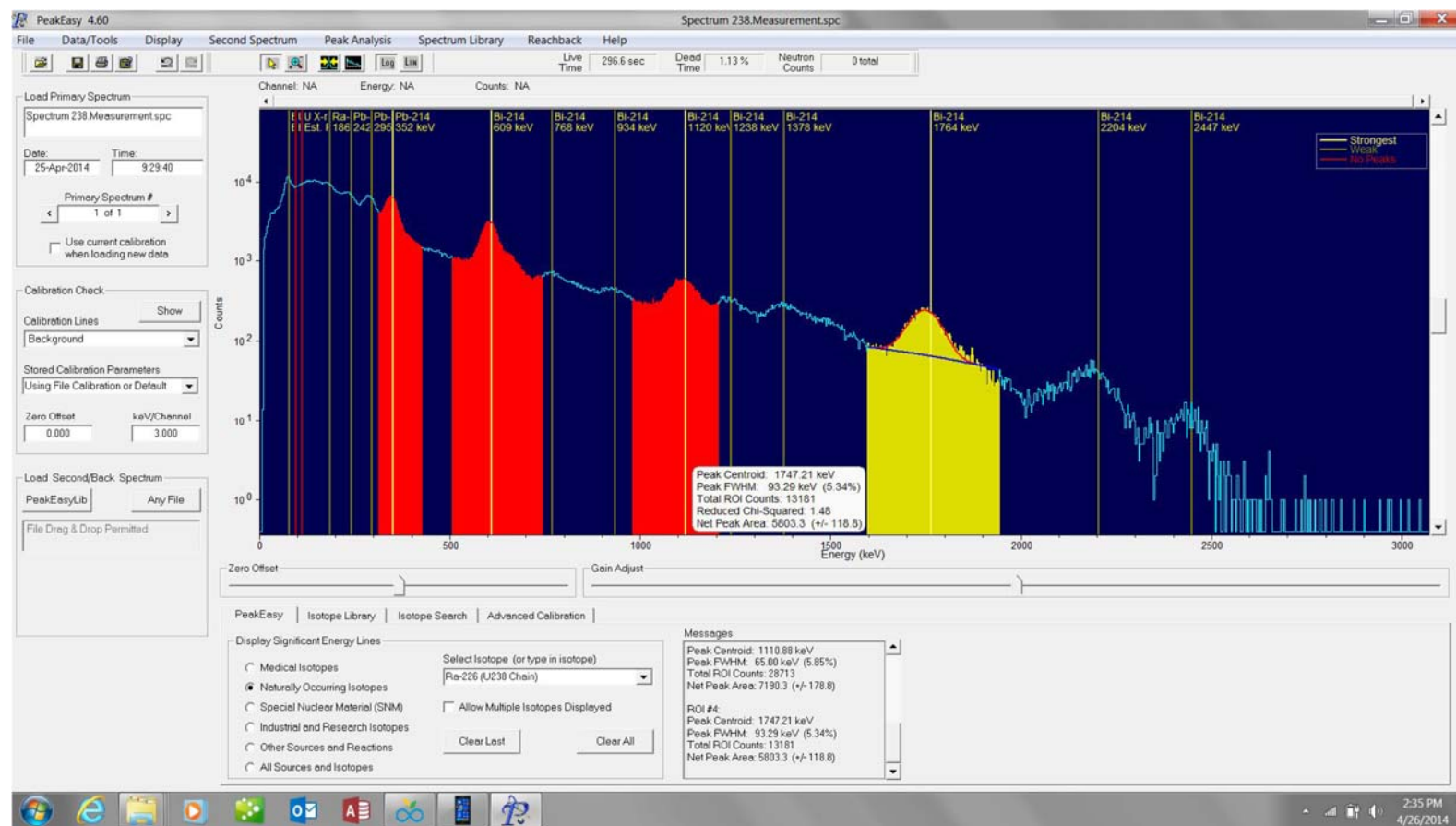
## Survey Unit 5

### Spectrum 236: Background (8 $\mu$ Rem/hr)

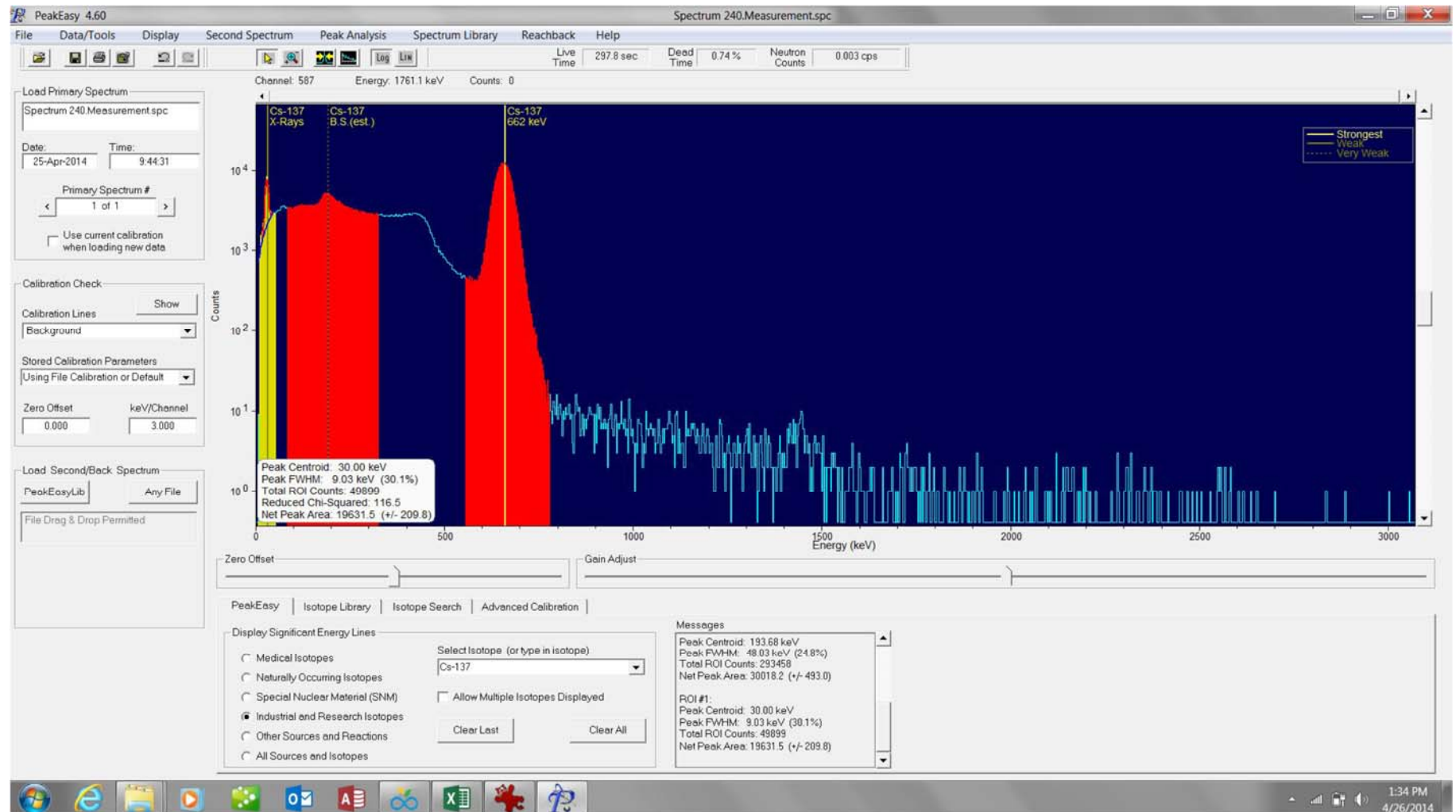




# Spectrum 238: SU-05-01-RI (3,000 $\mu$ Rem/hr or 3 mRem/hr)

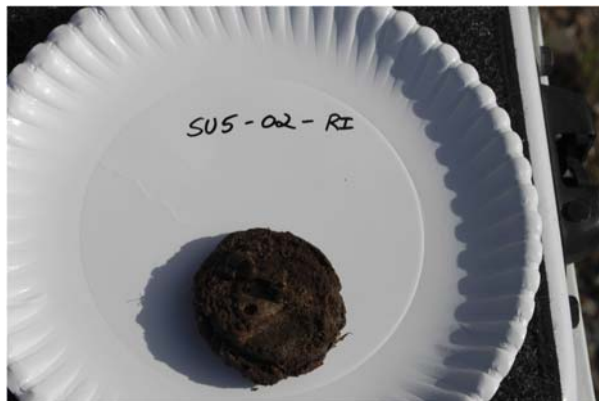


# Spectrum 240: Cs-137 Check Source (440 $\mu$ Rem/hr)

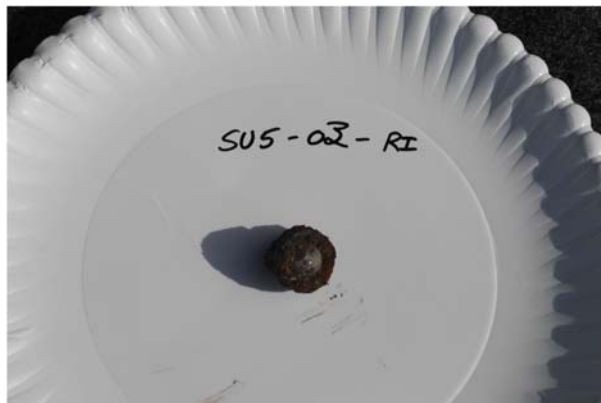
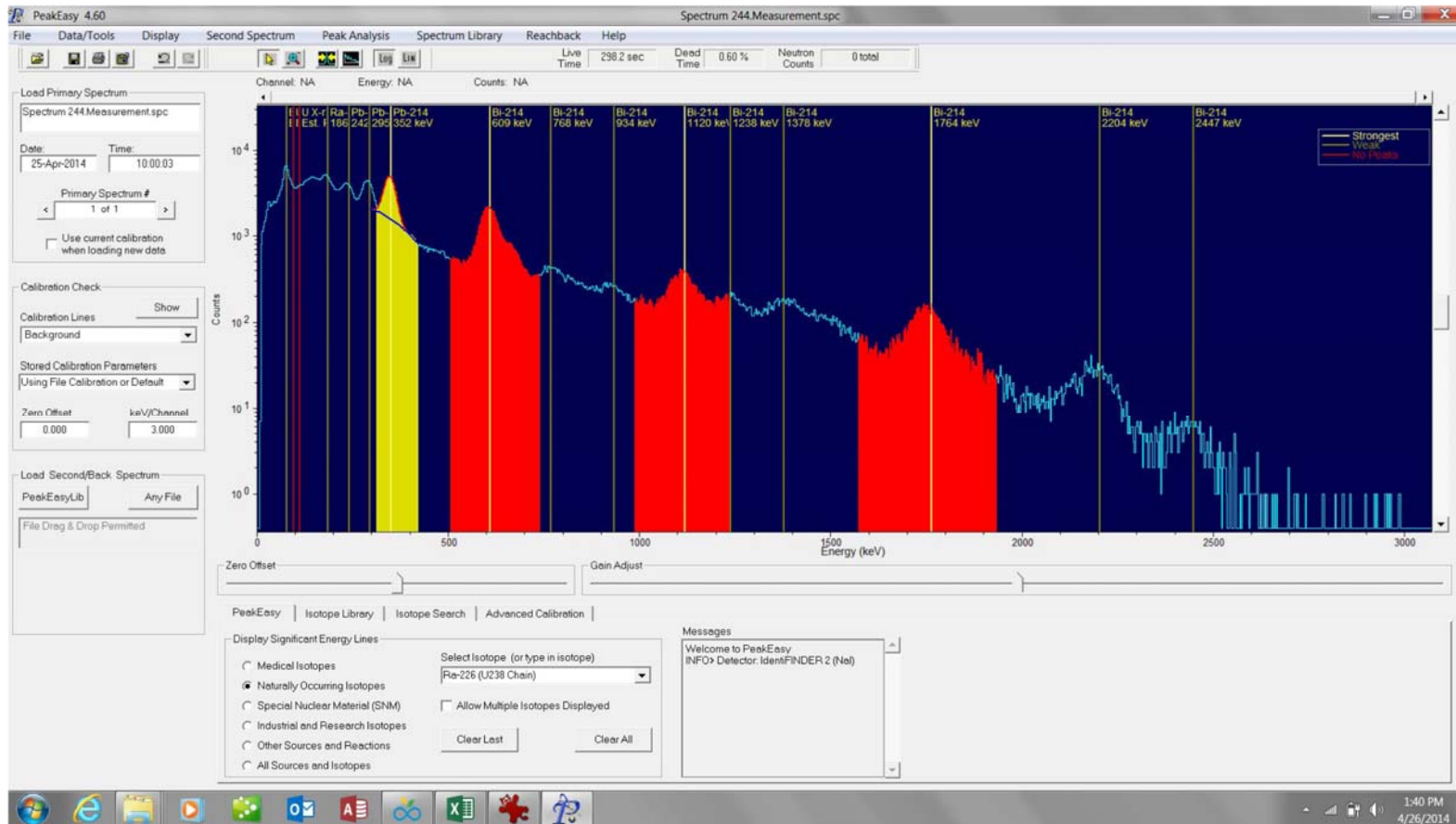




# Spectrum 242: SU-05-02-RI (220 $\mu$ Rem/hr)



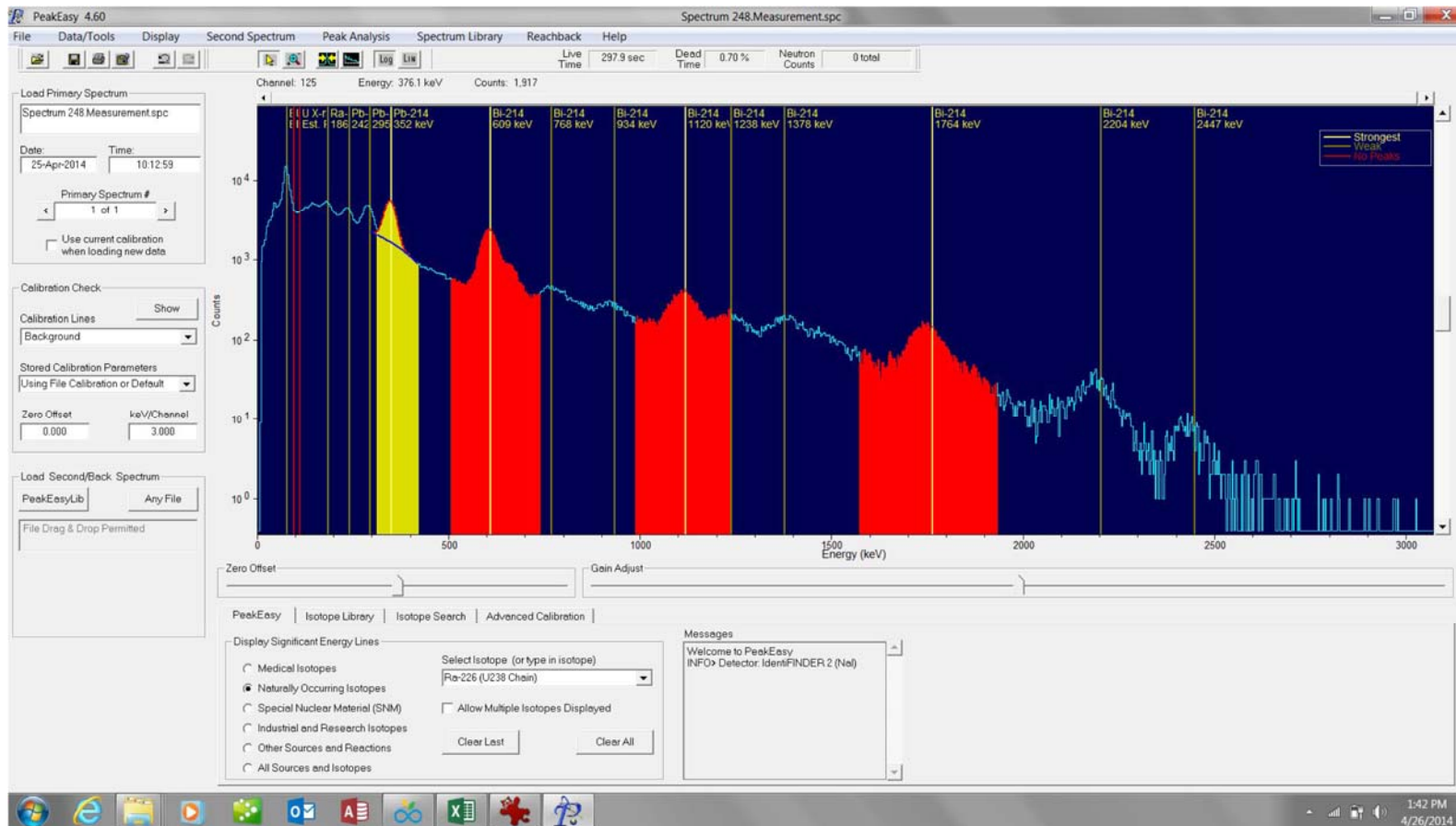
# Spectrum 244: SU-05-03-RI (1,100 $\mu$ Rem/hr)



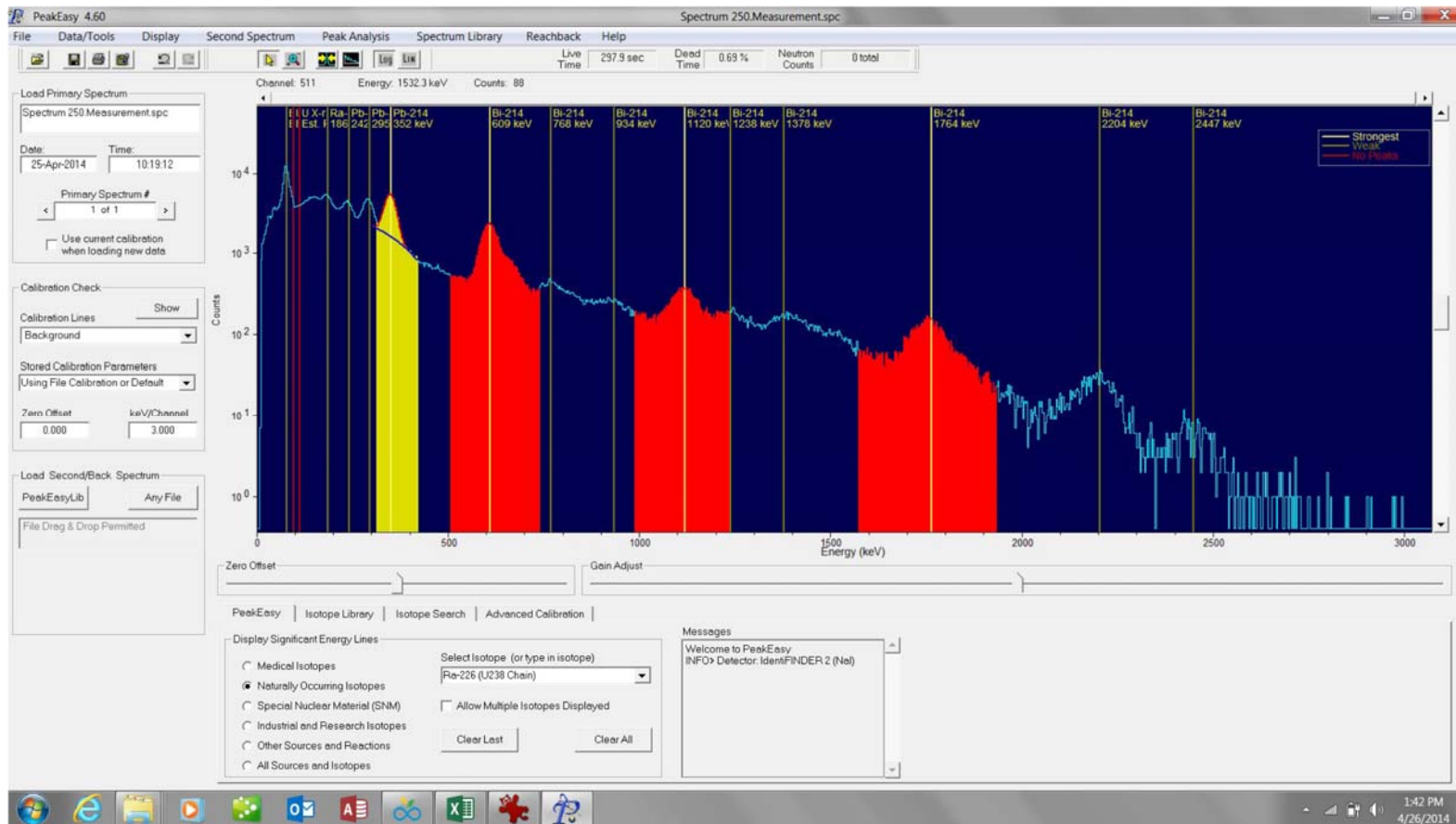
# Spectrum 246: SU-05-04-RI (130 $\mu$ Rem/hr)



Spectrum 248: SU-05-05-RI (6,700  $\mu$ Rem/hr or 6.7 mRem/hr)

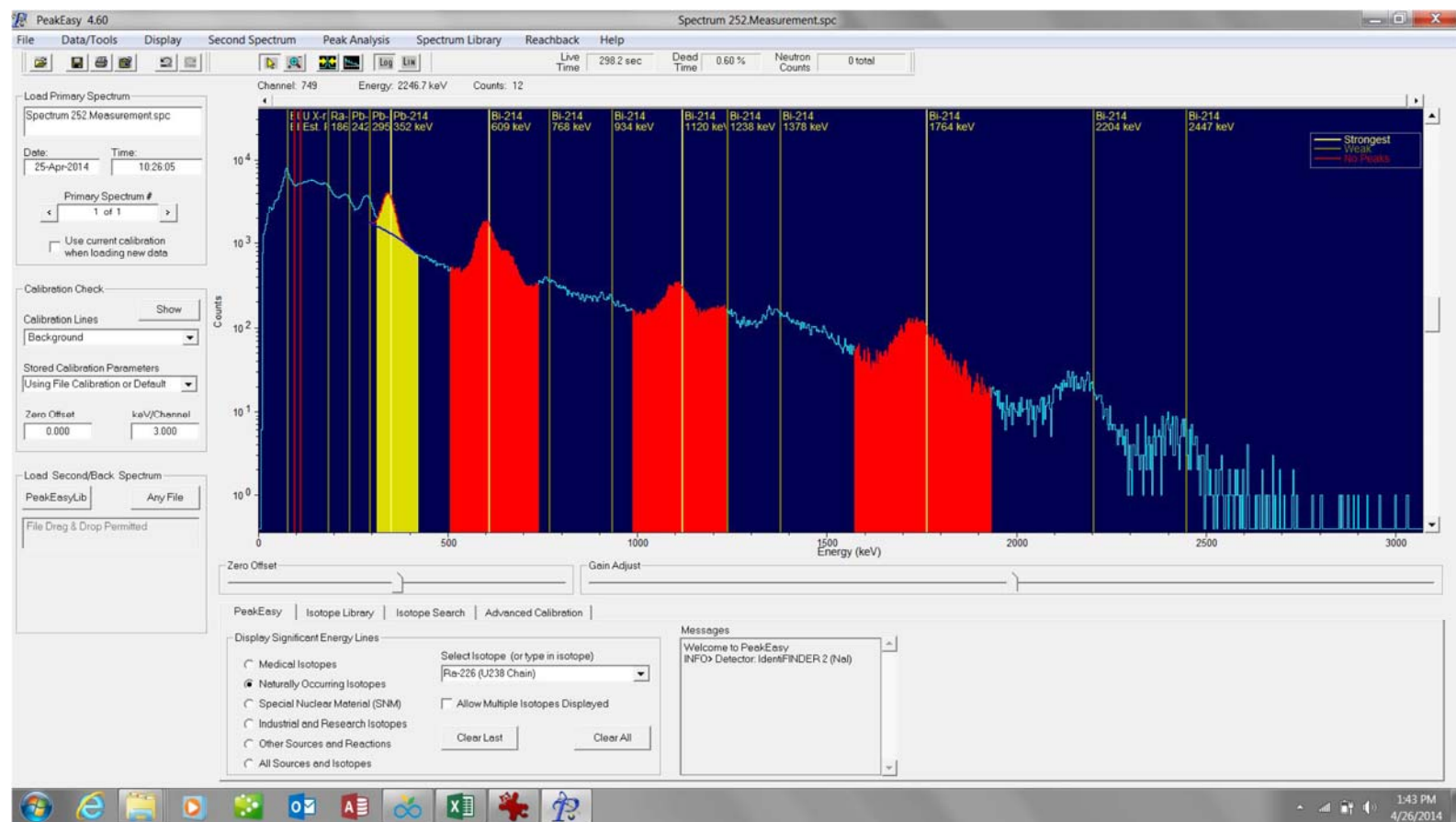


Spectrum 250: SU-05-07-RI (1,850  $\mu$ Rem/hr or 1.85 mRem/hr)





# Spectrum 252: SU-05-08-RI (50,000 $\mu$ Rem/hr or 50 mRem/hr)



Spectrum 254: SU-05-09-RI (2,400  $\mu$ Rem/hr or 2.4 mRem/hr)

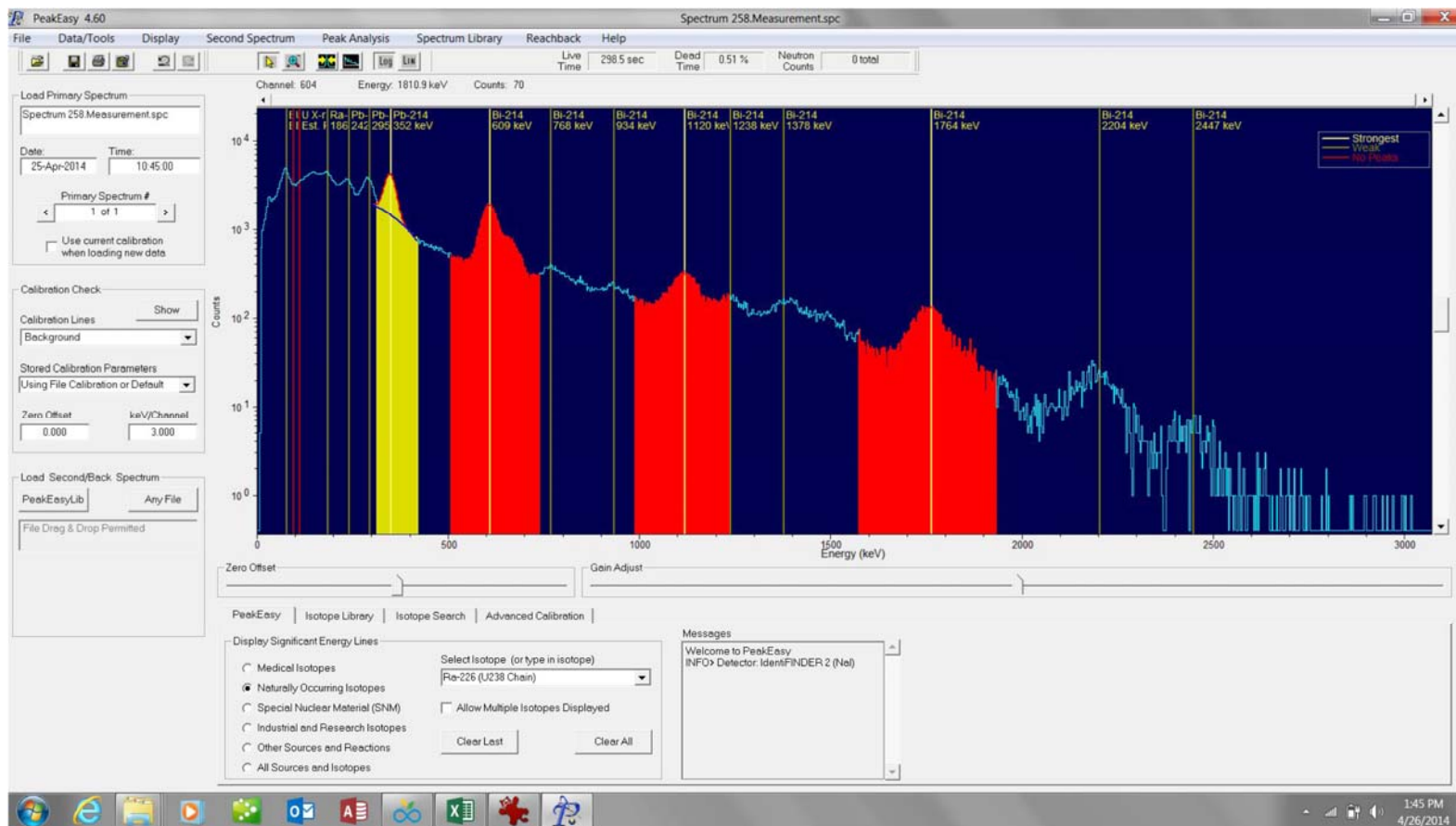




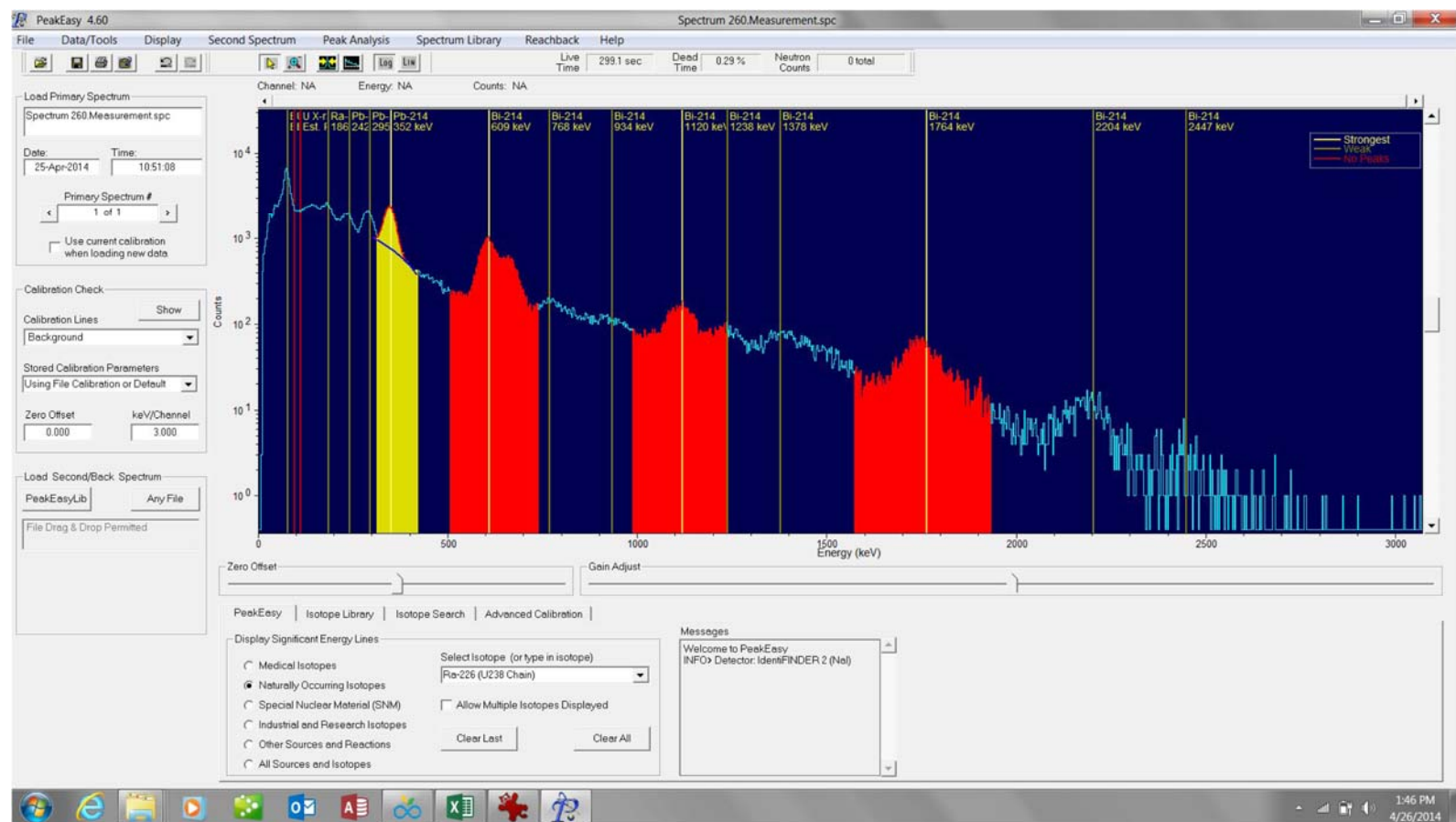
# Spectrum 256: SU-05-10-RI (6,500 $\mu$ Rem/hr or 6.5 mRem/hr)



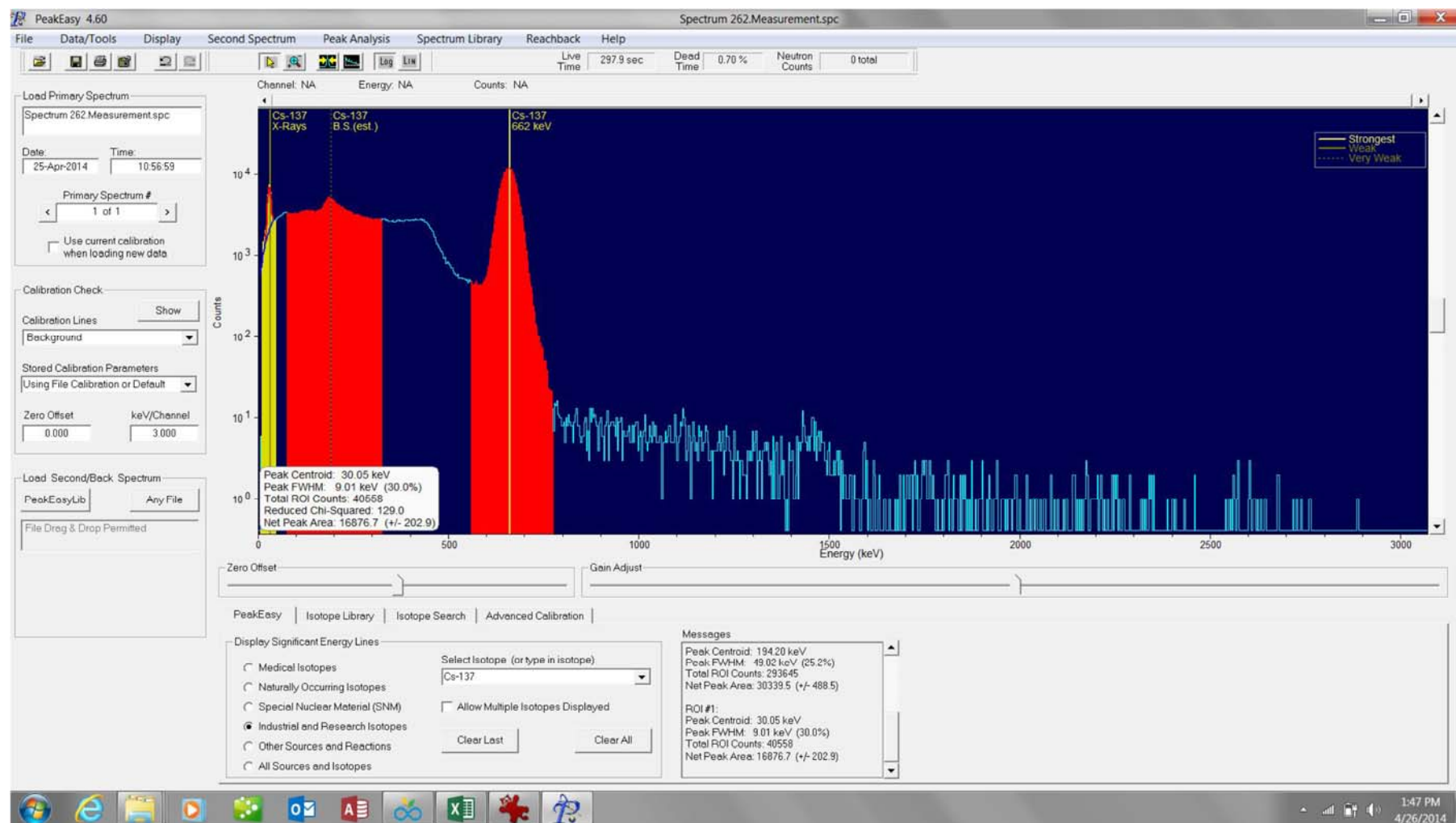
Spectrum 258: SU-05-11-RI (2,500  $\mu$ Rem/hr or 2.5 mRem/hr)



# Spectrum 260: SU-05-12-RI (800 $\mu$ Rem/hr)



# Spectrum 262: Cs-137 Source Check (440 $\mu$ Rem/hr)



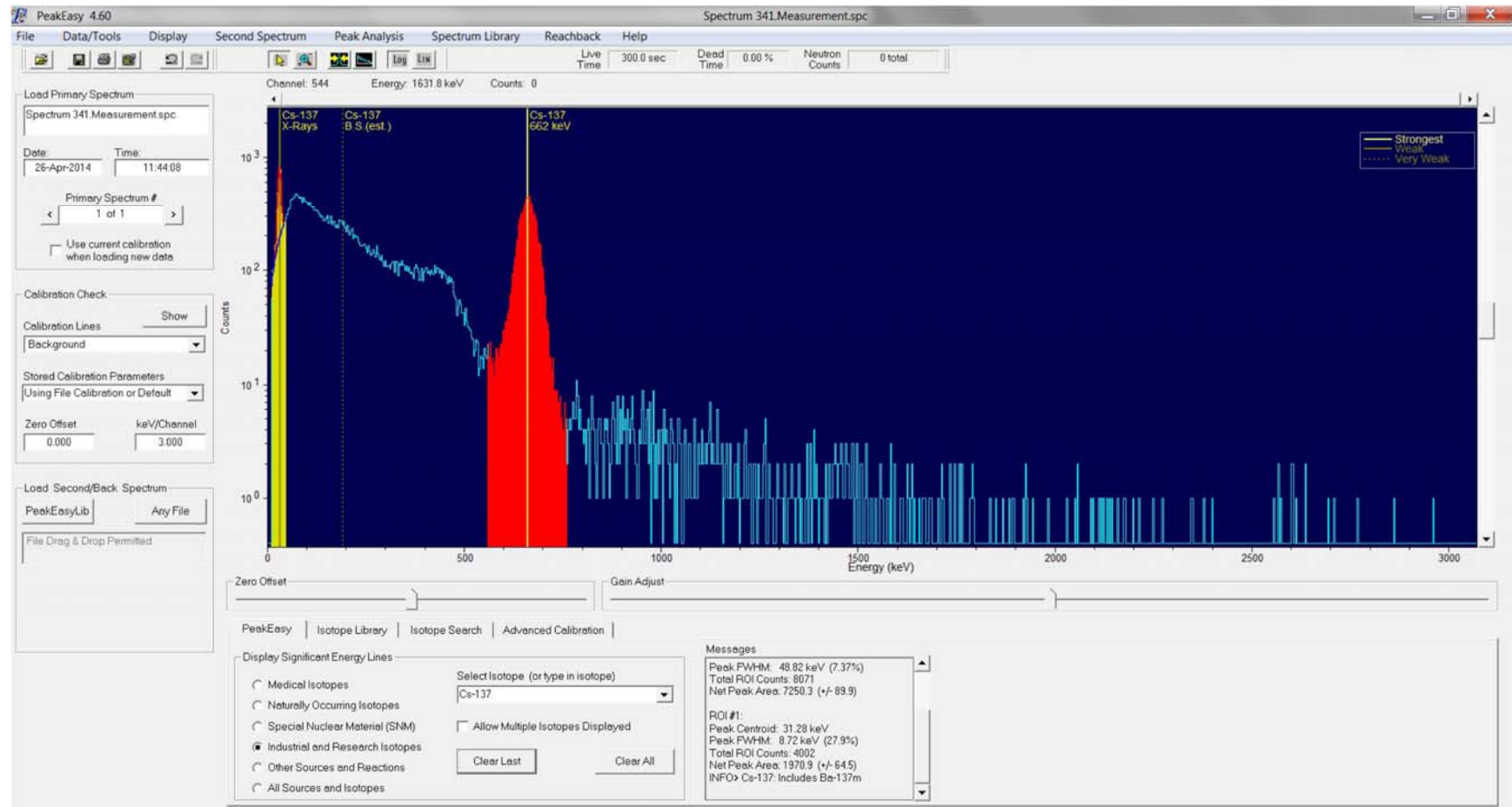


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**ATTACHMENT F: DISCRETIONARY SAMPLE SPECTRUMS**

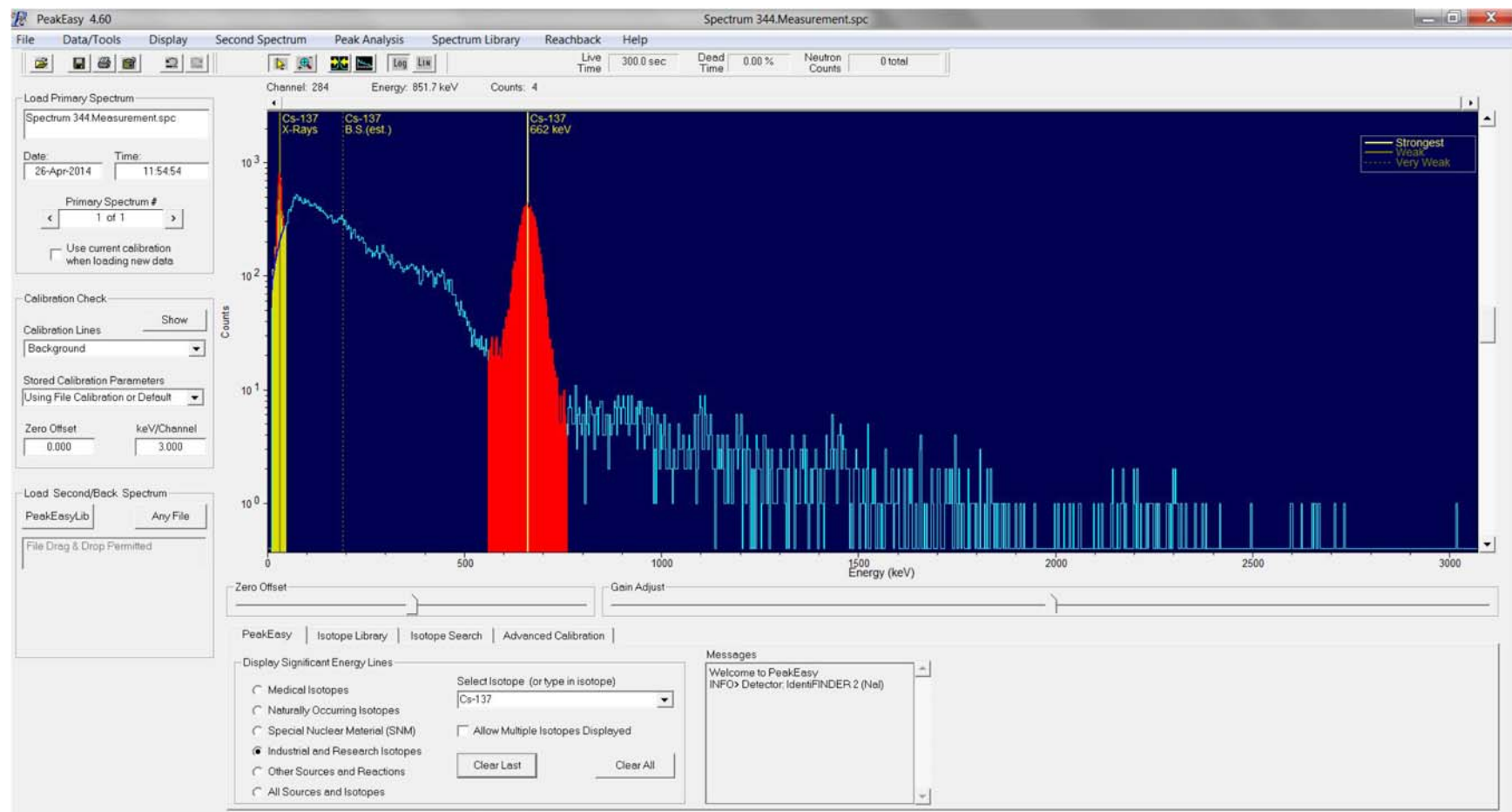
## Discretionary Spectrums

Spectrum 341: DISC-01-RI (8  $\mu$ Rem/hr)





# Spectrum 344: DISC-02-RI (8 $\mu$ Rem/hr)







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**ATTACHMENT G: INSTRUMENTATION DOCUMENTS**



# Certificate of Calibration

## Calibration and Efficiency Determination

Environmental Restoration Group, Inc.  
8809 Washington St NE, Suite 150  
Albuquerque, NM 87113  
(505) 298-4224  
www.ERGoffice.com

Meter: Manufacturer: Ludlum Model Number: 2221r Serial Number: 117636  
Detector: Manufacturer: Ludlum Model Number: 44-9 Serial Number: PR125466

☒ Mechanical Check ☒ THR/WIN Operation HV Check (+/- 2.5%): ☒ 500 V ☒ 1000 V ☒ 1500 V  
☒ F/S Response Check ☒ Reset Check Cable Length: ☒ 39-inch ☐ 72-inch ☐ Other: \_\_\_\_\_  
☒ Geotropism ☒ Audio Check  
☒ Meter Zeroed ☒ Battery Check (Min 4.4 VDC) Barometric Pressure: 24.57 inches Hg  
Source Distance: ☒ Contact ☐ 6 inches ☐ Other: Threshold: 40 mV Temperature: 75 °F  
Source Geometry: ☐ Side ☒ Below ☐ Other: Window: Relative Humidity: 20 %  
Instrument found within tolerance: ☒ Yes ☐ No

Range/Multiplier	Reference Setting	"As Found Reading"	Meter Reading	Integrated 1-Min. Count	Log Scale Count
x 1000	400	400 kcpm	400 kcpm	400185	400 kcpm
x 1000	100	100 kcpm	100 kcpm		100 kcpm
x 100	400	400 kcpm	400 kcpm	40054	400 kcpm
x 100	100	100 kcpm	100 kcpm		100 kcpm
x 10	400	400 kcpm	400 kcpm	4006	400 kcpm
x 10	100	100 kcpm	100 kcpm		100 kcpm
x 1	400	400 cpm	400 cpm	400	400 cpm
x 1	100	100 cpm	100 cpm		100 cpm

Gross Tc-99 counts (cpm): 2486  
Background counts (cpm): 63  
Net Tc-99 Counts (cpm): 2423

Gross Sr/Y-90 counts (cpm)  
Background counts (cpm):  
Net Sr/Y-90 counts (cpm):

Comments:

### Reference Instruments and/or Sources:

Ludlum pulser serial number: ☐ 97743 ☒ 201932  
☐ Alpha Source: Th-230 @ 12,800 dpm (1/4/12) sn: 4098-03  
☒ Beta Source: Tc-99 @ 17,700 dpm (1/4/12) sn: 4099-03

Fluke multimeter serial number: ☐ 8749012  
☐ Gamma Source: Cs-137 @ 5.2 uCi (1/4/12) sn: 4097-03  
☐ Other Source:

Calibrated By:

Calibration Date: 4-24-14

Calibration Due: 4-24-15

Reviewed By:

Review Date: 4/24/14



# Certificate of Calibration

Calibration and Voltage Plateau

Environmental Restoration Group, Inc.  
8809 Washington St NE, Suite 150  
Albuquerque, NM 87113  
(505) 298-4224  
www.ERGoffice.com

Meter: Manufacturer: Ludlum Model Number: 2221r Serial Number: 108846  
Detector: Manufacturer: Ludlum Model Number: 44-10 Serial Number: PR114540

- ☒ Mechanical Check ☒ THR/WIN Operation  
☒ F/S Response Check ☒ Reset Check  
☒ Geotropism ☒ Audio Check  
☒ Meter Zeroed ☒ Battery Check (Min 4.4 VDC)

Source Distance: ☐ Contact ☒ 6 inches ☐ Other:

Source Geometry: ☒ Side ☐ Below ☐ Other:

HV Check (+/- 2.5%): ☒ 500 V ☒ 1000 V ☒ 1500 V

Cable Length: ☒ 39-inch ☐ 72-inch ☒ Other:

Barometric Pressure: 24.51 inches Hg

Threshold: 10 mV

Temperature: 78 °F

Window:

Relative Humidity: 20 %

Instrument found within tolerance: ☒ Yes ☐ No

Range/Multiplier	Reference Setting	"As Found Reading"	Meter Reading	Integrated 1-Min. Count	Log Scale Count
x 1000	400	400	400	400175	400
x 1000	100	100	100		100
x 100	40	400	400	40030	400
x 100	10	100	100		100
x 10	4	400	400	4001	400
x 10	1	100	100		100
x 1	400	400	400	399	400
x 1	100	100	100		100

## High Voltage

700  
800  
900  
950  
1000  
1050  
1100  
1150  
1200

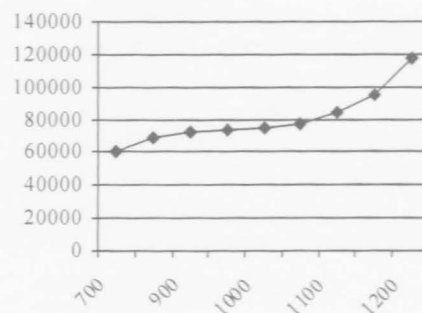
## Source Counts

60915  
68735  
72719  
73422  
74428  
77520  
83660  
94899  
117339

## Background

11741

## Voltage Plateau



Comments: HV Plateau Scaler Count Time = 1-min. Recommended HV = 950

## Reference Instruments and/or Sources:

Ludlum pulser serial number: ☐ 97743 ☒ 201932

Fluke multimeter serial number: ☐ 8749012

☐ Alpha Source: Th-230 @ 12,800 dpm (1/4/12) sn: 4098-03

☒ Gamma Source Cs-137 @ 5.2 uCi (1/4/12) sn: 4097-03

☐ Beta Source: Tc-99 @ 17,700 dpm (1/4/12) sn: 4099-03

☐ Other Source:

Calibrated By:

Calibration Date: 4/15/14

Calibration Due: 4/15/15

Reviewed By:

Date: 4/16/14

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997.



# Certificate of Calibration

Environmental Restoration  
8809 Washington St NE, S  
Albuquerque, NM 87113  
(505) 298-4224  
www.ERGoffice.com

## Calibration and Voltage Plateau

Meter/Detector: Manufacturer: Ludlum Model Number: 2929 & 43-10-1 Serial Number: 157320 & P

- ☒ Mechanical Check      ☒ THR/WIN Operation      HV Check (+/- 2.5%): ☒ 500 V ☒ 1000 V ☒ 15  
☐ F/S Response Check      ☐ Reset Check      Cable Length: ☒ 39-inch ☐ 72-inch ☐ Other:  
☐ Geotropism      ☒ Audio Check  
☐ Meter Zeroed      ☐ Battery Check (Min 4.4 VDC)

Alpha Threshold: 170 mV Barometric Pressure: 24.3  
 Beta Threshold: 4 mV Temperature: 75  
 Beta Window: 46 mV Relative Humidity: 20  
 Source Distance: ☐ Contact ☐ 6 inches ☒ Other: In Planchet  
 Source Geometry: ☐ Side ☐ Below ☒ Other: In Planchet

Instrument found within tolerance: ☒ Yes ☐ No

Range/Multiplier		Reference Setting		Integrated 1-Min. Count "As Found"		Integrated 1-Min. Count "Reading"	
				$\alpha$	$\beta$	$\alpha$	$\beta$
x 1000		400 Kcpm		399991	399997	399991	399997
x 100		40 Kcpm		39993	39993	39993	39993
x 10		4 Kcpm		4000	4000	4000	4000
x 1		400 cpm		400	400	400	400
High Voltage	Pot. Setting	Alpha Source		Beta Source		Background	
		$\alpha$	$\beta$	$\alpha$	$\beta$	$\alpha$	$\beta$
700	3.92	3718	296	5	1849	2	30
750	4.12	4366	307	5	2566	0	59
800	4.36	4496	363	6	3361	1	65
850	4.56	4670	582	3	4162	1	73

Comments: HV Plateau Scaler Count Time = 1-min. Recommended HV = 800, Pot. Setting = 4.36

### Reference Instruments and/or Sources:

Ludlum pulser serial number: ☐ 97743 ☒ 201932

Fluke multimeter serial number ☐ 8749012

☒ Alpha Source: Th-230 @ 12,800 dpm (1/4/12) sn: 4098-03

☐ Gamma Source Cs-137 @ 5.2 uCi (1/4/12) sn

☒ Beta Source: Tc-99 @ 17,700 dpm (1/4/12) sn: 4099-03

☐ Other Source:

Calibrated By: 

Calibration Date 4/16/14

Calibration Due 4/16/15

Reviewed By: 

Date: 4/16/14





## INSTRUMENTATION QC CHECK LOG

**METER: 2221/44-10 # PR125466**

DATE (MO/YR): April-14

[illegible]

1 Gamma scan instruments used for confirmation or verification surveys require a post check-in

Reviewed By:

Date:

4/27/14

## 43-10-1 Initial Instrument Check In

Meter Number:	157320	Detector Number:	157321
Meter Model:	2929	Detector Model:	43-10-1
Cal. Due:	4/16/2015	Cal. Due:	4/16/2015

ALPHA	Source Type:	Th-230	Threshold:	180 mV
ALPHA	Source #:	4006-02	High Voltage:	800
ALPHA	Source Activity:	22,000		
ALPHA	Source count time:	1	Background count time:	10 (min)
ALPHA	<b>Source GCPM</b>	<b>BKG CPM</b>	Average Bkg. (CPM):	2.9
ALPHA	7,997	1	Average Source (GCPM):	7,787
ALPHA	7,667	3	Average Net Source (NCPM):	7,784
ALPHA	7,740	2	Source Range (GCPM):	6,227 to 9,341
ALPHA	7,856	1	Background Range (CPM):	-4.2 to 10.0
ALPHA	7,830	0	Determined Efficiency:	35.4%
ALPHA	7,800	3		
ALPHA	7,760	7	20% of Bkg.	0.6
ALPHA	7,830	7	1 Standard Deviation of Bkg.	2.4
ALPHA	7,778	2	3 Standard Deviations of Bkg.	7.1
ALPHA	7,610	3		

## Beta / Gamma (circle one)

BETA	Source Type:	SrY-90	Threshold:	4 mV
BETA	Source #:	2148/90	High Voltage:	800
BETA	Source Activity:	10,733		
BETA	Source count time:	1 min.	Background count time:	1 minute (min)
BETA	<b>Source GCPM</b>	<b>BKG CPM</b>	Average Bkg. (CPM):	420
BETA	4,443	429	Average Source (GCPM):	4,313
BETA	4,249	427	Average Net Source (NCPM):	3,893
BETA	4,419	424	Source Range (GCPM):	3,451 to 5,176
BETA	4,314	435	Background Range (CPM):	387 to 454
BETA	4,230	409	Determined Efficiency:	36.3%
BETA	4,365	434		
BETA	4,246	409	20% of Bkg.	84
BETA	4,259	409	1 Standard Deviation of Bkg.	11
BETA	4,208	406	3 Standard Deviations of Bkg.	34
BETA	4,399	420		

Performed By: 

Date: 4/27/14

Reviewed By: 

(RPM / Asst. RPM)

Date: 4/27/14



## 44-9 # Fill In Meter # Initial Instrument Check In

Meter Number:	117636	Detector Number:	PR125466
Meter Model:	2221	Detector Model:	44-9
Cal. Due:	4/24/2015	Cal. Due:	4/24/2015

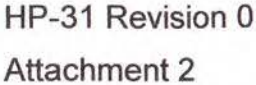
ALPHA	Source Type:		Threshold:	
ALPHA	Source #:		High Voltage:	
ALPHA	Source Activity:			
ALPHA	Source count time:		Background count time:	(min)
ALPHA	<b>Source GCPM</b>	<b>BKG CPM</b>	Average Bkg. (CPM):	#DIV/0!
ALPHA			Average Source (GCPM):	#DIV/0!
ALPHA			Average Net Source (NCPM):	#DIV/0!
ALPHA			Source Range (GCPM):	#DIV/0! to #DIV/0!
ALPHA			Background Range (CPM):	#DIV/0! to #DIV/0!
ALPHA			Determined Efficiency:	#DIV/0!
ALPHA				
ALPHA			20% of Bkg.	#DIV/0!
ALPHA			1 Standard Deviation of Bkg.	#DIV/0!
ALPHA			3 Standard Deviations of Bkg.	#DIV/0!
ALPHA				

## Beta / Gamma (circle one)

BETA	Source Type:	SrY-90	Threshold:	40 mV
BETA	Source #:	2148/90	High Voltage:	900 V
BETA	Source Activity:	10,733		
BETA	Source count time:	1 min.	Background count time:	1 minute (min)
BETA	<b>Source GCPM</b>	<b>BKG CPM</b>	Average Bkg. (CPM):	55
BETA	3,772	64	Average Source (GCPM):	3,768
BETA	3,736	60	Average Net Source (NCPM):	3,713
BETA	3,873	49	Source Range (GCPM):	3,014 to 4,522
BETA	3,753	39	Background Range (CPM):	44 to 66
BETA	3,776	57	Determined Efficiency:	N/A
BETA	3,784	70		
BETA	3,708	59	20% of Bkg.	11
BETA	3,839	44	1 Standard Deviation of Bkg.	10
BETA	3,704	47	3 Standard Deviations of Bkg.	30
BETA	3,735	62		

 Performed By:  Date: 4/24/14

 Reviewed By:  Date: 4/24/14  
 (RPM / Asst. RPM)



DATE (MO/YR): April-14

1 Gamma scan instruments used for confirmation or verification surveys require a post check-in

Date: 4/27/14



## 43-10-1 Initial Instrument Check In

Meter Number:	157320	Detector Number:	157321
Meter Model:	2929	Detector Model:	43-10-1
Cal. Due:	4/16/2015	Cal. Due:	4/16/2015

ALPHA	Source Type:	Th-230	Threshold:	180 mV
ALPHA	Source #:	4006-02	High Voltage:	800
ALPHA	Source Activity:	22,000		
ALPHA	Source count time:	1	Background count time:	10 (min)
ALPHA	<b>Source GCPM</b>	<b>BKG CPM</b>	Average Bkg. (CPM):	2.9
ALPHA	7,997	1	Average Source (GCPM):	7,787
ALPHA	7,667	3	Average Net Source (NCPM):	7,784
ALPHA	7,740	2	Source Range (GCPM):	6,227 to 9,341
ALPHA	7,856	1	Background Range (CPM):	-4.2 to 10.0
ALPHA	7,830	0	Determined Efficiency:	35.4%
ALPHA	7,800	3		
ALPHA	7,760	7	20% of Bkg.	0.6
ALPHA	7,830	7	1 Standard Deviation of Bkg.	2.4
ALPHA	7,778	2	3 Standard Deviations of Bkg.	7.1
ALPHA	7,610	3		

## Beta / Gamma (circle one)

BETA	Source Type:	SrY-90	Threshold:	4 mV
BETA	Source #:	2148/90	High Voltage:	800
BETA	Source Activity:	10,733		
BETA	Source count time:	1 min.	Background count time:	1 minute (min)
BETA	<b>Source GCPM</b>	<b>BKG CPM</b>	Average Bkg. (CPM):	420
BETA	4,443	429	Average Source (GCPM):	4,313
BETA	4,249	427	Average Net Source (NCPM):	3,893
BETA	4,419	424	Source Range (GCPM):	3,451 to 5,176
BETA	4,314	435	Background Range (CPM):	387 to 454
BETA	4,230	409	Determined Efficiency:	36.3%
BETA	4,365	434		
BETA	4,246	409	20% of Bkg.	84
BETA	4,259	409	1 Standard Deviation of Bkg.	11
BETA	4,208	406	3 Standard Deviations of Bkg.	34
BETA	4,399	420		

Performed By:

Date:

4/24/14

Reviewed By:

  
(RPM / Asst. RPM)

Date:

4/24/14

## INSTRUMENTATION QC CHECK LOG

**METER: 2929/43-10-1**

DATE (MO/YR):

**April-14**

[illegible]

1 An unsatisfactory QC check requires the recording the result in the comment column and repeating the evaluation. Tag the instrument out of service and notify the HP Supervisor upon failing the QC check two times in succession

Reviewed By: David Kye

Date: 4/27/14



***American Veteran Environmental Services, Inc.***  
A Service Disabled Veteran Owned Small Business

**FIGURES**





**Figure A: All Proposed Gamma Spectroscopy Sample Locations**



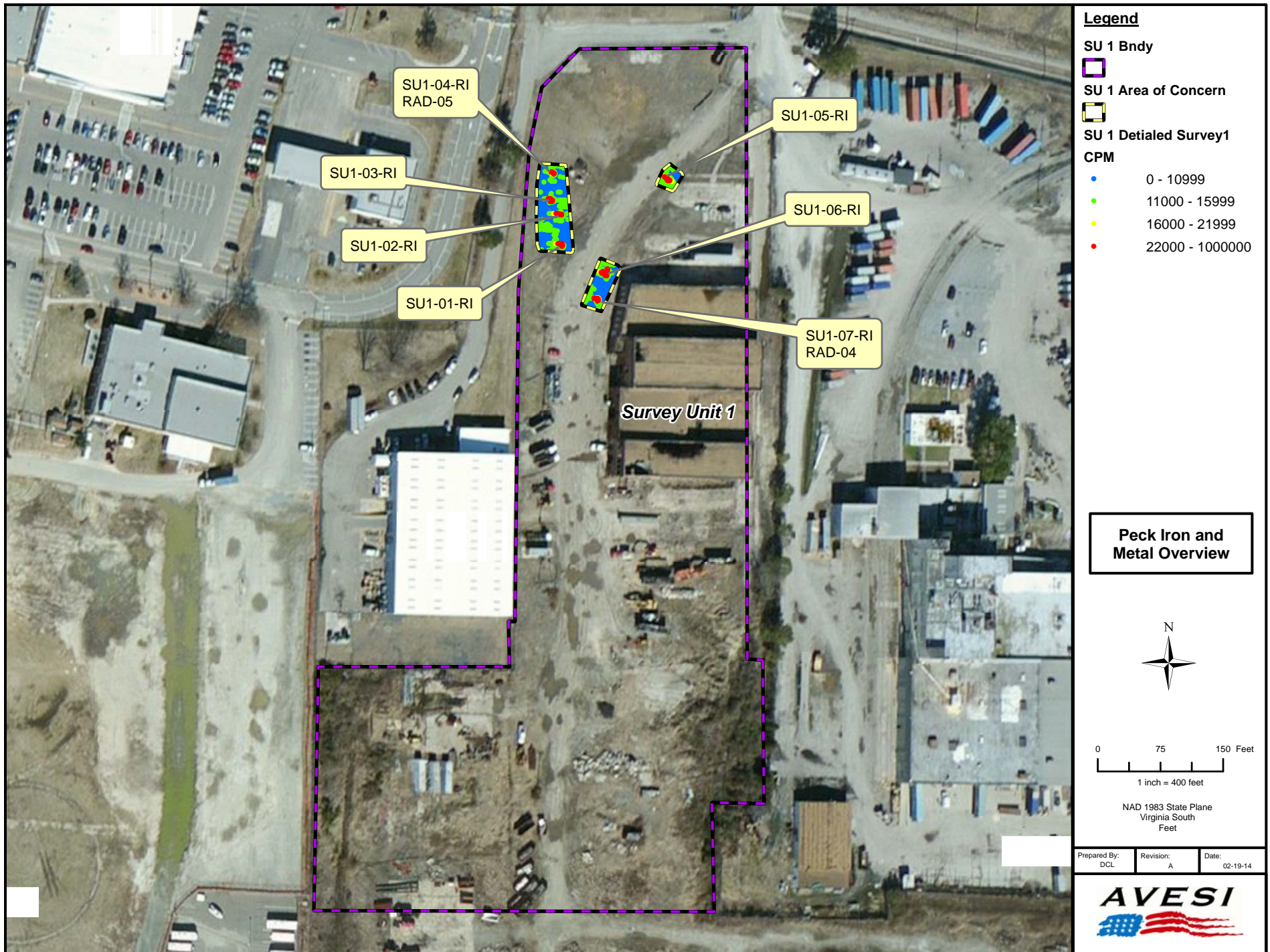
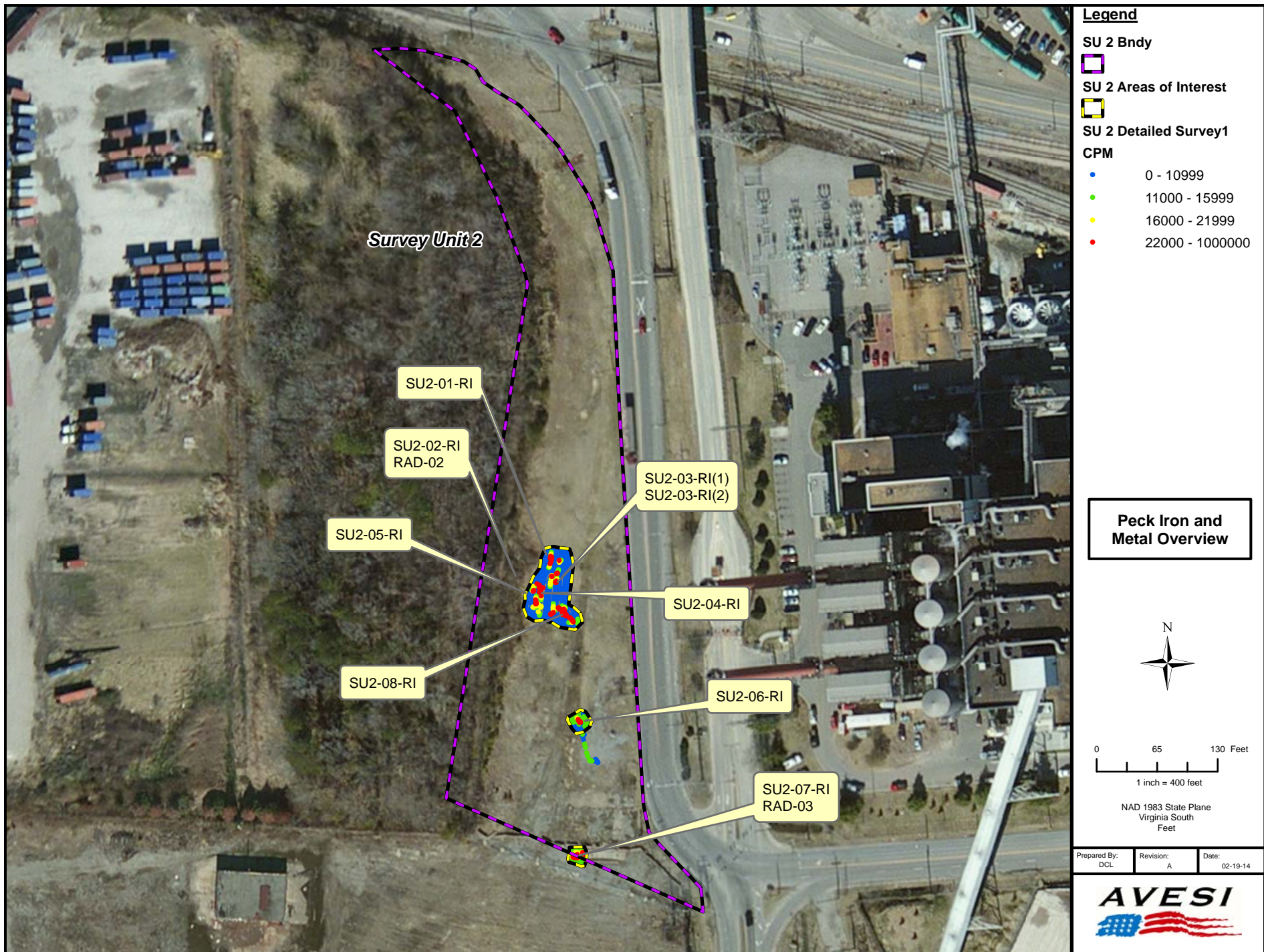


Figure 1-1: Peck Iron and Metal SU 1 Gamma Spectroscopy Sample Locations





**Figure 1-2: Peck Iron and Metal SU 2 Gamma Spectroscopy Sample Locations**



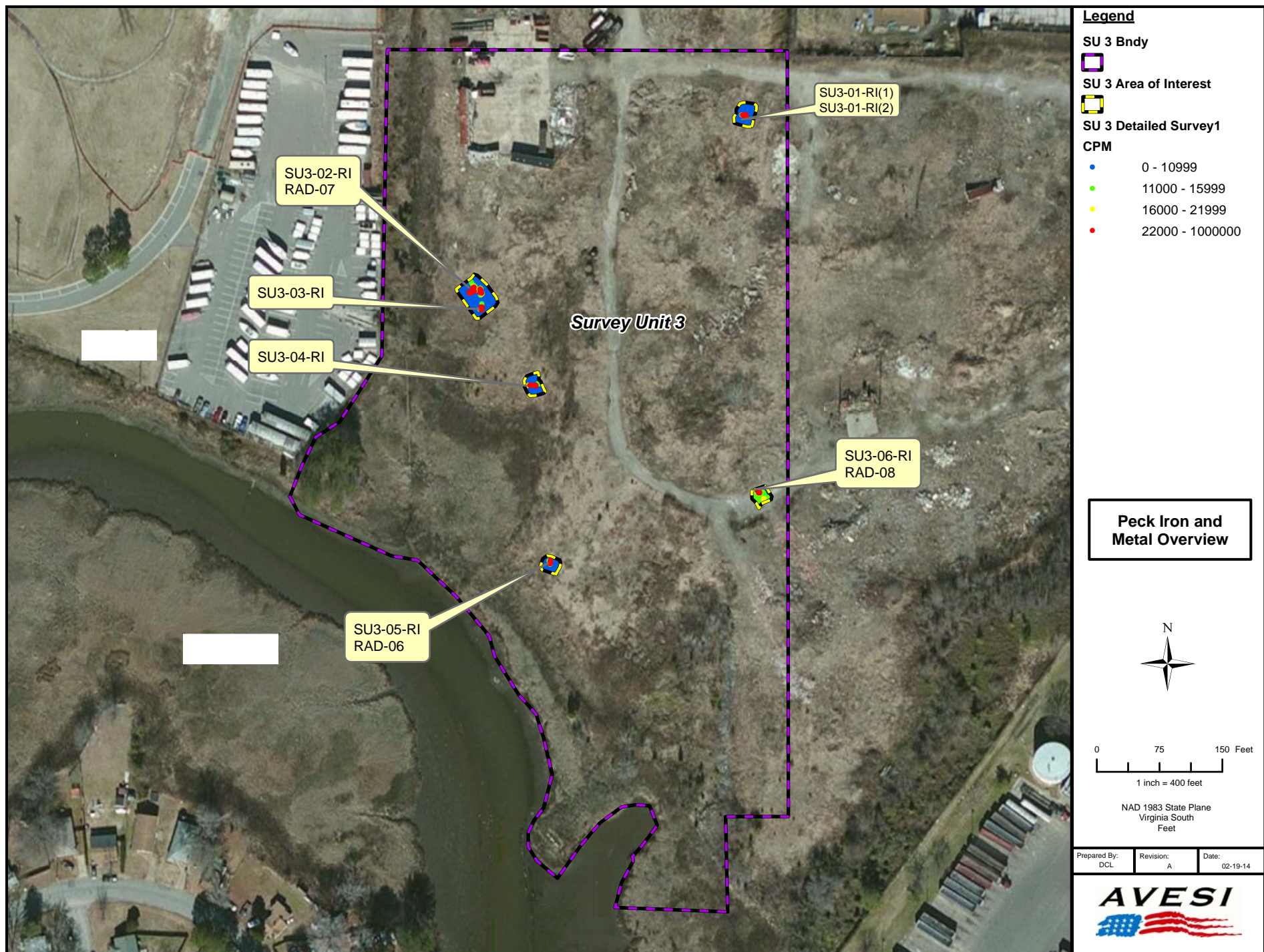


Figure 1-3 :Peck Iron and Metal SU 3 Gamma Spectroscopy Sample Locations



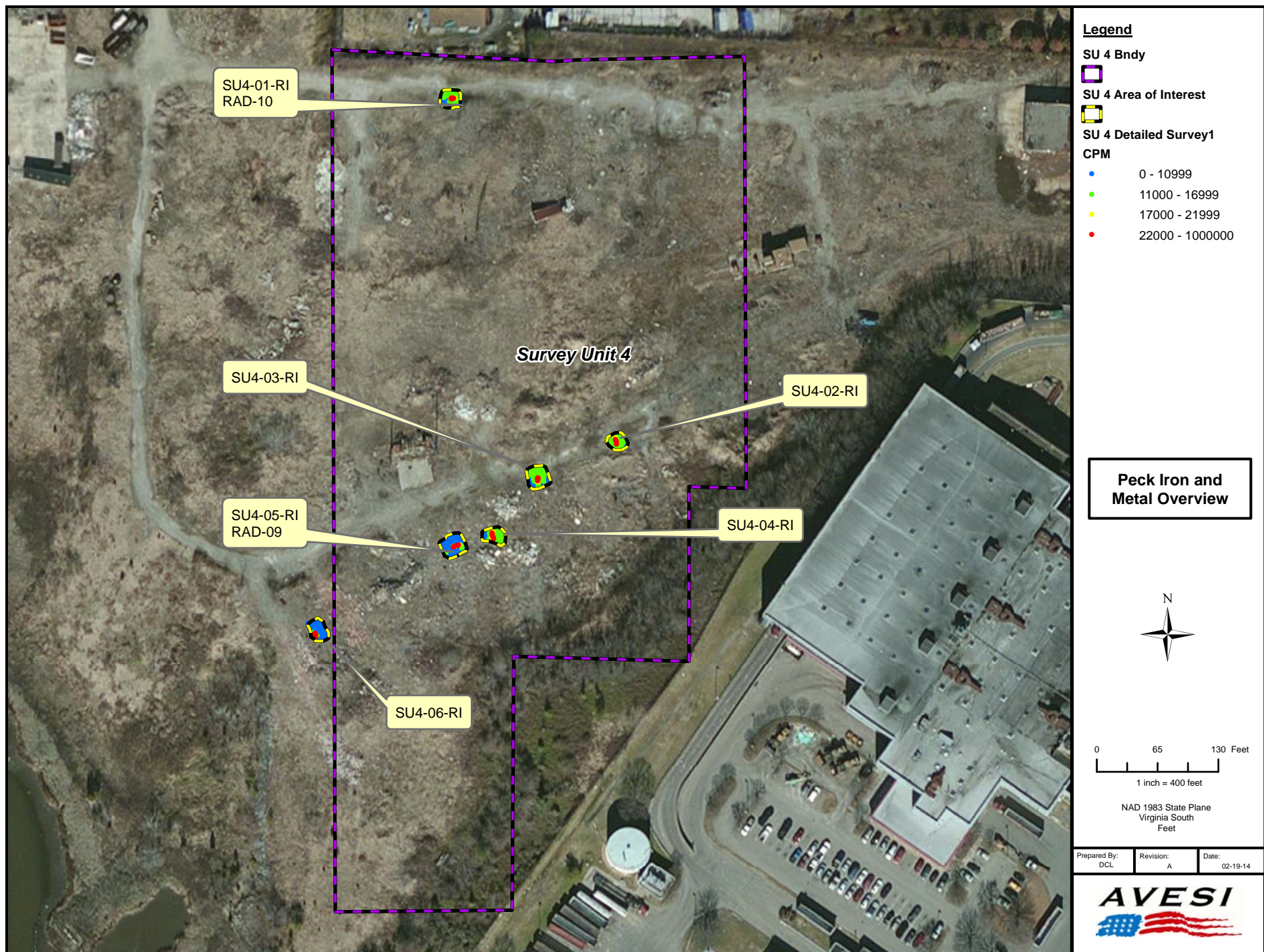


Figure 1-4: Peck Iron and Metal SU 4 Gamma Spectroscopy Sample Locations



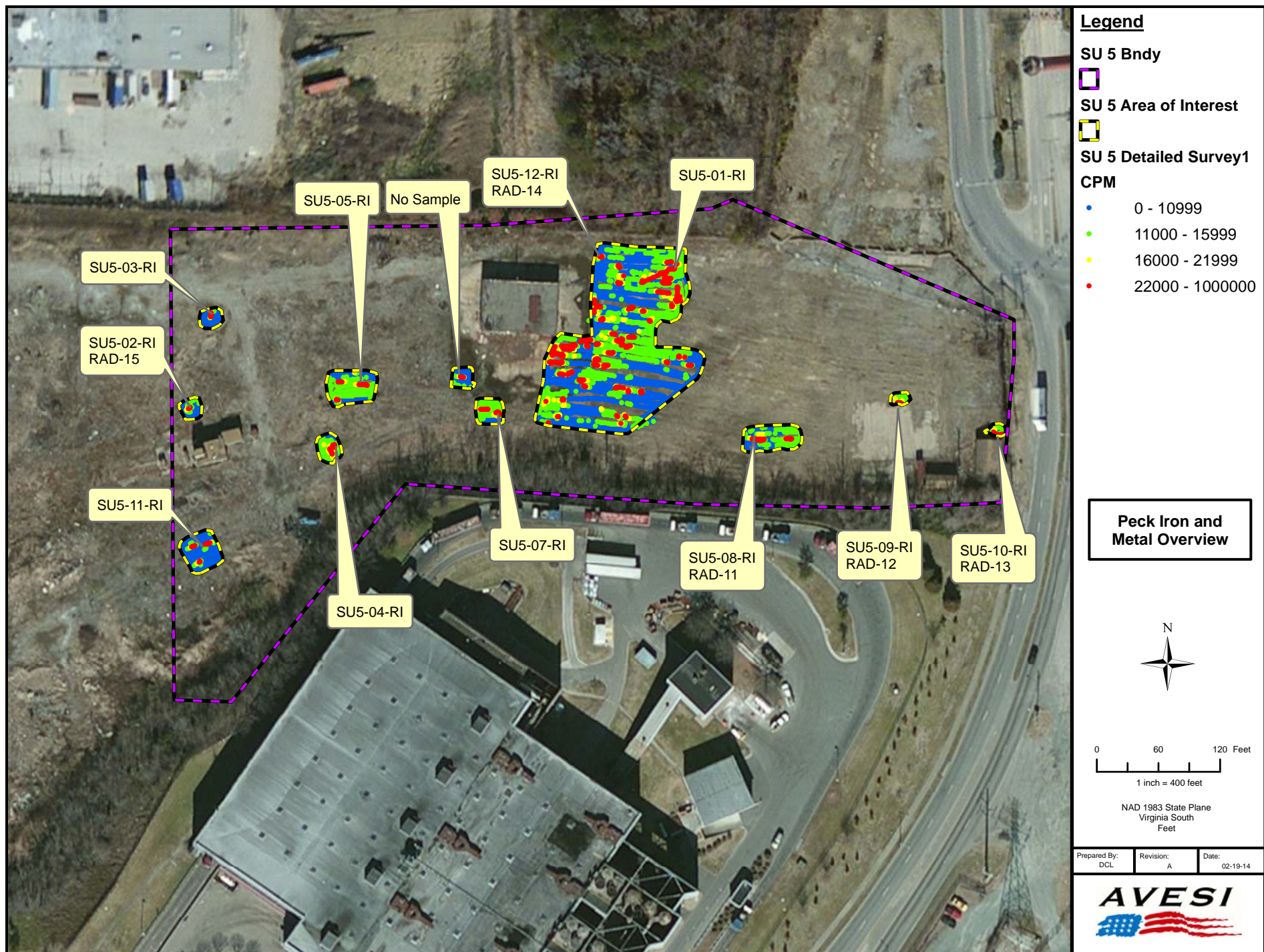


Figure 1-5: Peck Iron and Metal SU 5 Gamma Spectroscopy Sample Locations





**Figure 1-6: Peck Iron and Metal Discretionary Gamma Spectroscopy Sample Locations**



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**TABLES**



Table A: All Survey Units Sampling Summary

Rad Survey Flagged ID	Soil Sample ID	Gamma Spec Sample ID	Gamma Spectrum ID	Northing	Easting	44-10 CPM on Counting	Dose Rate on Contact (Micro Rem) BKG=13	Dose Rate @ 3 Feet (Micro Rem) BKG=13	Size (sqft)	Gamma Spectrum Sample Number (RI)	Spectrum Number	Object Description	Gamma Spec Dose Rate (µRem/hr)	Identified Radionuclide
SU1-01		SU1-01-RI	322	3461915	12124307	150K	140	15	>1	SU-1-01-RI	322	Small brown tubing	450	Radium 226
SU1-02		SU1-02-RI	324	3461951	12124304	210K	190	14	>1	SU-1-02-RI	324	Small brown tubing	450	Radium 226
SU1-03		SU1-03-RI	326	3461969	12124295	280K	28	16	>1	SU-1-03-RI	326	Small brown tubing	800	Radium 226
SU1-04	RAD-05	SU1-04-RI	328	3462000	12124298	550K	310	18	>2	SU-1-04-RI	328	Small tan tubing	1,600	Radium 226
SU1-05		SU1-05-RI	330	3461993	12124436	380K	420	18	>2	SU-1-05-RI	330	Small tan tubing	800	Radium 226
SU1-06		SU1-06-RI	332	3461881	12124360	290K	380	24	>2	SU-1-06-RI	332	Small tan tubing	1,500	Radium 226
SU1-07	RAD-04	SU1-07-RI	334	3461849	12124348	160K	180	24	>1	SU-1-07-RI	334	Small tan tubing	1,000	Radium 226
SU2-01		SU2-01-RI	302	3461396	12125595	210K	110	19	>1	SU-2-01-RI	302	Soil	210	Radium 226
SU2-02	RAD-02	SU2-02-RI	304	3461368	12125600	28K	39	10	>1	SU-2-02-RI	304	Metallic Chunks	500	Radium 226
SU2-03		SU2-03-RI(1)	304	3461363	12125581	310K	210	26	>1	SU-2-03-RI(1)	306	Piece of plastic like material	250	Radium 226
SU2-03		SU2-03-RI(2)	308	3461363	12125581	N/A	N/A	N/A	N/A	SU-2-03-RI(2)	308	Soil from around material	80	Radium 226
SU2-04		SU2-04-RI	301	3461350	12125572	85K	90	13	>1	SU-2-04-RI	310	Big chunk of metal	14,000	Radium 226
SU2-05		SU2-05-RI	312	3461375	12125561	100K	110	23	>1	SU-2-05-RI	312	Soil	35	Radium 226
SU2-06		SU2-06-RI	314	3461219	12125616	42K	45	14	>1	SU-2-06-RI	314	Soil	25	Radium 226
SU2-07	RAD-03	SU2-07-RI	316	3461078	12125614	700K	900	60	>2	SU-2-07-RI	316	Metallic Chunks	130	Radium 226
SU2-08	RAD-01	SU2-08-RI	318	3461328	12125614	150K	60	19	>1	SU-2-08-RI	318	Deck Marker	6,200	Radium 226
SU3-01		SU3-01-RI(1)	281	3461043	12124432	125K	120	14	>1	SU-3-01-RI(1)	281	Soil	8	Non Detect
SU3-01		SU3-01-RI(2)	283	3461043	12124432	N/A	N/A	N/A	N/A	SU-3-01-RI(2)	283	Device	3,800	Radium 226
SU3-02	RAD-07	SU3-02	285	3460829	12124100	290K	190	23	>2	SU-3-02-RI	285	Chunk of black material	1,700	Radium 226
SU3-03		SU3-03	287	3460814	12124115	185k	120	18	>1	SU-3-03-RI	287	Metal Device	3,600	Radium 226
SU3-04		SU3-04	289	3460719	12124180	200K	200	24	>1	SU-3-04-RI	289	Big Chunk	9,000	Radium 226
SU3-05	RAD-06	SU3-05	291	3460507	12124198	60K	60	14	>1	SU-3-05-RI	291	Clay Like Soil	430	Radium 226
SU3-06	RAD-08	SU3-06	293	3460590	12124449	100K	50	14	>1	SU-3-06-RI	293	Chunk of rock	1,000	Radium 226
SU4-01	RAD-10	SU4-01-RI	267	3461065	12124612	40K	40	14	>1	SU-4-01-RI	267	Large Gauge	100	Radium 226
SU4-02		SU4-02-RI	269	3460693	12124793	225K	110	14	>1	SU-4-02-RI	269	Small Button	1,700	Radium 226
SU4-03		SU4-03-RI	271	3460654	12124704	90K	50	14	>1	SU-4-03-RI	271	Small Button	1,350	Radium 226
SU4-04		SU4-04-RI	273	3460589	12124660	190K	100	15	>1	SU-4-04-RI	273	Small Button	1,150	Radium 226
SU4-05	RAD-09	SU4-05-RI	275	3460582	12124617	450K	210	20	>2	SU-4-05-RI	275	Small Button	3,600	Radium 226
SU4-06		SU4-06-RI	277	3460490	12124470	125K	130	14	>1	SU-4-06-RI	277	Chunk of corroded metal?	260	Radium 226
SU5-01		SU5-01-RI	238	3461056	12125417	<1000K	2900	170	6	SU-5-01-RI	238	Glass Bulb	3,000	Radium 226
SU5-02	RAD-15	SU5-02-RI	242	3460936	12124947	50K	40	14	>1	SU-5-02-RI	242	Deck Marker Badge	220	Radium 226
SU5-03		SU5-03-RI	244	3461023	12124966	225K	120	14	>1	SU-5-03-RI	244	Small Button	1,100	Radium 226
SU5-04		SU5-04-RI	246	3460896	12125082	250K	200	30	>1	SU-5-04-RI	246	Soil	130	Radium 226
SU5-05		SU5-05-RI	248	3460958	12125117	250K	200	20	>1	SU-5-05-RI	248	Deck Marker	6,700	Radium 226
SU5-06		N/A	N/A	3460968	12125212	60K	50	14	>1	SU-5-06-RI	N/A	N/A	N/A	N/A
SU5-07		SU5-07-RI	250	3460937	12125239	150K	300	18	>1	SU-5-07-RI	250	Small Button	1850	Radium 226
SU5-08	RAD-11	SU5-08-RI	252	3460904	12125501	<1000K	1000	150	6	SU-5-08-RI	252	Small piece of Plastic	50,000	Radium 226
SU5-09	RAD-12	SU5-09-RI	254	3460943	12125634	80K	40	14	>1	SU-5-09-RI	254	Small Button	2,400	Radium 226
SU5-10	RAD-13	SU5-10-RI	256	3460912	12125729	240K	280	15	>2	SU-5-10-RI	256	Deck Marker	6,500	Radium 226
SU5-11		SU5-11-RI	258	3460803	12124961	160K	60	16	>1	SU-5-11-RI	258	Small Button	2,500	Radium 226
SU5-12	RAD-14	SU5-12-RI	260	3461076	12126368	150K	220	14	>1	SU-5-12-RI	260	Wood and Metal	800	Radium 226
N/A	N/A	DISC-01-RI	341	12124116	3460423	11k	8	8	N/A	SU-5-01-RI	341	In-situ, Soil	8	Non-Detect
N/A	N/A	DISC-02-RI	344	12124152	3460340	11k	8	8	N/A	SU-5-02-RI	344	In-situ, Soil	8	Non-Detect