

D&D Procedure
CHARACTERIZATION/LICENSE TERMINATION PROCEDURE

**GAMMA SURVEY USING THE ERG MODEL 104G GPS ARRAY WITH LUDLUM
44-10 DETECTORS**
ZS-LT-300-001-007
Revision I

Preparer: (Print name / sign): Robert Yetter III *Rob Yetter* Date: 10/18/2021
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VP Regulatory Affairs or Designee has reviewed and determined required program & regulatory reviews (*new procedures only*): SIGNATURE _____ DATE: _____	
Regulatory Required Reviews (per AD-11, "Regulatory Reviews")	
Part 72 ISFSI Impact License: 10 CFR 72.48	<input type="checkbox"/> YES <input checked="" type="checkbox"/> NO
Part 50 License: 10 CFR 50.59 and 50.90	<input type="checkbox"/> YES <input checked="" type="checkbox"/> NO
Fire Protection: 10 CFR 50.48(f)	<input type="checkbox"/> YES <input checked="" type="checkbox"/> NO
Conditions of License: E-Plan: 10 CFR 50.54(q)	<input type="checkbox"/> YES <input checked="" type="checkbox"/> NO
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Approval Section	
DEPARTMENT MANAGER: <u>Sarah Roberts</u> <i>Sarah Roberts</i> DATE: <u>10/18/21</u> Print Name / Signature _____	
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GAMMA SURVEY USING THE ERG MODEL 104G GPS ARRAY WITH LUDLUM 44-10 DETECTORS

1. OBJECTIVE

- 1.1 This procedure details the use of the Environmental Restoration Group, Inc. (ERG) GPS Array configured with Ludlum 44-10 NaI(Tl) detectors and provides direction on how to perform gamma array surveys at the Zion Station Restoration Project (ZSRP).
- 1.2 It implements the survey portion of ZS-LT-07 “*Survey Plan for Discrete Radioactive Particle Identification and Remediation*”. The plan focuses on the detection of discrete radioactive particles (DRP) containing radionuclides that emit gamma radiation.
- 1.3 A 62-inch wide array of six Ludlum Model 44-10 2”x2” NaI(Tl) detectors are mounted on a Utility Terrain Vehicle (UTV), with two detectors at the end and 4 spaced equidistantly in between. The center of the detectors are placed 12.4 inches apart at 2.75 inches above the ground. At a scan speed of 0.25 m/sec, the detector moves 9.8 inches during the 1-second sampling interval.

2. REFERENCES

- 2.1 TSD 21-001, “*Calibration and Discrete Radioactive Particle Detection Sensitivity and Performance Assessment for a Ludlum 44-10 Six-Detector Array*”
- 2.2 ZS-QA-10, “*Quality Assurance Project Plan*”, Revision 12, July 2012.
- 2.3 ZS-LT-07, “*Survey Plan for Discrete Radioactive Particle Identification and Remediation*”, Revision 0, October 2021.
- 2.4 ZS-LT-01, “*Quality Assurance Project Plan (QAPP) for Characterization and Final Status Survey*”, Revision 7, September 2019.
- 2.5 ERG User Guide: *Setup and Operation of the ERG Model 104G (GPS Array System) Revision: 1.*
- 2.6 Ludlum Model 44-10 *Gamma Scintillator Manual*, September 2015.
- 2.7 Ludlum Model 4612 *12-Channel Counter Manual*, November 2019.

2.8 ZS-RP-JA-011, "Use of the M3/M12-44-10 Gamma Detector for Discrete Radioactive Particles", Rev. 2, October 2017.

3. EQUIPMENT

- 3.1 ERG Model 104G GPS Array System
- 3.2 NaI(Tl) detectors, 2" (Ludlum Model 44-10 or equivalent).
- 3.3 Quality Control (QC) check source R171-H or equivalent.
- 3.4 Ruggedized notebook computer or equivalent with USB port
- 3.5 ERG scanning software.
- 3.6 USB removable drive.

4. PRECAUTIONS

- 4.1 Battery Safety

WARNING HEADER

Do not attempt to use any charger not rated for the battery specifications.
An incorrectly charged battery can cause explosion or fire.

- a. Never attempt to open or access the cells of the sealed lead acid battery. Doing so may pose a health hazard.
- b. Always check the polarity of the cables before connecting the wires. Incorrectly connecting the battery to the inverter will cause damage to one or more devices.
- c. Do not use or store the battery inside a hot area or in direct sunlight. If battery is being utilized in warmer temperatures, ensure the battery is properly shaded to prevent overheating.
- d. Do not charge the battery if it appears to be damaged or if the charging light stays red for more than a 36-hour period.
- e. Always charge the battery in a well-ventilated area to prevent hydrogen buildup.

- 4.2 The meter channels and each detector are calibrated as a pair, do not use if the detector does not match up with the meter channel as depicted on the calibration sheet (Reference 2.1).

5. DISCUSSION

This procedure applies to surveys performed over all ground surfaces. This procedure is not intended to quantify radioactivity on or near the surface, but to identify localized areas that are outliers relative to the remainder of the area. Areas identified as outliers will require follow-up investigation to determine specific radionuclides and quantification of activity.

The Model 104G is a GPS mapping system for performing outdoor gamma radiological scans. The Model 104G consists of an electronics hardware interface box (interface box) and accompanying computer. The system contains all the necessary equipment and software to acquire position correlated radiological scan data from ground surfaces and export the data for processing using a variety of applications.

The Model 104G uses an off-the-shelf Ludlum Model 4612, a 12-channel counter that may be used with up to 12 detectors simultaneously. The Model 104G positioning system uses a single Trimble GPS receiver and antenna combined with a high accuracy inertial measurement unit (IMU). The Ludlum Model 4612, Trimble GPS receiver, and the IMU are integrated using an on-board laptop computer running the ERG scanning software.

6. INSTRUCTIONS

6.1 Equipment Set Up

- 6.1.1 The Model 4612 counter is mounted inside the electronics hardware box to protect it from moisture and dust. All detector cables must be routed through the large circular port on the front of the box.

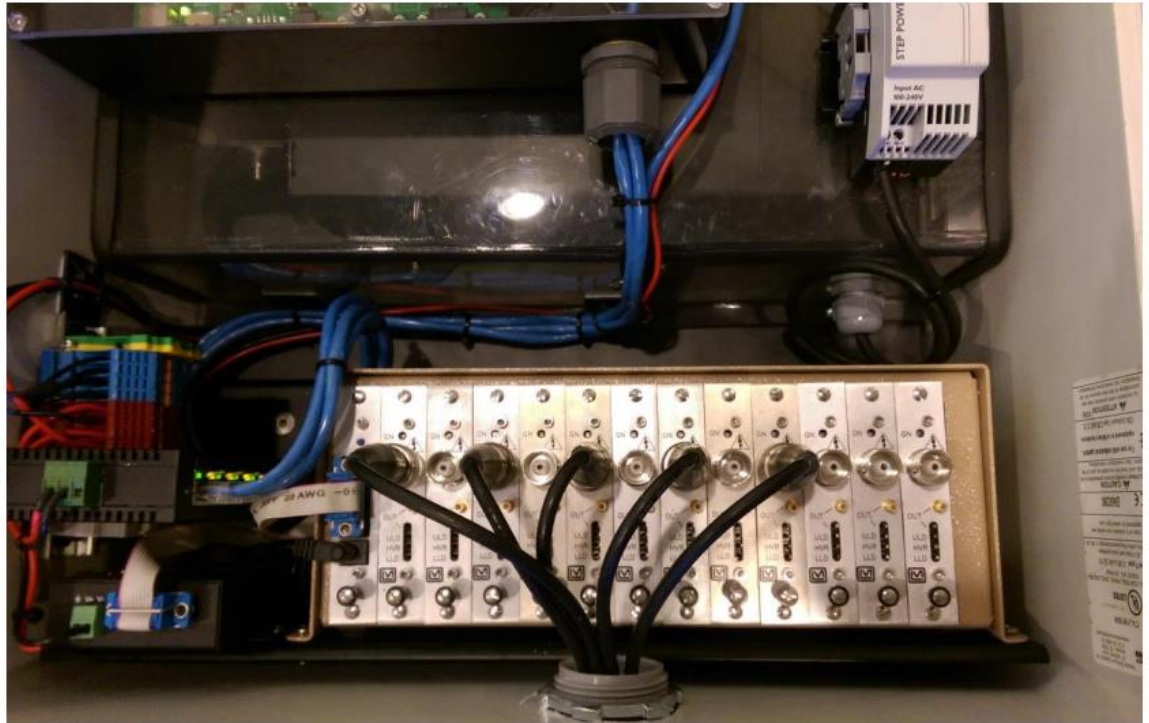


Figure 1 Connecting detector cables to the Model 4612

- 6.1.2 Prior to routing the cables through this port, label both ends of every detector C-cable with a unique detector or channel number to ensure all detectors are connected to their proper Model 4612 channel (e.g., detector 1 to zone 1, detector 2 to zone 2, etc..).
- 6.1.3 To feed the cables through the box, the plastic grommet must be unscrewed completely to release the pressure on the internal rubber seal.
- 6.1.4 Refer to Section 6.2 for the procedure on how to assign specific detectors to Model 4612 channels.
- 6.1.5 The Model 104G uses a common 12-volt direct current (DC) connection. Power may be supplied through direct connection to an auxiliary battery or through a 12-volt port, such as an automotive cigarette lighter port.
- 6.1.6 Ensure the power cable is properly connected to the power supply. If directly connecting to a battery, ensure the connections are tightened properly to prevent loosening during rough terrain.
- 6.1.7 All Model 104G components are powered by an internal inverter. The inverter is turned on by the power switch located on the side of the interface box.

- 6.1.8 The power button must be held for longer than one second to power on the box. A LED light above the power button will turn green when the interface box is powered on.



Figure 2 Interface box power button, Ethernet port and AC power outlet



Figure 3 Battery voltage LED display

- 6.1.9 Similarly, to power off the box, hold the button for two seconds until the green LED light turns off and a short beep is heard. A LED display on the inverter located inside the box will display the voltage of the battery and is viewable through a small window on the side of the box.

- 6.1.10 It is recommended the battery be recharged when the voltage drops below 12 volts. When the voltage gets dangerously low, the box will make a continuous audible beep. If this beep is heard, the survey file should be saved, the software program closed, and the box powered off to prevent an accidental loss of survey data.
- 6.1.11 The Model 4612, GPS controller, and IMU use a TCP based protocol for communication with the control computer.
- 6.1.12 Connect the interface box to the control computer using a standard CAT5 or CAT6 Ethernet cable.
- 6.1.13 Attach the survey array frame to the UTV using the rear mounted 2" receiver hitch.
- 6.1.14 The 6 Ludlum 44-10 NaI detectors must be attached to the survey array. The center of the detectors must be positioned at 12.4" apart.
- 6.1.15 The detectors must be positioned so that the detector end-cap will be 2.75" above the ground surface. This results in a distance of 4" from the ground surface to the center of the detector.
- 6.1.16 Detector 1 must be positioned on the right side of the array in the direction of travel.
- 6.1.17 The other detectors should then be positioned in numerical order from Detector 1.
- 6.1.18 Connect the cables from the Model 4612 to the correct detector.
- 6.2 Operation of the Model 4612 Interface Application
 - 6.2.1 The Model 4612 Interface program is installed as part of the GPS Array software suite and provides the ability to set up equipment and perform quality counts.
 - 6.2.2 Open the Model 4612 Interface application. The application uses a database to store all instrument information as well as quality control counts and daily instrument function check counts.
 - 6.2.3 Prior to assigning instruments and performing counts, a project database must be created.
 - 6.2.4 From the **File** menu, **Project** submenu option, select the **Create New Database** to create a new project database.

- 6.2.5 Enter a name specific to the project and click '**Create**' button. Click the '**Yes**' button when the application asks if you would like to set the database to the current project.

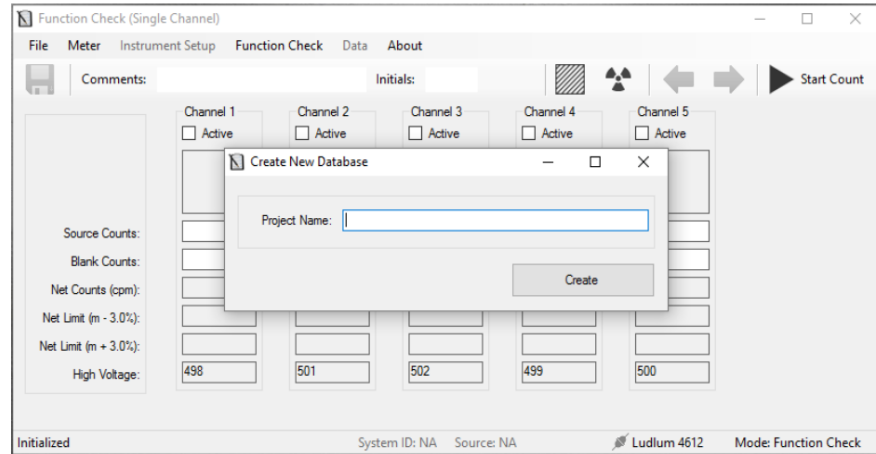


Figure 4 Creating a new project database

- 6.2.6 After creating the database, it is necessary to define all detectors being used with the Model 104G.
- 6.2.7 Prior to adding detectors, you must define the number that will be used. From the **File** menu select the **Settings** submenu and set the **Active Detector Zones** to the number of detectors that will be used, in this case 6 detectors are being used.
- 6.2.8 Click on the '**Save**' button. Restart the application to save any changes made.
- 6.2.9 From the **Instrument Setup** menu select the **Add/Edit – Meter/Detector** submenu option. From the **Equipment Type** drop down menu choose either **Ratemeter** or **Detector** as appropriate and enter all the required information.
- 6.2.10 Once entered, click the '**Save**' button to save it to the database. Once saved, the instrument (Model 4612 or detector) will appear in the table view. Repeat this step for every Model 4612 or detector that will be used, and then when finished close this window.

addequipment

Equipment Type:

Equipment Name:

Serial Number:

Calibration Date:

	ID	Type	EqName	SerialNumber	CalibrationDate
▶	1	Ratemeter	4612	254665	10/12/2015
*					

Figure 5 Adding new instruments

6.2.11 From the **Instrument Setup** menu select the **Define System ID** option.

NOTE:

This step is extremely important because the GPS surveying application will use this data to determine how data are assigned to specific channels.

6.2.12 Select the appropriate channel and define the Model 4612 counter channel (1 through 12) and detector serial number for each channel. In this case there are 6 detectors and 6 channels being used. The calibration certificate defines which detector has been assigned to which channel.

NOTE:

Take extra care to ensure that channel 1 is always on the right side of the array with respect to the direction of travel.

6.2.13 Once all detector and meter pairings are defined, enter a System ID to be used for the array. This number will ensure differentiation between scan data and quality count data when all data are being analyzed together. In this case, there is only 1 system being used and therefore the System ID is 1.

6.2.14 Click the **Define System ID** button to save all the settings.

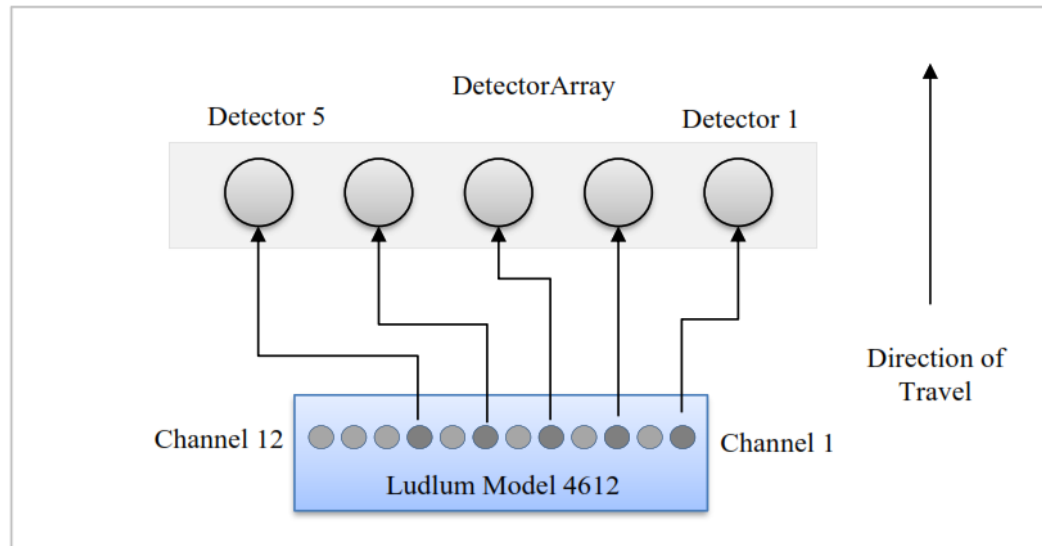


Figure 6 Example of meter and detector pairing

6.2.15 From the **Instrument Setup** menu select the **Add/Edit – Source** submenu option and add all radiological check sources that will be used for quality control counts and function checks.

6.2.16 Enter all the source information and click on the **Save** button.

6.2.17 The check source selected for this project is R-171H. It is a NIST traceable Cs-137 source. Its initial activity was 0.919 microcuries on 1 July 2013.

6.2.18 From the **File** menu select the Settings submenu and set the System ID previously defined and the radiological check source that will be used for function checking.

6.2.19 Click the **Save** button and ensure that the status bar shows the correct System ID and radiological check source.

6.3 Performing Initial Quality Control Counts

- 6.3.1 From the **Instrument Setup** menu select the **Perform Initial Counts** submenu option to perform initial Quality Control (QC) counts. Enter the number of one-minute counts to be performed for each detector in the textbox.
- 6.3.2 The initial baseline value shall be determined by obtaining at least 10 count rate values. The average of the 10 values will be used as the baseline value. The initial baseline values shall be recorded on Attachment 1 with "initial" in the comment field.
- 6.3.3 Record the baseline average value and source serial # at the top of Attachment A. Calculate and record the +/- 20% acceptance values on Attachment 1.
- 6.3.4 A minimum of 10 QC counts should be selected. With this setting 10 one-minute QC source counts and 10 one-minute background counts will be made for each detector.

NOTE:

For use of the survey program the terms 'blank' and 'background' are used interchangeably. It should be noted that background is representative of the detector without regard to a survey matrix (concrete, soil, etc.) and blank is background with regards to a specific survey matrix.

- 6.3.5 Click the **OK** button to start the quality control counts. A form showing the source and blank counts for each detector will appear in a new window, as shown in Figure 8. This window may be resized and moved so both the function Check form and Quality Counts form can be seen simultaneously.
- 6.3.6 On the Function Check form, enter the technician initials.

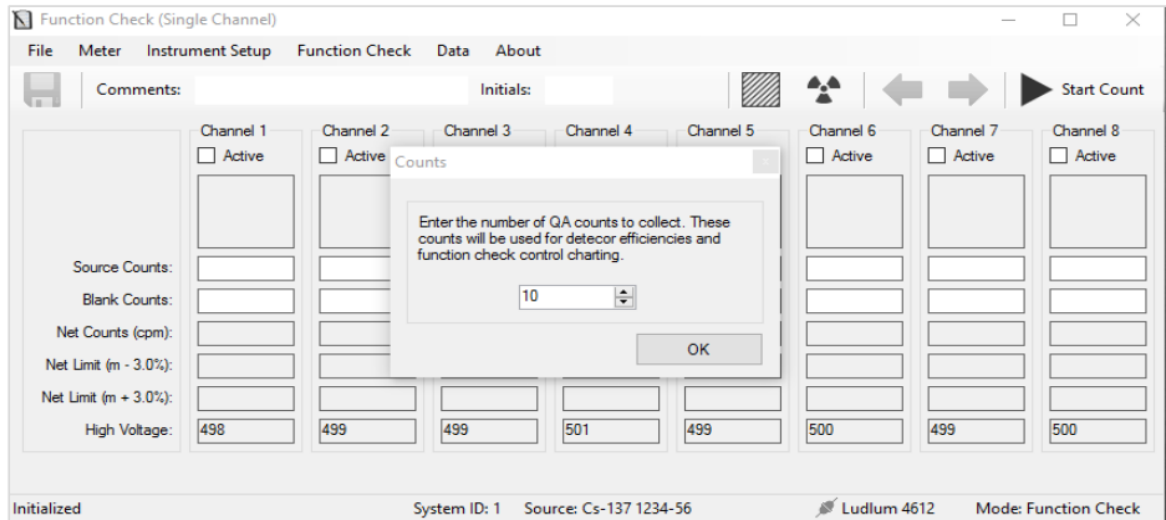


Figure 7 Performing Initial Quality Counts

Channel 1			Channel 2			Channel 3			Channel 4		
N	Source	Blank	N	Source	Blank	N	Source	Blank	N	Source	Blank
1			1			1			1		
2			2			2			2		
3			3			3			3		
4			4			4			4		
5			5			5			5		
6			6			6			6		
7			7			7			7		
8			8			8			8		
9			9			9			9		
10			10			10			10		

Channel 5			Channel 6			Channel 7			Channel 8		
N	Source	Blank	N	Source	Blank	N	Source	Blank	N	Source	Blank
1			1			1			1		
2			2			2			2		
3			3			3			3		
4			4			4			4		
5			5			5			5		
6			6			6			6		
7			7			7			7		
8			8			8			8		
9			9			9			9		
10			10			10			10		

Figure 8 Initial Quality Count Data

6.3.7 From the tool bar select the **Blank** tool to activate all channels, and then click the **Start Count** button to start the counting process. Each channel will count simultaneously until all quality counts have been obtained.

- 6.3.8 The QC source counts must be obtained individually per detector, unlike the background counts. Click the **Source** tool to activate channel 1 and indicate that a radiological check source is being used in the count.
- 6.3.9 Position the designated QC check source on the correct detector. The location of the check source as placed on the detector shall be marked, or a jig utilized, to allow for reproducibility of geometry on subsequent days.
- 6.3.10 Click the **Start Count** button to begin the QC source counts. When complete, use the left-right arrows to toggle between channels, and then repeat the counts until all QC source counts for all detectors have been obtained.

NOTE:

If at any point the process must be interrupted, or if an error occurs, the data can be recovered by using the **Last QA** option located in the **File** menu **Restore** submenu. This option will only restore counts in the channels that have obtained the specified number of quality counts.

- 6.3.11 Once complete, click the **Save** tool to save the quality control counts.
- 6.3.12 Once all quality counts have been obtained, an upper and lower threshold must be set to ensure that all succeeding function check counts fall within the permitted range.
- 6.3.13 For this project the upper threshold should be set at a value of 20% above the mean value. The lower threshold should be set at a value 20% below the mean value.
- 6.3.14 The threshold setting may be set from the **File** menu. Select the **Settings** option. Enter a threshold value in the '*Flag values that exceed*' textbox and select the *percent* checkbox.
- 6.3.15 Click the **Save** button to save the settings. Upon restarting the application, the Net Limit text boxes will be populated with the upper and lower bounds of the quality assurance counts. For example, if a threshold of 20-percent was defined, the lower limit will be the mean of the net total QA counts minus 20-percent of the net mean. Similarly, the upper bound will be the net mean of all counts plus 20-percent of the mean.

6.4 Performing a Function Check

- 6.4.1 When necessary, a function check may be performed to ensure that the meter and detectors are functioning properly.
 - 6.4.2 At a minimum, function checks shall be performed at the beginning and end of each workday.
 - 6.4.3 Open the Model 4612 Interface application. Enter technician initials and any comments.
 - 6.4.4 Click the background toolbar to activate all channels and click the **Count** tool.
 - 6.4.5 Position the designated QC check source on the correct detector. The location of the check source as placed on the detector shall be marked, or a jig utilized, to allow for reproducibility of geometry on subsequent days.
 - 6.4.6 When complete, click the **Source** tool to select the active channel and click the **Count** button again.
 - 6.4.7 Repeat the steps for each channel until all source and background entries are complete.
 - 6.4.8 If a count does not meet the defined threshold, the blank or net counts textbox will turn red.
 - 6.4.9 The value obtained from the daily source checks shall be recorded on Attachment 1 and verified to be within the acceptance criteria.
 - 6.4.10 Failure of the daily source check requires notification and approval of the Project Manager prior to using the instrument to collect survey data.
 - 6.4.11 Once complete, click the **Save** tool to save the function check entry.
 - 6.4.12 Return the QC check source to its designated storage area.
- 6.5 Operation of the GPS Array Software
- 6.5.1 Initial Setup
 - a. Once installed, connect the laptop to the GPS Array interface box and apply power by holding the on switch momentarily.
 - b. Start the GPS Array application. The application may prompt for the location of the detector database.

- c. If prompted, select the “Zion Due Diligence Survey” database that was created during the initial setup of the 4612 Interface application.
- d. Prior to obtaining positions, a coordinate system must be defined so the application can properly project background files.
- e. To set the coordinate system click the **Settings** tool – **Coordinate Projection – Set**. The coordinate system must be a projected coordinate system and must be in units of feet or meters.
- f. The Coordinate Projection for the Zion site is the “*NAD_1983_StatePlane_Illinois_East_FIPS_1201*”.
- g. The GPS receiver must be disconnected through the **Setting** menu before the coordinate system can be modified.
- h. Click the apply button to set the coordinate system and restart the application if prompted.
- i. The array parameters must also be defined initially prior to surveying. Open the project settings form in the **File** tool as shown in Figure 9.
- j. When the database channel mapping box is checked, the number of detectors and their corresponding ports on the meter will be queried from the database previously defined.
- k. The number of channels may also be manually chosen by turning off the channel mapping option.
- l. Enter the array length by measuring the distance between the detectors at each end of the array. Extreme care should be taken to ensure this value is correct, otherwise individual detector positions may be incorrect.
- m. Click the **Save** button to apply the settings.

GPS Array Settings

System ID: 1

Beep when scaler counts are >: 450 CPS Test

Use Database for Channel Mapping

Active Channels: 6

Array Length: 6 Detector to Detector (Feet)

Meter Port:

GPS Receiver: ERG

GPS Receiver Port: TCP Port

Filter Variance: 0.01 IMU Sensitivity: 2 ?

Line Size: 2 Line Color: [Black]

Position Size: 2 Position Color: [Black]

Shape Point Size: 4 Point Color: [Black]

Map Display Mode: Scaler Ratemeter

Save Cancel

Figure 9 Defining the array parameters

6.6 Performing a Survey

- 6.6.1 The GPS Array software is used to view, collect, and analyze spatially correlated radiological data with superior accuracy and data quality.
- 6.6.2 Using this application, the position and orientation of the array, and collected radiological data are viewed in real-time. In addition, the application provides the ability to apply a legend to background and survey data to provide real-time detection of anomalies.
- 6.6.3 The GPS Array application interface is shown in Figure 10.
- 6.6.4 The application contains three primary interfaces, including the map window, the project toolbar, and the map toolbar.



Figure 10 GPS Array Software Interface

6.6.5 Initializing a Position.

- a. To initially define the heading, open the GPS Array application and wait until enough satellites are acquired to do GPS fixes as indicated in the status bar in the lower left-hand corner of the interface.
- b. For this project, a minimum of 3 satellites must be acquired
- c. Drive in a straight line in the forward direction at a speed of greater than 0.3 meters/second until the on-screen array is properly aligned with the direction of travel. The heading lock should take no longer than a second or two to complete.
- d. If the heading needs to be redefined, the current lock may be cleared by clicking **Clear Heading** tool in the **Settings** toolbar.

6.6.6 Defining a Legend

- a. The legend can be used to assign specific colors to defined ranges of count rate data.
- b. Although the array system records both ratemeter and one-second scalar data, only the ratemeter will be evaluated and displayed using the legend.
- c. To apply a legend, open the **Legend** window from **Settings – Legend**. The thresholds and associated colors will be shown.

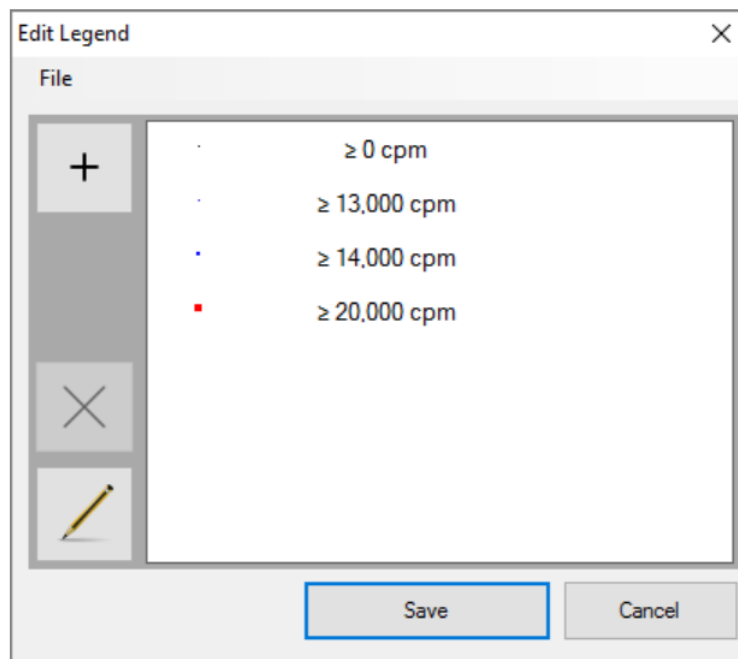


Figure 11 Defining a map legend

- d. To add a new legend break, click the **Add** button.
- e. Enter the new threshold, desired point size, and the color, then click **Save**.
- f. The threshold is defined as the count rate at which the data will be colored if it is equal to or exceeds the value.
- g. To edit an existing break, click on the break you wish to edit, and click the **Edit** button.
- h. Make the necessary changes to the threshold, point size, or color and click the **Save** button to apply changes.

- i. The default map point will be defined by the ≥ 0 cpm break. The color and size of the point may be modified, but the threshold must be zero, and the break may not be deleted.
- j. Once the legend is defined, click the **Save** button to apply changes.
- k. The legend changes will be applied and will be displayed in the lower right-hand corner of the map window.
- l. To turn the legend on or off, click the **Show Legend** tool in the **Settings** toolbar. Note that this option will only remove the legend from the window, but thresholds will still be applied to the data.
- m. The legend will be applied to both the background layers and the real time data.
- n. The legend breaks will be ordered from smallest to largest values when being drawn on the map. This allows the larger, and typically more important values, to be more visible when viewing the data that are on top of each other spatially.
- o. To maximize mapping performance, the software will combine pixel data when data are clustered together so multiple points at the same location do not get drawn continuously.
- p. To prevent masking the data that are higher in value, the software will always place priority on drawing the highest legend value.
- q. It is extremely important to note, however, that the other legend break colors may not be visible when zoomed out too far.
- r. If multiple legends are being used, use the menu in the legend editor to save and recall legends.

6.6.7 Creating a Survey File and Collecting Data

- a. Prior to collecting survey data, a file must be created that will store all the records.
- b. To create a file, click on the **Create File** tool from the **File** menu.

- c. A **Create New Survey File** dialog box will be displayed as shown in Figure 12.

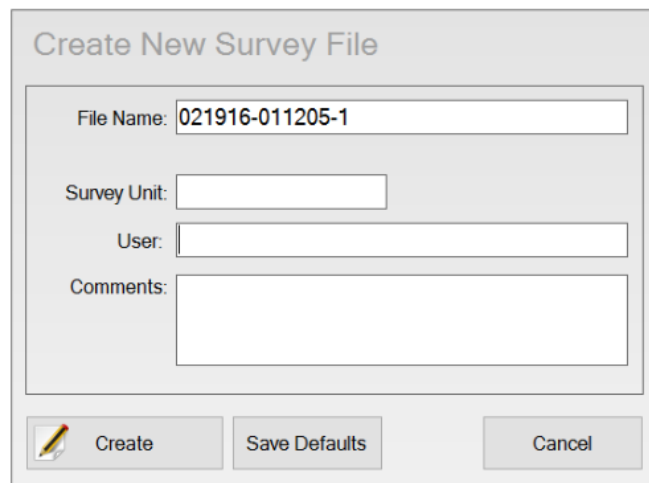


Figure 12 Creating a survey file

- d. The filename will be automatically created using the date, time, and the system ID of the array system. Record the file name on Attachment 2.
- e. If desired, add additional information to the beginning of the filename string, however it is highly recommended that the numerical fields are not modified.
- f. Enter additional information in the following textboxes:
- the survey unit,
 - the technician performing the survey,
 - and any additional comments.
- g. Click the **Create** button to create the file.
- h. Once a survey file has been created, survey data may be collected. Recall that prior to collecting data, the heading must be initialized as discussed in Section 6.6.5.
- i. Click the **Collect** tool to start collecting data. Logged data will appear on the map in real time as individual points. The total number of records logged to the file is also shown in the status bar.

- j. Surveys will be performed by driving in lines or “strips”. The pattern to be driven must be planned and recorded on the survey file map.
- k. Surveys will be performed by driving each planned strip at a speed of approximately 0.25 m/s. The survey scan speed is displayed in the Mapping Tools section of the Map Window.
- l. The desired scan speed is 0.25 m/s. If 0.25 m/s cannot be maintained due to survey conditions, it should be recorded on the Survey Record Sheet (Attachment 2).
- m. Click the **Collect** tool to start collecting data. Logged data will appear on the map in real time as individual points. The total number of records logged to the file is also shown in the status bar.
- n. The actual scan MDC can be determined from the recorded scan speed in the saved data file in post processing.
- o. Alarms and anomalies will be investigated in accordance with ZS-RP-JA-011, “*Use of the M3/M12-44-10 Gamma Detector for Discrete Radioactive Particles*”.
- p. To pause the data collection, press the **Stop** tool.
- q. When surveying is complete, close the file by clicking the **Close** tool in the **File** menu. Once a file is closed, it may not be reopened to append data, however, all collected files may be opened as background layers.

6.6.8 Adding Background Layers

- a. The ability to add background files is an important feature that may be used to specify survey transects or to see where previous surveys have been performed.
- b. The application allows previous *gsf* survey files (ERG Geographical Survey File), or ESRI shapefile (.shp) files to be loaded as background layers.
- c. As discussed in previous sections, the same legend that is active on the map will be applied to the *gsf* survey files that are loaded as background layers.
- d. This greatly simplifies the process of navigating back to anomalies or areas of concern based on survey data alone.

- e. A shapefile may be a line, polygon, or point feature set. Note that when a point feature set is loaded, the map legend will not be applied to the shapefile data.
- f. To add or clear a background layer, use the **Layers** tool bar. Up to 10 layers be added to the map and all coordinate systems will be re-projected into the active coordinate system if it differs.

6.6.9 Notifications and Alarms

- a. The software employs several different notifications and alarms to minimize errors and assist in the real-time detection of elevated counts. An audible alarm may be set to beep when the counts in a one-second counting interval exceed some threshold.
- b. To set the audible alarm, open the **Project Settings** from the **File** menu and click the **General** tab.
- c. Check the '**Beep when scaler counts are \geq** ' and set the desired threshold. Note that the threshold will be the number of integrated counts in one second. This value is different than the ratemeter value obtained in the same second and is provided as a method for detecting small changes that occur in counts that may otherwise be undetectable.
- d. The application also has an alarm that is intended for determining when a count appears to be lower than the operating count range. This alarm is useful when an unexpected event, such as a bad cable, broken crystal, or malfunctioning meter occurs while surveying. If one or more detectors returns an abnormally low number of counts, the application will make a short beep and the error symbol will appear in the tool bar.
- e. Click the error symbol to view more information about the specific error. A similar audible beep will also occur if the Ludlum 4612 or GPS receiver returns an unexpected error.

6.6.10 Meter Count Rate Display

- a. At times, it is desirable to view the count data from the Ludlum 4612.
- b. To view the raw data, click the **View Data** tool in the **Settings – Meter** menu.

- c. The data from all channels will be displayed in both ratemeter counts (top) and one-second scalar counts (bottom).
- d. The data control may be left open while surveying and may be moved to a location that still allows spatial data to be viewed. Because channel 1 will always be on the right from a surveyor's perspective, the **Switch Perspective** button allows counts to be oriented with the array configuration.

6.7 Survey Data Management and Export

6.7.1 The GPS Array software is used to view, collect, and analyze spatially correlated radiological data with superior accuracy and data quality.

- a. All log files created by the Model 104G are saved in a binary file format for integrity and write speed.
- b. It is necessary to use the included software to view the data in a meaningful format.
- c. The ERG GSF File Manager (Local Mode) software is included with the GPS Array survey software and provides the ability to perform data calculations as well as view and export data.
- d. The Local Mode version of the software is intended to be used as an analysis tool in the field to view and locate measurements of concern.

6.7.2 Open the ERG GSF File Manager software from the same directory as the GPS Array survey software. The program will consist of several menus and tools, a layer window, and a map window.

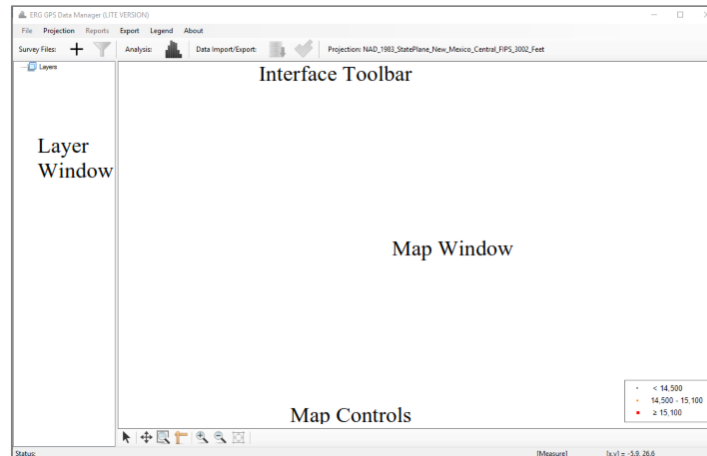



Figure 13 ERG GSF File Manager Interface

- a. Add files by clicking the  tool.
- b. Each added file will appear in the Layer Window. Double click on an individual layer to view the survey information about the file.
- c. Right click on a layer to get additional options.
- d. A list of each layer option and its action is described below.
 1. Zoom to Layer – Zooms to the selected layer. Use the map control tool View Extents to view all data.
 2. Remove Layer – Removes the selected layer.
 3. Layer Properties – This will display the file information such as system ID, channel, zone, building, SU, user, comments, and the number of records in the file.
 4. Double clicking on the layer will also perform this action.
 5. Attributes – The Attributes menu will open a data table consisting of all the raw records logged during the survey. Individual columns may be sorted by clicking on the column header.

6.7.3 ERG GSF File Manager Analysis and Results.

- a. The GSF File Manager application may be used to view statistics about multiple survey files while in the field. Up to ten survey files may be added to the map and viewed simultaneously.
- b. The legend will be set to the same legend that is active while using the GPS Array software.
- c. Care should be taken when modifying the legend because any changes made in the Data Manager application will be updated in the GPS Array application.
- d. Click the histogram tool to view statistics about all the data currently added to the project.
- e. A histogram window will be displayed as shown in Figure 14.

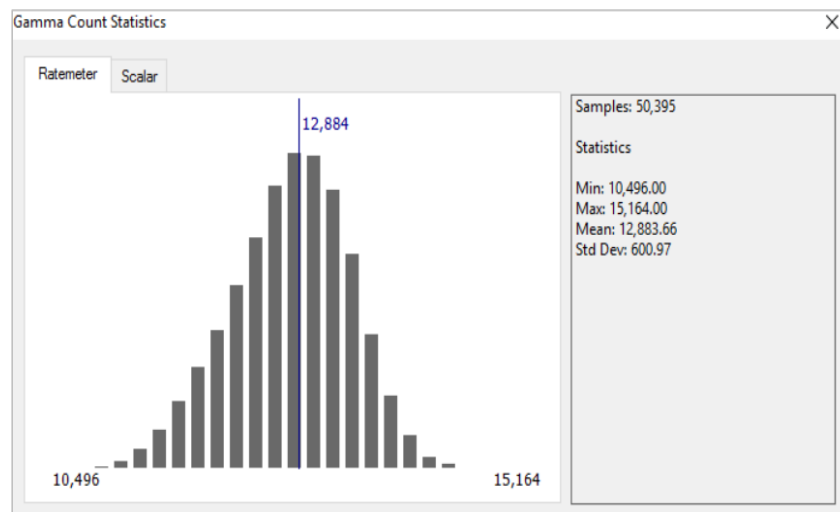


Figure 14 Gamma Count Statistics Window

- f. Use the tabs to switch between the statistics for ratemeter count rate data, and integrated scaler data.
- g. Click and drag the vertical blue bar in the histogram window to view the counts at different locations.

6.7.4 ERG File Export Utility

- a. The ERG file Export Utility is included with the GPS Array survey software package. The File Export Utility handles the copying of data from the field computer.
- b. Exporting Data
 1. At the end of each survey day, typically after the final function check or at any other desired frequency, place a standard USB disk drive into the project computer and open the File Export Utility.
 2. The software will display the discovered survey files on the computer as well as the database used for function checking the equipment as shown in Figure 15.

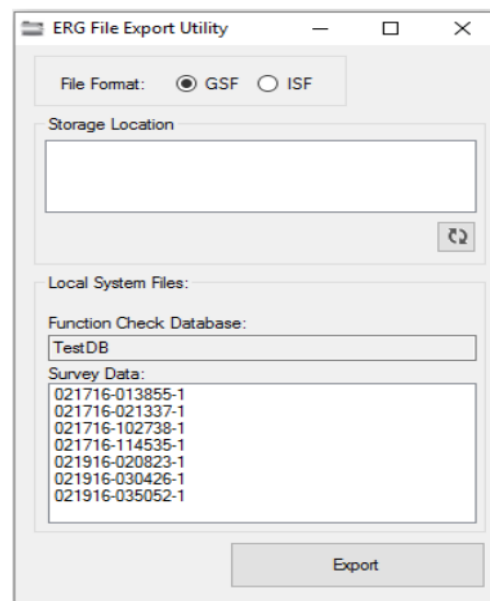



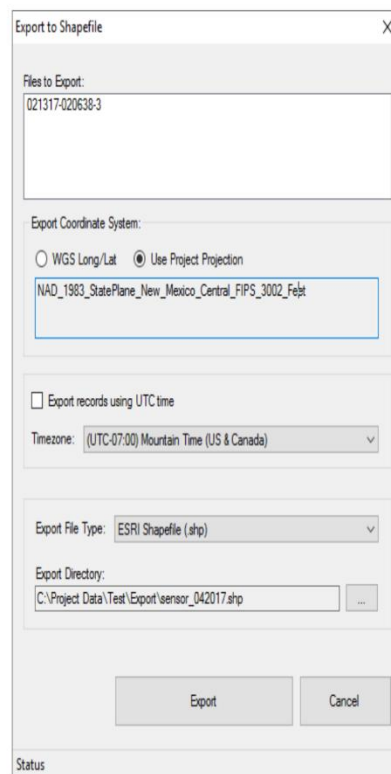
Figure 15 ERG File Export Utility

3. Click the **Export** button to export all applicable data to the disk drive.
4. During the export process, the software will only copy files that have not previously been copied. In addition, the size of database will be checked to ensure that only newer databases are maintained, and a backup of the old database will always be maintained on the drive.

5. When complete, a summary of the files transferred will be displayed.
6. Close the application and remove the drive using the standard method for ejecting removable drives.

6.7.5 Data Export

- a. Following all required analysis, the summarized analysis can be exported in either comma separated or shapefile format.
- b. The export file will combine all layer files and include both the ratemeter and one-second scalar data.
- c. Click the  tool to export the data as a shapefile or csv file.
- d. An export window will appear as shown in Figure 16.



- e. Choose the desired coordinate system and the desired time to export each record.
- f. Select the 'use UTC time' check box, the default GPS time will be used for each record.

- g. Click **Export**.
- h. Once saved, the file can be opened in a third-party application for data reporting, such as ArcGIS.

7. FORMS AND ATTACHMENTS

- 7.1 Attachment 1: Daily Source Check Form
- 7.2 Attachment 2: Gamma Scan Survey Form
- 7.3 Attachment 3: Typical Scan Survey Data Map

8. SUMMARY OF CHANGES

ZS-LT-300-001-007 Revision 1, changed references from ZS-LT-06 to ZS-LT-07.

Attachment 1
Daily Source Check Form

Instrument S/N: _____ Probe S/N: _____

Baseline Average: _____ cpm Source S/N: _____

Acceptance Criteria: _____ (-20%) cpm to _____ (+20%) cpm

Date	Response (cpm)	Acceptable (Y/N)	Comment	Technician Initials

Attachment 2
Gamma Scan Survey Form

Section 1: Survey Parameters

Survey File Numbers:	
Survey Unit:	
Description:	
Survey Date/Time:	
Technician:	

Section 2: Comments/Diagram

Attachment 3

Typical Scan Survey Data Map

