SYSTEM 2000 USER MANUAL

MAINTENANCE AND OPERATION INSTRUCTIONS
WITH
PARTS BREAKDOWN

Expendable Unattended Ground Sensor (E-UGS) System

Revision A

WARNING – The US Department of Commerce, Bureau of Industry and Security, has classified the E-UGS as ECCN 6A999.c (Commerce Control List, Part 774, Supplement No.1). This means the E-UGS system must not be exported or re-exported to embargoed or sanctioned countries, to parties of concern, or in support of prohibited end-uses (in the case of E-UGS, the prohibited end-use is Antiterrorism)

04 December 2013

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Table of Contents

1 System Safety Warnings

Before use of the E-UGS system, read the safety warnings in Section 10 of this manual.

2 FCC Notice

Changes or modifications not approved by ARA may void the user's authority to operate this equipment.

3 Theory of Operations

E-UGS stands for Expendable Unattended Ground Sensors. The ground sensors are near real-time security and situational awareness tools that utilize seismic technology to detect footstep and vehicle activity.

The purpose of the E-UGS system is to provide early warning of footstep and vehicle traffic in remote locations. A remote location is defined not only as a physically remote area, but also an area where there is a remote likelihood of activity.

For an intruder to be successful, they must maintain the element of surprise and maneuverability. The E-UGS system is designed to take that away by revealing intruder movement patterns, routes, locations and intent long before engagement.

Footstep detection will reliably occur within 0 to 15m of the sensor and vehicle detection within 0 to 20m. It is possible to get detections at much greater distances. The detection radius depends on what is being detected (vehicles or footsteps), terrain (such as rocky, mountainous or vegetated), operational mode of the sensor (footsteps only or all activity), and method of emplacement (surface or buried). The sensors need to be in contact with the ground.

Burying is optimal, but surface emplacement can also be effective if burial is not practical. Simply place the sensors on the ground and then conceal them with rocks, loose sand, etc. The same surface emplacement works in cleared or abandoned building structures by placing the sensors on the floor of a building and concealing with urban camouflage like trash or placing them under furniture.

Once a sensor detects activity of either footsteps or activity within its vicinity, it transmits a detection report to the E-UGS system Base Station. The Base Station includes a

compact receiver enclosure, an antenna, cables to interface with the user supplied computer, and the E-UGS software for displaying sensor and alert locations.

The Base Station components should be located in a secure place for monitoring. The distance from the sensor to the Base Stations can be up to 20 km but may be reduced if the terrain is mountainous, or has obstructions like vegetation and buildings.

4 Equipment Description

4.1 Storage and Transport Cases

Depending on the configuration, the E-UGS system may be supplied with a rugged travel case large enough to hold the Base Station components, sensor emplacement tools and up to ten sensors.

Additional travel cases are available that are designed exclusively for sensors, and can hold up to fifty five with emplacement tools.

4.1.1 Base Station Kit

The Base Station Kit houses the RF receiver, antenna, cables, sensor emplacement tools, accessories, system documentation and up to ten sensors. The exterior dimensions of the Base Station Case are 24.6" x 19.7" x 8.6" (62.5cm x 50cm x 21.8cm). The weight of the system will vary depending on configuration and will be less than 50lbs (23kg) when fully loaded with the base station parts and ten sensors.

Figure 1: E-UGS Base Station Case

4.1.2 Optional Sensor Kit

The packed sensor kit, shown in Figure 2 holds 55 sensors and two digging tools. The exterior dimensions of the Sensor Kit are 24.6” x 19.7” x 8.6” (62.5cm x 50cm x 21.8cm) and weighs 55lbs (25kg) when loaded with 55 sensors and all items listed in Table 2.

Figure 2: Sensor Kit

4.2 Base Station Components

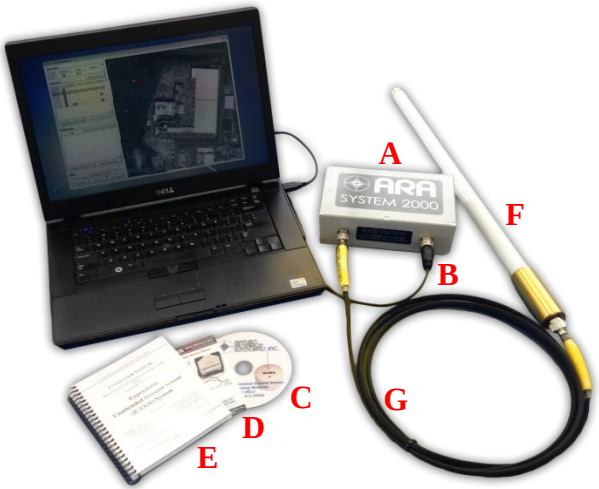


Figure 3: Base Station Components

Table 1: Typical Base Station Parts

Item	Description	Part Number
A	Receiver	ENCL-0100
B	Receiver USB cable	CBL-0015
C	E-UGS software CD	SOFT-0004
D	E-UGS User Manual	DOC-3008
E	Base Station Quick Reference Card	DOC-3003
F	Antenna	36142

Item	Description	Part Number
G	Antenna cable	CBL-0012

4.2.1 Receiver

The RF receiver (Figure 4) receives the modulated RF signal from the E-UGS sensors and transmits that information to the computer via a standard USB cable. The receiver is powered by the same USB cable. The second connection on the receiver is for the antenna.

Figure 4: RF Receiver Module

4.2.2 USB Cable

The USB cable is connected between the receiver and the customer supplied computer for communications and power.

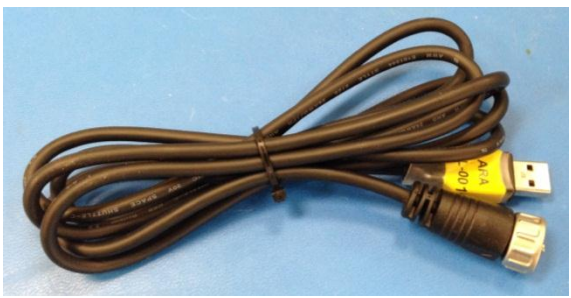


Figure 5: USB Cable

4.2.3 Receiver Antenna

The E-UGS system is supplied with a 3dBi omnidirectional antenna. The antenna is connected to the RF Receiver with an antenna cable during system use.

4.2.4 E-UGS Software CD

The E-UGS software is provided in the Base Station Kit on a CD so it can be installed on a user supplied computer. The E-UGS software allows the operator to input and edit sensor locations on a map, label points of interest, view detections, etc.

4.2.5 Receiver Antenna Cable

The antenna cables provided with the system is shown in Figure 6. This cable connects between the antenna and RF receiver.

Figure 6: Receiver Antenna Cable

4.2.6 User Manual and Quick Reference Cards

This manual is kept in the Base Station Kit along with a Quick Reference Card that describes the Base Station setup at a glance.

4.3 Sensors and Emplacement Tools

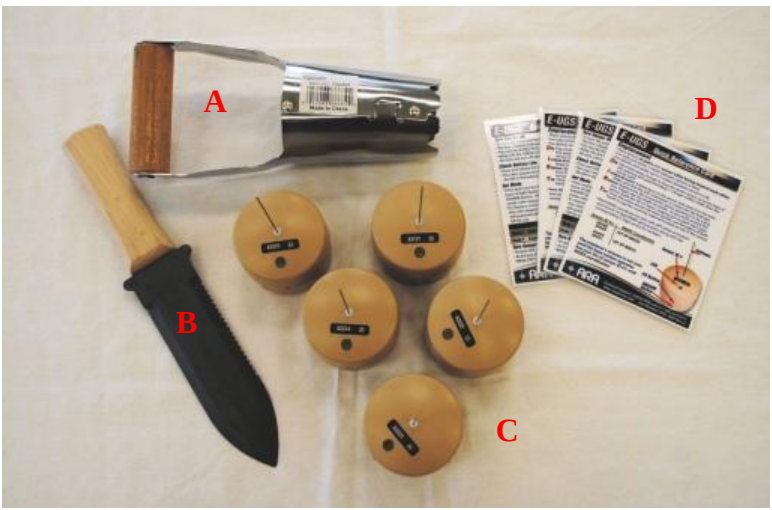


Figure 7: Sensor and Emplacement Tools

Table 2: Sensor and Emplacement Tools Parts List

Description		ARA Part Number
A	Emplacement Tool	4410

B	Soil Knife	70753
C	E-UGS Sensors	ENCL-0101
D	Quick Reference Cards	DOC-3002

4.3.1 E-UGS Sensors (Battery Powered)

Each E-UGS sensor (Figure 8) is 2.6 inches in diameter, 2.2 inches high, and weighs 10.5 oz. The sensor housing is made of watertight molded plastic.

The exterior features of the sensor include:

- ON/OFF Button
- Mode Select Button
- LED Status Indicator
- Antenna
- Sensor ID Number

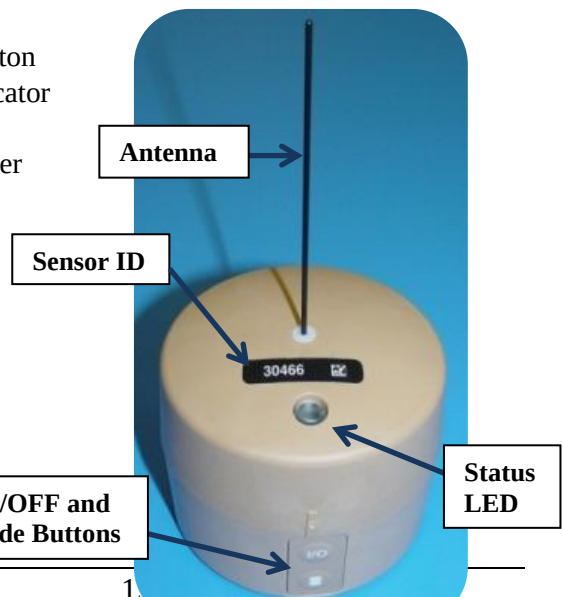


Figure 8: Expendable Unattended Ground Sensor

4.3.2 E-UGS Sensors (Shore Powered)

The hard-wired version of the E-UGS sensor (Figure 9) is very similar to the battery powered version except that wires replace the battery. This allows for 5-16VDC to be applied to the sensor to power it. Do not exceed 16VDC.

There is no mode selection available for this version; once power is applied the sensor is active. It is always in the default factory-set mode which is typically footstep mode.

Figure 9:Shore Powered Sensor

NOTE

A flashing red light is present whenever the E-UGS is OFF. E-UGS Sensors should be turned OFF for storage and transport to avoid unwanted transmissions and drain of the battery. The red light flashes every five seconds.

⚠CAUTION

The sensor antenna is rigid and is a potential puncture hazard if not handled carefully.

4.3.3 Quick Reference Cards

The Quick Reference cards summarize sensor emplacement technique for easy use in the field.

4.3.4 Emplacement Tools

The emplacement tools are provided to aid in emplacement of the E-UGS in the ground.

⚠ CAUTION

The emplacement tool and soil knife have sharp edges and are a potential hazard if not handled carefully.

4.3.4.1 Emplacement Tool

The emplacement tool minimizes soil disturbance as it quickly removes a soil plug the approximate size and height of the ground sensor.

Figure 10: Emplacement Tool

4.3.4.2 Soil Knife

The soil knife assists with sensor emplacement in areas where the emplacement tools will not work, such as in very hard soils or loose sands. It can also be used to cut roots and vegetation.

Figure 11: Soil Knife

5 Base Station Operation

5.1 Base Station Setup

The following steps should be completed in a secure area.

5.1.1 Parts Check

Ensure you have the following components:

a. RF Receiver
b. User supplied computer with E-UGS software
c. USB cable
d. Antenna
e. Antenna cable

5.1.2 Base Station Connections

The base station RF receiver has only two connections.

a. Connect the USB cable between the receiver and the computer.
b. Connect the antenna cable between the receiver and the antenna.

5.1.3 Antenna Mounting

Mount the antenna as high as possible and as far from other RF noise as possible.

5.2 E-UGS Software

5.2.1 Install E-UGS Software

The software needs to be installed on each individual computer that is running the E-UGS software. See Section 5 for E-UGS software installation and updating instructions as required.

5.2.2 Software Features

Some important features of the Base Station software are the following:

- The system is capable of monitoring a nearly unlimited number of sensors.
- The GUI screen flashes “red” and computer emits audible alarms when sensor messages are received.
- Maps are user configurable.

5.2.3 Software Main Menu

The E-UGS software program main screen includes a map, receiver and sensor status indicators as well as other settings and features.

The individual features are covered in detail on the following pages.

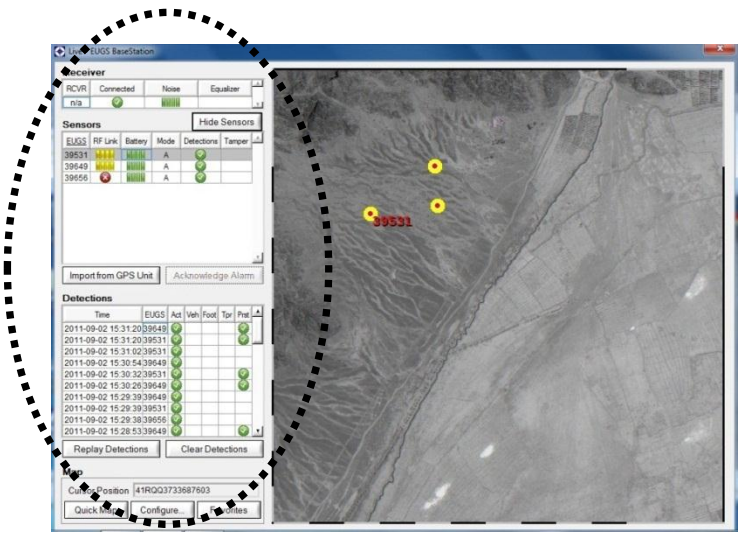


Figure 12: Software Main Menu

Feature List:

a) Receiver ID number
b) Receiver connection status
c) Receiver noise and equalization status
d) Sensor ID number
e) Sensor RF Link Status
f) Sensor Battery Status
g) Sensor Operational Mode
h) Sensor Detections
i) Sensor Tamper reports - appear in the “Detections” chart (o) as well as the “Sensors” Chart.
j) Button to auto download GPS coordinates
k) Button to acknowledge alarm
l) Time of Detection
m) E-UGS sensor ID, with detection
n) Type of detection
o) Tamper, see (i) above.
p) Persistent Activity, “Hold” & removal
q) Button for replaying the listed detections.
r) Button to clear detections
s) MGRS coordinate of cursor position on map
t) Button for Quick Map feature
u) Button to configure map
v) Button to use saved map “Favorites”
w) Button to hide sensor on map with no detections

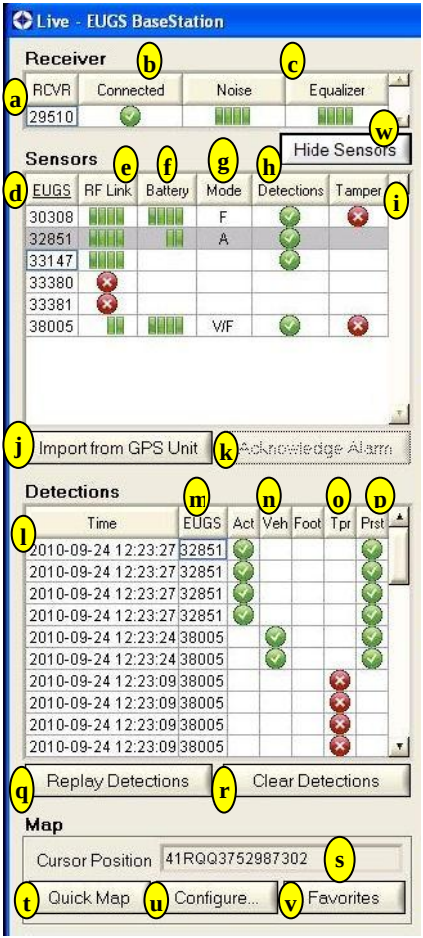


Figure 13: Main Menu

5.2.3.1 Receiver Indicators

The following Figure indicates whether or not the E-UGS is properly connected.

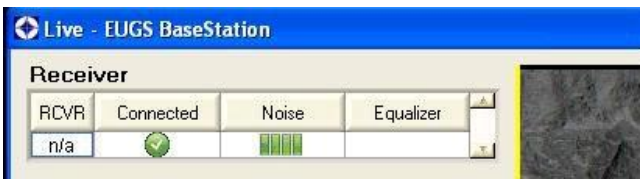


Figure 14 - Receiver Indicators

1) RCVR – Receiver software ID

2) Connected– indicates communication between the computer and receiver. A green check mark means communication has been established. A red circle with an X means there is no communication.

3) Noise – Indicates RF noise level. The ideal condition is to have 4 green bars. If the bars are fewer, red or yellow try altering antenna positioning. As detections from the sensors are received, the noise level will often drop to a single red bar and then bounce back up. When this occurs, a detection report usually follows.

4) Equalizer - not applicable

5.2.3.2 Sensor Indicators

Read the rows from left to right to determine the status of each sensor, by ID #. None of these status display columns represent a live feed. They only display the results of the most recent status or detection message sent by the sensors. Status messages are sent immediately at startup, then 2 minutes, 17 minutes, 30 minutes, 45 minutes, 60 minutes and then every 12 hours. The sensors report whenever they are turned off. Refer to section 6.4.6.5 for more details about status reports and for using the Hide Sensors button. Refer to section 5.2.4.7 for details on using the Import from GPS feature.

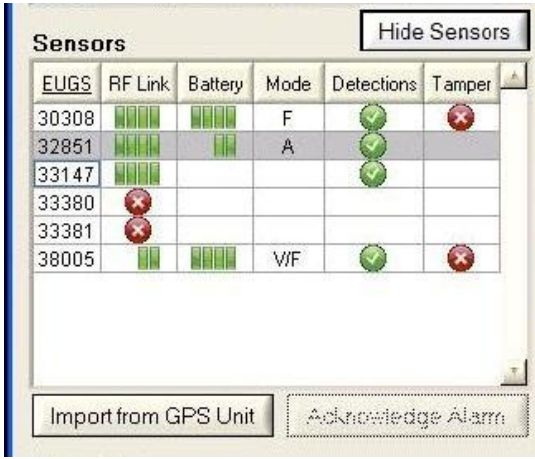


Figure 15 - Sensor Indicators

1) E-UGS – the ID of the sensors that have been added to the system.

2) RF Link – Indicates quality of connection between the sensor and receiver at the last transmission. A red circle with a white X indicates the sensor is no longer transmitting to the receiver

3) Battery – Indicates the battery life remaining in the sensor at the last status transmission.

4) Mode – Displays operational mode sensor is set to.

5) Detections – Indicates if the sensor has had any detection events.

6) Tamper - Indicates if the sensor has had any tamper events.

NOTE

If the Base Station is not operational within 60 minutes of sensor emplacement, verification that communication has been established between the Base Station and sensor will not occur for another 12hrs when the next sensor status report is sent.

5.2.3.3 Detections Indicators

The detections menu shows the detection history as they occurred. The top detection line is always the most current detection. Displayed are the time of detection, sensor ID #, the type of detection and whether or not the detections went into persistent mode. Persistent detections occur when the sensor receives two detections within a one minute period. Sensors in persistent mode will no longer report detections until they go 30 seconds without detection. The purpose for this feature is to conserve battery strength. Tamper detections are reported when the sensor is tilted. Refer to section 0 for detection (alarm) acknowledgment, and clearing and replaying detections.

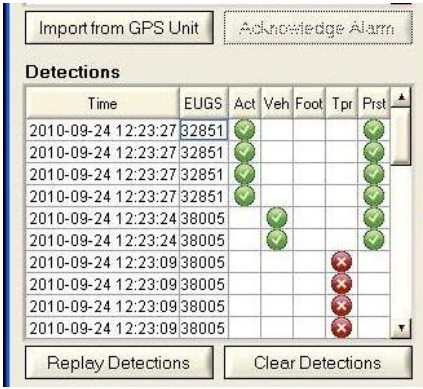


Figure 16 - Detections Indicators

5.2.3.4 Map Menu

The Map section is used to generate and/or configure the map display. Refer to Section **Error! Reference source ot found.** for map configuration.

Figure 17: Maps Menu

5.2.4 Software Operations

5.2.4.1 Sensor Sorting

The sensor indicators can be sorted by clicking on the column header.

- E-UGS Column: Sort by sensor ID#
- RF Link Column: Sort by RF link strength (weakest at the top)
- Battery Column: Sort by battery life remaining (shortest battery life at the top)
- Mode Column: Sort by operational mode
- Detections Column: Sort by detections in the detection table (most recent at the top)
- Tamper Column: Sort by un-cleared tamper warnings.

5.2.4.2 Remove Sensor

To remove sensors from the Sensor Status table, select the sensor ID by left clicking and holding the Ctrl key for multiple sensors. Release the left and Ctrl key, right-click and select “Remove sensors from list”. Click “Yes” in the confirmation dialog box.

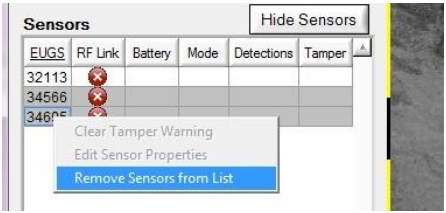


Figure 18: Remove Sensors

5.2.4.3 Edit Sensor Properties

Right click on the sensor ID number and select Edit Receiver Properties to edit the sensor ID number or location coordinates.

5.2.4.4 Clear Tamper Warning

Right click on the sensor ID number and select Clear Tamper Warning to remove the tamper alarm indicator from that sensor.

5.2.4.5 Detection Alarm

Sensor detections will trigger an audible alarm accompanied by a flashing red background in the E-UGS Base Station "Live" window. Reset the alarm by clicking the Acknowledge Alarm button. The audible alarm can be turned on or off using the Control Panel menu if the user has administrator access.

Once detection has occurred, the sensor indicator on the map will turn red with a yellow circle around it. If the sensor is then inactive for a period of time, the yellow circle will go away. The red circle will remain until the detection has been cleared from the Detections list.

Figure 19: Sensor Alarm

5.2.4.6 Hide Sensors

The Hide Sensors button is used to remove sensors from the map (only) that have not had detections or the detection has been cleared from the Detections list. If a sensor is selected on the Sensor list and the Hide Sensors button is pressed, the selected sensor will not be hidden. If detection occurs, the sensor will automatically appear on the map. If the sensor detections are cleared while the sensor is shown and the Hide Sensors button is active, the sensors will automatically be removed from the map.

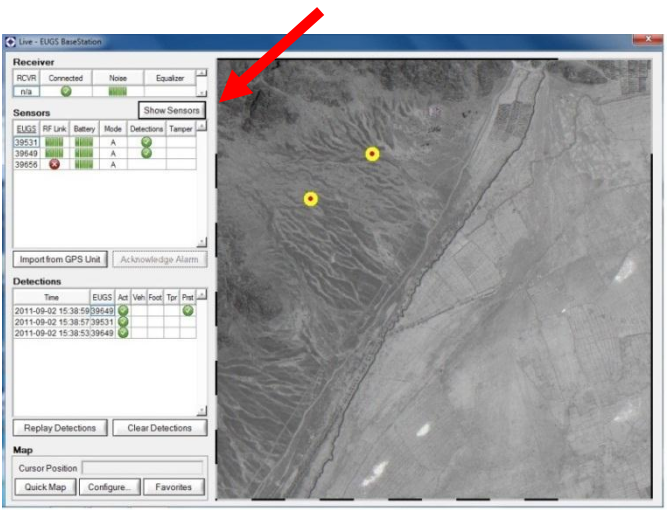


Figure 20: Hide Inactive Sensors

5.2.4.7 Importing E-UGS Locations from GPS units

NOTE

GPS unit drivers must be installed on the computer before the import will work.

This section describes how to upload waypoints from the Garmin GPS unit. Refer to the next section of this manual for details on how to upload waypoints for DAGR supported devices.

1. Plug the GPS unit into the laptop using the supplied cable.
2. Click the "Import from GPS Unit" button (Figure 21) located on the "Live" window.

Figure 21: Import E-UGS Location from GPS

3. Select the Garmin protocol device from the drop down menu and appropriate COM or USB port, then OK.

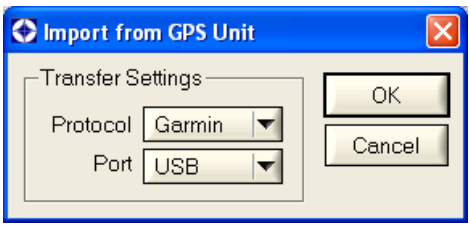


Figure 22: Select Protocol and Port

4. Garmin GPS units will automatically import any waypoints stored in the unit. Waypoints will be recognized as the locations of E-UGS sensors with the corresponding ID# and show up on the Sensor table and map, if applicable.

5.2.4.8 Clear Detections

Use the Clear detections button to remove all detections from the Detections list.

5.2.4.9 Replay Detections

The Replay allows the play back of all detections recorded over the past 24 hours. Click the Replay Detections button.

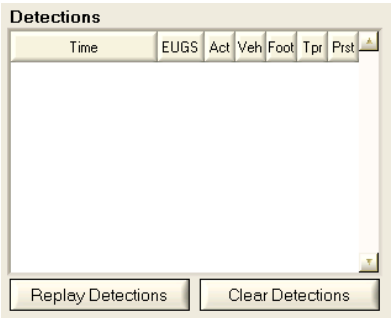


Figure 23: Replay Detections Button

Figure 24 shows the Replay window. The Replay controls can be seen on the top left portion of the window. The map shows “REPLAY” in the top left and bottom right corners. Sensors cannot be added to the map in this window.

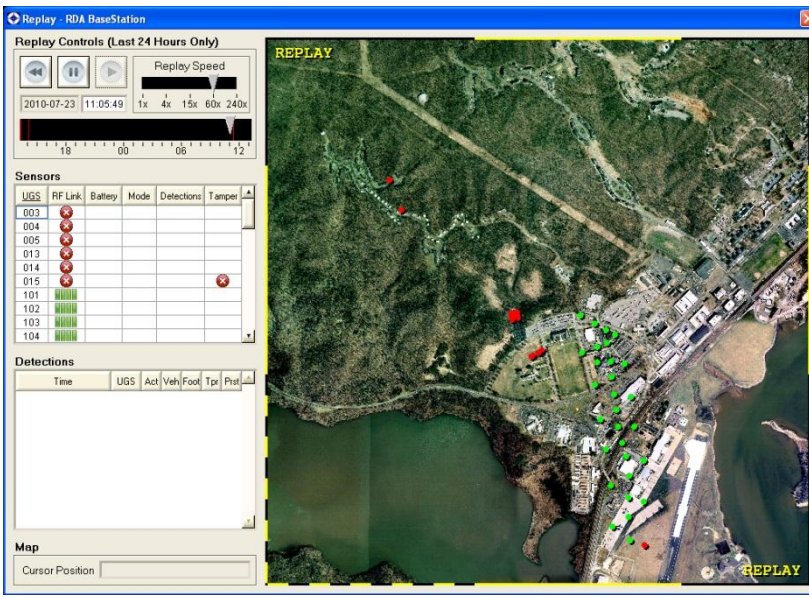


Figure 24: Replay Detections Screen

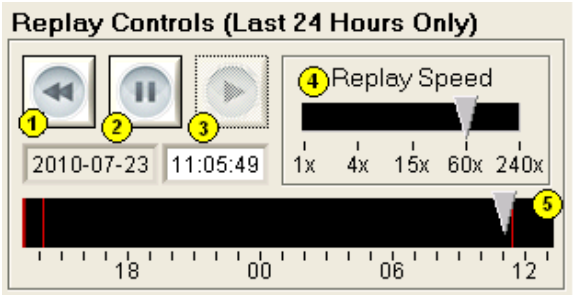


Figure 25: Replay Menu

To begin replay click the play button in the Replay Controls. Other functions of the replay window are:

1. **Rewind button:** Resets the replay back to the first detection saved in the Detections table.
2. **Pause:** Stop replay.
3. **Play button:** Start replay.
4. **Replay speed:** Controlled by moving the triangle to different time multipliers.
5. **Timeline scroll:** Shows what time the replay is currently displaying. The triangle can be moved to manually choose what time the replay should begin playback. The scroll bar also shows orange to red

lines indicating sensor activity. The color of the bar indicates the quantity of detections recorded during that time period:

a. Orange = light activity

b. Red = heavy activity

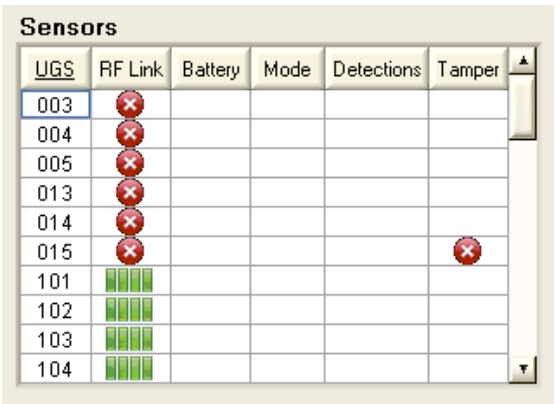


Figure 26: Sensors Table

The Sensors table shown in Figure 26 contains the sensors that will be played back during replay. Sensors cannot be added to this table. To replay sensors not included in the table the Replay window must be closed and sensors added in the "Live" window.

6 Sensor Operation

6.1 Battery Powered Sensors

6.1.1 Sensor Buttons

The E-UGS sensor has two buttons. The top button is the ON/OFF button and the bottom button is the Mode button. Both buttons are used in conjunction with the Status LED to operate the sensor.

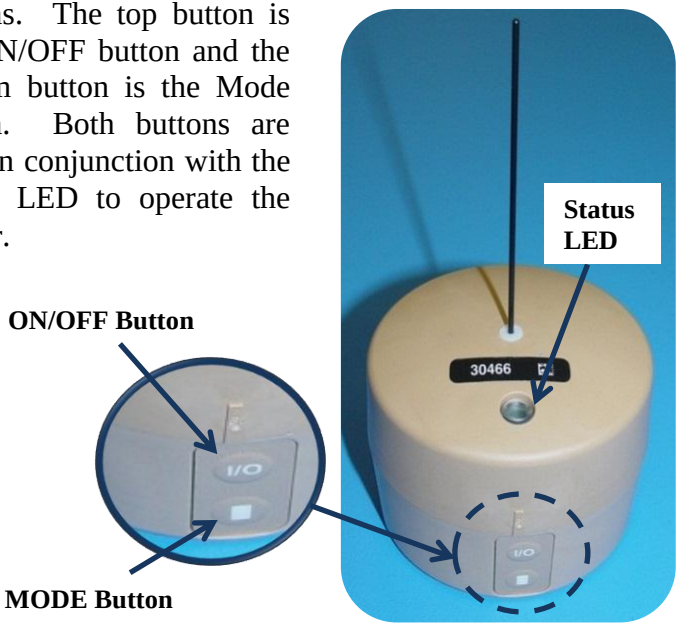


Figure 27: E-UGS Sensor Buttons

- **ON/OFF button (top)** - turns sensor ON and OFF
    - To turn the sensor **ON**, press and hold the top button for 5 seconds until the status LED begins to flash the mode color code. After the mode sequence is complete and a test transmission is sent, the sensor will flash green every 5 seconds, indicating it is ON. It will stop flashing after 17 minutes.
    - To turn the sensor **OFF**, press and hold the top button for 5 seconds until the status LED begins to flash red rapidly. After the rapid sequence is complete, the sensor will flash red every 5 seconds indicating it is OFF.
- **MODE Button (bottom)** – used to check battery life and set the operational mode
    - To **check battery life**, push and release the mode button. This can be done when the sensor is on or off. A series of four lights will flash indicating battery charge level. The lights will either be green (GN) or red (RD).

- The four light sequence indicates the following approximate battery life remaining in the sensor as shown below:

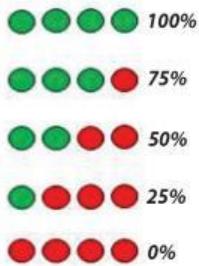


Figure 28: Battery Life Indicators

- The E-UGS sensor has two 2 modes (refer to section 6.1.2 for more details about the modes):
  - Activity Mode
  - Footstep Mode

  The sensor's operational mode is indicated by the status LED when the sensor is first turned on.

  After the sensor has been turned on, **change the operational mode** by pressing and holding the bottom button for 5 seconds until the status LED

displays a burst of multi-colored flashes. After the burst of flashes, release the bottom button.

The sensor will then begin to go through the mode color code sequences. Each color code is 3 pulses long.

To select a particular mode, press and release the bottom button after the color sequence of the desired mode. After the mode is selected, the sensor will turn off.

NOTE

When a sensor mode is changed the sensor will be turned OFF automatically. Turn the sensor back ON before emplacement.

6.1.2 Sensor Operational Modes

The sensor has two operational modes: Activity Mode and Footstep Mode. These modes are designed for use in specific deployment scenarios and should be chosen based on physical location and strategic objective. The mode color code sequences are summarized in Figure 29.

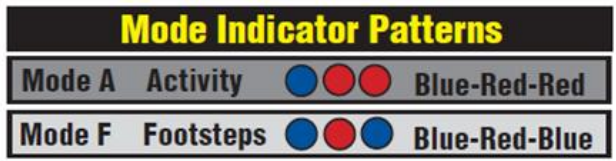


Figure 29: Sensor Mode Color Codes and Uses

6.1.2.1 Activity Mode (BLUE-RED-RED)

- **Default mode**: When the sensor is turned on for the first time, it will default to this mode.
- **Detection:** Detects all human footstep and vehicles activity. More sensitive than Footstep mode.
- **Terrains:** Use in barren, desert and mountainous areas.
- **Structures:** Use at isolated urban structure or place inside building near points of entry.
- **Emplacement:** Surface placement and burial emplacement capable (burial preferred).

6.1.2.2 Footstep Mode (BLUE-RED-BLUE)

- **Detection:** Detects human footsteps only. Less sensitive than Activity mode.
- **Terrain:** Designed for vegetative terrain such as those containing grassy areas, trees, or crop fields.

- **Scenario:** Best mode for route detection operations.
- **Emplacement:** Surface placement and burial emplacement capable (burial preferred).

6.2 Shore Powered (Wired) Sensors

The wired sensors have no buttons. As soon as 5 to 16VDC power is applied to the sensors, they will turn on. Depending on the factory-set configuration, the sensors may be in Footstep Mode or Activity Mode. This mode is not selectable by the customer.

6.3 Sensor Transport

Sensors are best transported in individual bags or collectively in a rucksack or case.

⚠CAUTION

Be careful how the sensors are carried. Antennas are rigid and can protrude through pockets which may cause injury.

6.4 Sensor Emplacement

6.4.1 Burial Emplacement

D: Dig: Dig a hole deep enough to bury the entire sensor up to the base of the antenna and approximately 1-2 finger widths wider than the sensor itself.

I: Initiate and Insert: Initiate/turn on the sensor and insert it in the hole. Make sure that the status LED orientation is correct for the final pair.

R: Replace: Replace the dirt around the sensor, packing it in by using your fingers. As you work around the sensor, build the dirt in layers, making sure to pack each layer.

T: Tap: Once the entire sensor has been buried, use the palms of both hands to tap the covering material located on top of the sensor.

NOTE

Burial is always better than surface mount.
Use surface mount only when digging is not an option.

6.4.2 Surface Emplacement

S: Secure: Secure the sensor in your hand.

O: Orient: Orient the sensor for the optimal emplacement orientation.

L: Locate: Locate the best surface for emplacement.

I: Initiate: Initiate/turn on the sensor.

D: Disguise: Use rocks, plastic bottles and containers, or place underneath furniture. Do not use metal objects as they may interfere with sensor transmission

NOTE

The status LED can be seen in the dark, especially in remote areas due to lack of ambient light from cities, etc. Therefore, during night emplacement, emplace in such a manner to prevent visual detection of the sensor. Tape can be used so that the LED

lights will not be seen.

6.4.3 Sensor Geo-Location

- Once the sensor has been emplaced, record the 10-digit grid coordinate location from a GPS unit. Record the corresponding 5 digit sensor ID numbers found on the top of each sensor.

NOTE

Grid coordinates and sensor ID are critical for knowing where the sensors are emplaced. When emplacing sensors, be sure to update the Base Station map with this information.

6.4.4 Sensor Detection Radius

The detection radius depends on what is being detected (vehicles or footsteps), the terrain (such as rocky, mountainous or vegetated), operational mode of the sensor (footsteps only or all activity) and method of emplacement (surface or buried). The sensor is designed to repeatedly detect activity and footsteps within 0 to 15m of the sensor, and vehicles within 0 to 20m. However, field tests have indicated much greater distances are typical.

NOTE

Activity mode detection radius is vulnerable to wind induced "activity" in root structures.

6.4.5 Sensor Transmission Range

Sensor transmission range is largely dependent on line of sight to the Base Station antenna and if there are obstructions in the way, such as buildings, vegetation or hills, transmission distances will be reduced. A good strategy is to place the antenna as high as possible.

6.4.6 Sensor Reports

There are five types of reports, or transmissions, that the sensor sends to the Base Station. Four are alarms and one is a periodic sensor status report.

- Footstep Detection
- Activity Detection
- Persistence Alarm
- Tamper Alarm
- Sensor Status

6.4.6.1 Footstep

Footstep mode reports ground activity that matches human footstep characteristics. Background activity, such as rain, high wind, etc., is gradually filtered out by the sensor's firmware to reduce the chance of false detections. The sensor will only send this type of report if it is in Footsteps mode.

6.4.6.2 Activity

Activity detection reports result from any ground disturbance. This mode is more sensitive to seismic vibrations than Footstep mode. The sensor must be set to Activity mode to send this type of report.

6.4.6.3 Tamper Detection

A tamper alarm occurs when the E-UGS sensor is tilted. To allow for placement time, the tamper transmission will occur only if the tamper occurs more than two minutes after the E-UGS is powered up. The tamper alarm is transmitted four times at 12-second intervals. A new tamper report is issued if detected more than 17 minutes after the previous tamper detection.

NOTE

Unwanted, tamper-induced transmissions occur if you tip the E-UGS while it is turned on. To allow time for emplacing the E-UGS Sensor, tamper-induced transmissions will occur only if the tamper occurs more than two minutes after the E-UGS is powered up.

6.4.6.4 "Persistence" Reports

"Persistence" reports are triggered when multiple detections occur within a short period of time. A Persistence report initiates a hold on report transmissions to minimize redundant information and preserve battery life for a particular E-UGS location and time. When report transmissions are on hold, new detections will not be transmitted until a period with no activity has passed.

Persistence reports eliminate large numbers of unnecessary transmissions in a variety of situations such as a group of people active for a length of time near one or more E-UGS sensors, in adverse weather such as hail storms or heavy wind causing tree root movement, or water slapping on a nearby riverbank.

6.4.6.5 Sensor Status

Similar to the power up test transmission, condition status reports inform the user of the sensor condition. The report transmits the battery level, detection mode and strength of the RF link. After the initial power on, status transmissions are sent to the Base Station at 2, 17, 30, 45 and 60 minutes and then every 12 hours. If the sensor battery is depleted or the sensor is turned off it will send the Base Station an OFF status signal.

6.4.7 Battery Status (Battery Powered Only)

To check battery status, press and quickly release the Mode Select button. This can be done when the sensor is turned on or is off. The LED will display a sequence of four green and/or red lights. The sequence represents the estimated remaining battery life with each green light representing 25% of the battery life. For example, three green lights followed by one red light indicate a battery with ¾ of its charge remaining. Generally speaking, a new sensor will last about five months after emplacement. This time is an estimate because the battery life is dependent on the operating temperature and the number of transmissions it sends over its lifetime.

7 Working with Maps

This section describes how to use, find and prepare maps for use in the E-UGS Software. This section contains information on obtaining imagery from Google Earth™, importing existing map data, and geo-referencing raster images.

A World File is used by the E-UGS Software to geo-rectify a graphic image. It specifies the pixel resolution or average width and height in decimal degrees. It specifies the latitude and longitude of the top left pixel of the image. It also specifies the interpretation of the x and y ground coordinate and the GPS datum (earth fixed global reference frame definition) used.

7.1 Quick Map and Generate Map

The Quick Map and Generate New Map features can only be used with CADRG file types. When using these features, the Base Station software automatically looks for this type of map in the location indicated in the BaseStationConfig file that is installed with the E-UGS software. This location must match the actual location of the maps. Contact Technical Support for more information on CADRG maps and required folder and file setup.

7.2 Map Favorites

To save the current map window into favorites for later use click Favorites.

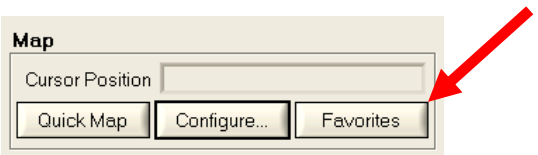


Figure 30: Open the Favorite Map Window

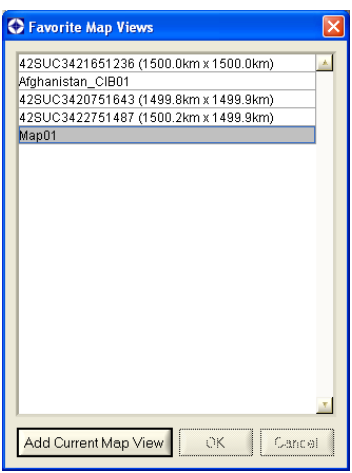


Figure 31: Favorite Map Views Window

Save the currently displayed map by clicking "Add Current Map View". A new row will appear with the MGRS coordinate and map dimensions as the default name. Click OK to save the new map entry or Cancel to remove the entry. To delete or rename previously saved maps right click on the map name and a menu with "Rename" and "Delete" will pop up.

In the map window the border around the map image shows the scale of the map (Yellow and Black when the map is active, Gray and Black when the map is passive). The bottoms left corner shows 100m separation. The rest of the border shows 1km separation. The scale will auto adjust as the map is zoomed in and out. Figure 32 is an example of a map that is 3km x 3km.

Figure 32: Map Window

7.3 Creating New Maps

7.3.1 Maps from Google Earth™

The following steps outline how to install and run Google Earth™.

1. Download Google Earth™
    a. Go to http://earth.google.com/ and download the Google Earth™ install. In this document, we reference the free version.

NOTE

When using the free version of Google Earth™ the saved map resolution will be limited by the display of the computer used.

2. Install Google Earth™
    a. Follow the standard or default options for installation.
3. Run Google Earth™
    a. Change Lat/Long from Degrees, Minutes, Seconds to Degrees Decimal
    b. Find the Google Earth Options dialog window under the Tools drop down menu. Change the lat/long display method from "Degrees, Minutes, Seconds" to "Decimal Degrees". This option will display all

lat/long coordinates in a decimal degree format (see Figure 33).

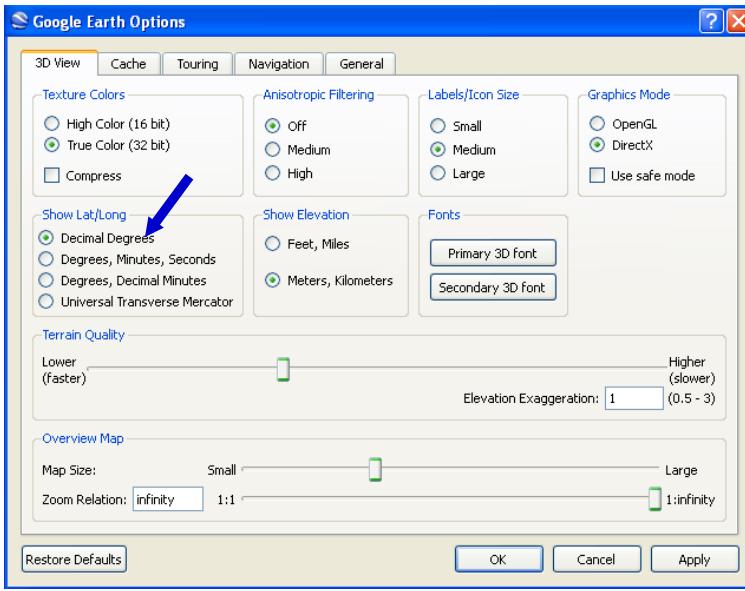


Figure 33: Select Decimal Degrees

4. De-select Auto Tilt.
   a. While in the Options Menu, select the Navigation Tab and look for the Navigation field. Uncheck the box labeled,

"Automatically tilt while zooming". You will only need to do this once (see Figure 34).

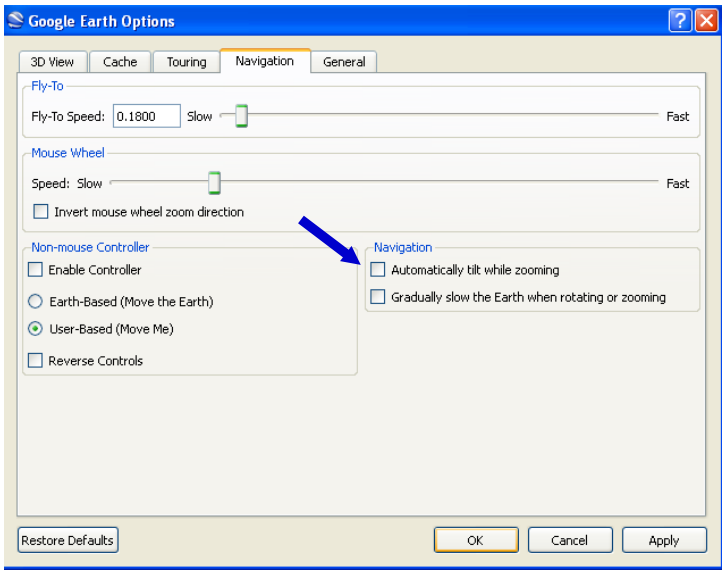


Figure 34: De-select Auto Tilt Box

7.3.2 Saving Map Images and Coordinates

The following steps outline how to save a map image and how to obtain information for the World File Creation Tool.

1. Zoom and Pan to Desired Area.
    a. Navigate in Google Earth until the desired map area to be saved is viewable. The saved map will match the current view exactly (see
    b. Figure 35).

NOTE

Be sure to reset Tilt and North (press 'U' and 'N' on the keyboard) settings prior to saving the map image and proceeding. Proper map geo-rectification is dependent on proper image orientation such that vertical pixels point straight north and that the view is straight down on the earth.

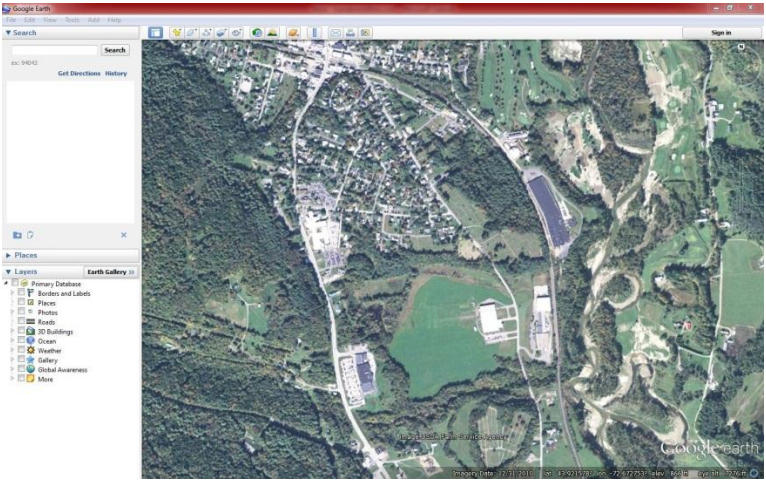


Figure 35: Zoom and Pan to Desired Area

2. Save the Current View to File.
    a. Under the file menu, click "Save->Save Image". Choose an appropriate file name that describes the image contents and save the file under C:\Program Files\E-UGS\Maps (see Figure 36).

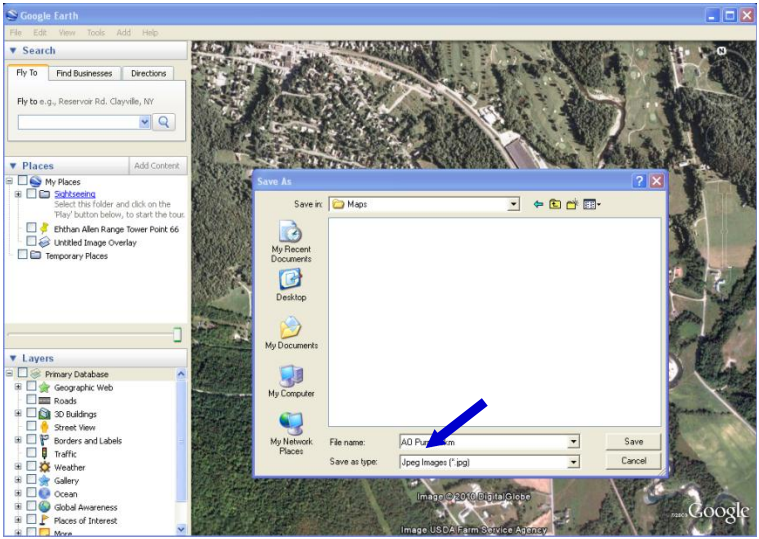


Figure 36: Save Image to File

3. Open the Image Overlay Tool.
    a. Under the "Add" menu, click "Image Overlay". This will open the New Image Overlay dialog box. Click the Location Tab of the Image Overlay dialog box. The image overlay outline will be used to identify the latitude and longitude extents of the current view. The outline *MUST* extend to each

corner of the image, without moving the current view of the map.

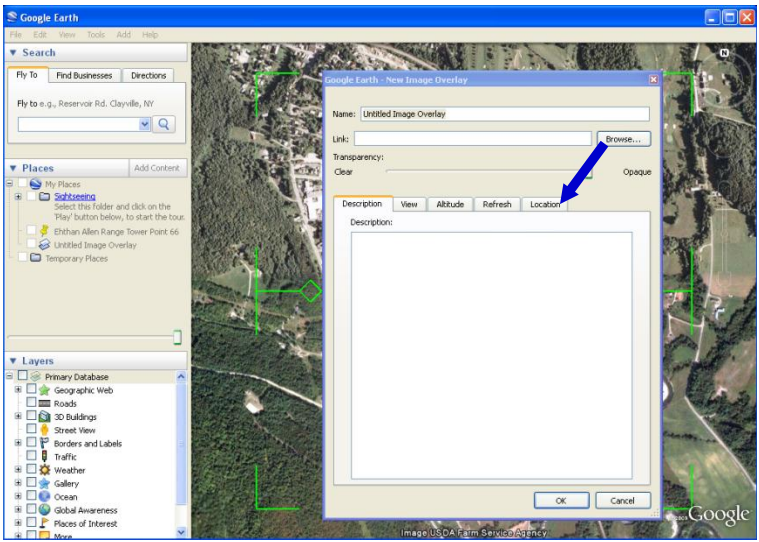


Figure 37: Open New Image Overlay Tool

4. Resize the New Image Overlay dialog box so that the **green image overlay outline** of the Overlay Tool can be seen; you will only need to do this once (see Figure 38).

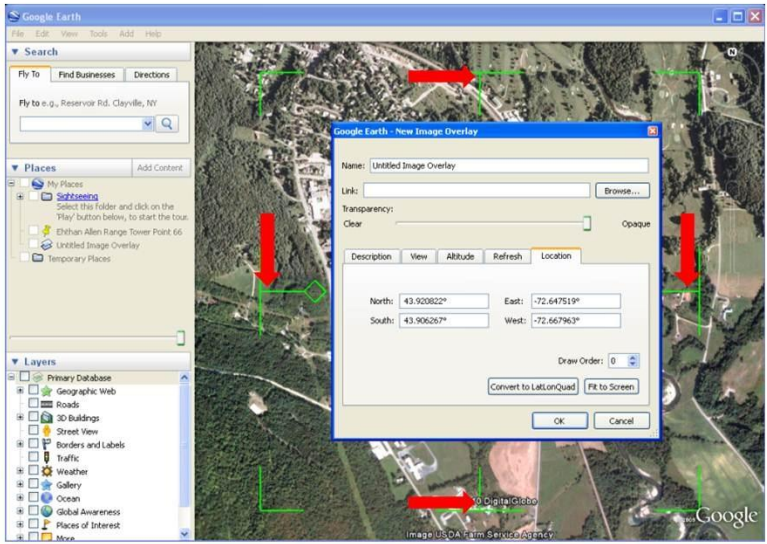


Figure 38: Image Overlay Resize

5. Resize the Overlay Outline to cover the entire view. Move the cursor over the middle of the edge of the **green image overlay outline**. When the hand changes from open palm to a pointing finger, click and drag the outline edge until it lies on the edge of the viewable picture (Figure 39). *Be sure not to click on and move the map itself*. The map view must remain constant through the entire process. If

moved, you will have to start over and save a new image.

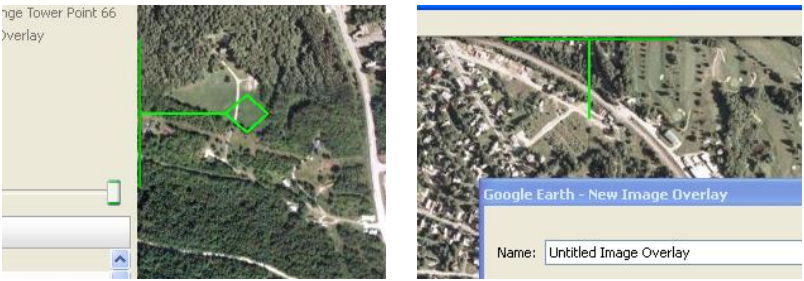


Figure 39: Image Overlay Alignment

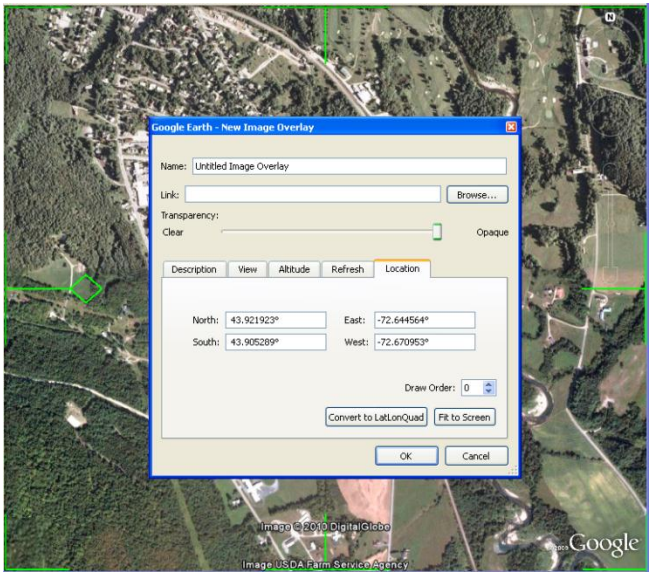


Figure 40: Resize Overlay Outline to Cover Entire View

6. Record coordinates (North, East, South, West)
7. Proceed to Section 7.3.4, Geo-Rectifying Images.

NOTE

When entering the data into the E-UGS World File Tool, it is critical the correct coordinates be entered into the correct boxes.

7.3.3 Maps from other Sources

The following steps describe how to take a map image from another source, S-2, S-4, or a scanned paper map, and generate a World File for use with the E-UGS Software.

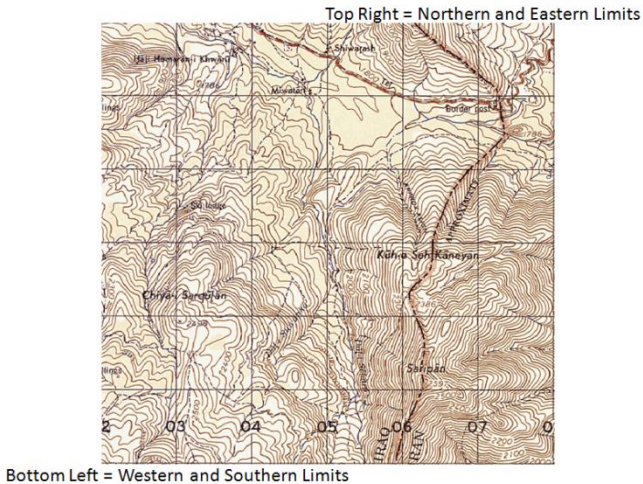


Figure 41: Sample Map

1. Record coordinates (North, East, South, West)
2. Proceed to Section 7.3.4, Geo-Rectifying Images.

NOTE

When entering data into the E-UGS World File Tool, it is critical that the correct coordinates be entered into the correct boxes.

7.3.4 Geo-Rectifying Images – E-UGS World File Tool

This section describes the process for creating a World File for geo-rectifying images in the E-UGS Software. Google Earth™ map-viewing software can be used for this process. Other software may be used in a similar fashion; it is left up to the user to obtain the correct image latitude and longitude extents.

The following steps describe how to use the E-UGS World File Tool to generate a World File. A World File is used to geo-rectify an image in the E-UGS Software.

1. Open World File Tool application.

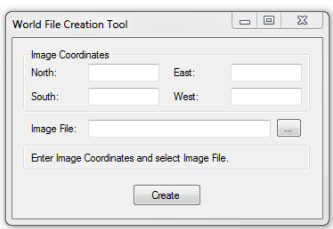


Figure 42: E-UGS World File Creation Tool

2. Enter the map image coordinates in decimal degrees.

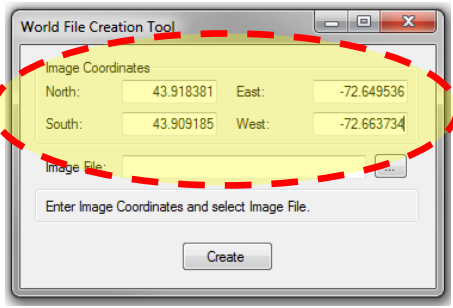


Figure 43: Entered Coordinates

3. Select the image file using the Browse button.

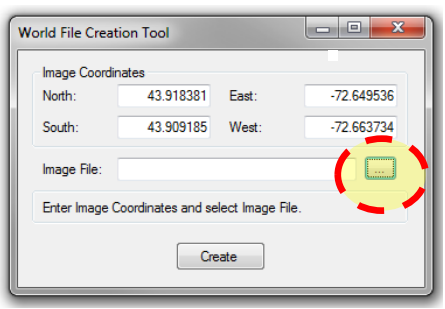


Figure 44: Browse Button

4. Select the image file.

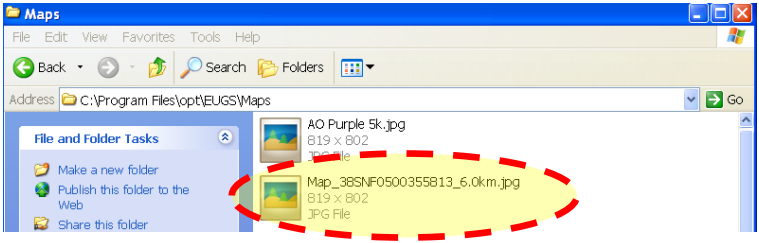


Figure 45: Image File (.JPG) in Tile View

5. Select the Create button.

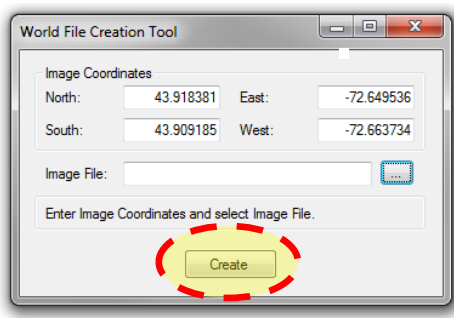


Figure 46: Create Button

6. Creation of the image and a corresponding World File for use in the E-UGS Software are complete, as shown in Figure 47. Open them in the E-UGS software

using the Open Existing Map button in the Map Configuration window.

NOTE

The World File (.JPGW) must be in the same directory as the image file (.JPG). If the World File was created in a different directory, the World File must be moved to the same directory as the image file.

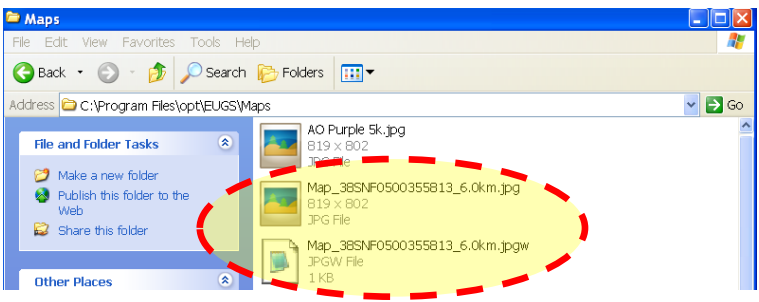
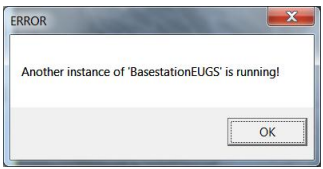


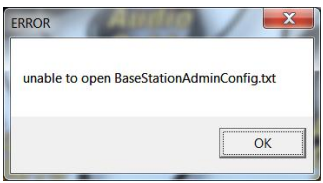
Figure 47: Image Dimensions File (.JPGW)

8 Troubleshooting Guide

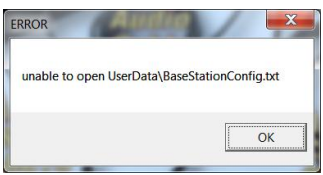
8.1 Summary of Error Dialogs



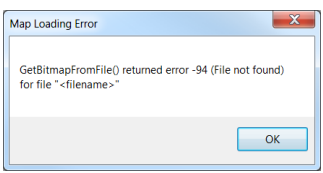
This dialog indicates that the E-UGS Base Station software is already running. After selecting the OK button, the new copy of the base station software will close. The already running copy will continue normal operation.



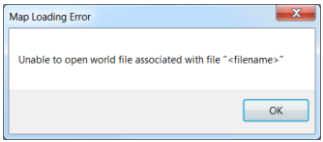
The administrative configuration file for the Base Station software is not installed. The E-UGS software must be reinstalled to correct this error. Contact technical support.



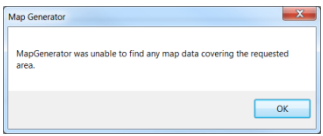
The general configuration file for the base station software is not installed. The E-UGS software must be reinstalled to correct this error. Contact technical support.



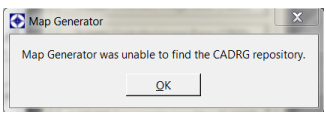
The user attempted to open a map that did not exist. The user should verify the map location and try again.



The user attempted to load a map image without associated coordinate data.



The user attempted to generate a map using a location with no map data.



The CADRG map directory is not setup properly or the path is incorrect in the BaseStationConfig file.

8.2 Troubleshooting Matrix

PROBLEM: No communication between computer & receiver			
Possible Cause	**Visual Indicators**	**Solution**	**Section Reference**
No power to receiver	Connected column displays 	Verify power cable (CBL-0043 or CBL-0151) is connected to receiver and AC power source	5.1
Communication setting is incorrect	Connected column displays 	Right click on connected column and verify settings.	5.2.3.1
Receiver not functional		Replace with new receiver.	4.2 Table 1
Damaged cable		Identify damaged cable and replace with new cable.	4.2 Table 1
E-UGS software not functional	Possible error messages	Replace computer	Contact Technical Support
E-UGS software not functional	Possible error messages	Verify the Base Station program is running. Verify Windows firewall is not blocking the Base Station program from running. Verify computer security settings are not disallowing write access to C:\Program Files\Applied Research Associates\E-UGS.	Contact Technical Support

Table 3: No Communication with Base Station

PROBLEM: No sensor transmissions are received, or transmissions are intermittent (CONTINUED ON NEXT PAGE)			
Possible Cause	**Visual Indicators**	**Solution**	**Section Reference**
No communication between computer and receiver	Connected column displays 	Refer to Table 3	5.1
Sensor ID not entered in software	Sensor light indicates transmission sent	Enter sensor ID number on map	5.2.3.2
Wrong E-UGS serial number entered into E-UGS software		Verify serial number on sensor lid matches that entered into the software	5.2.3
Sensor not ON	Sensor light does not indicate transmission when stimulated	Turn ON	6.1.1
Sensor battery dead	Prior transmissions report low battery status	Check sensor battery status and replace if required.	9.2
Sensor damaged		Replace sensor	4.3 Table 2

PROBLEM: No sensor transmissions are received, or transmissions are intermittent (CONTINUED)			
Possible Cause	**Visual Indicators**	**Solution**	**Section Reference**
Sensor out of range	Sensor light indicates transmission	Move sensors or Base Stations so they are closer. Remove line of sight obstructions between sensors and Base Station.	6.4.5
Base Station Antenna or antenna cable damaged or not connected	Connectors appear damaged	Visually inspect cable and antenna connectors for damage. Cable connector center pin should not spin. Replace or reconnect as needed.	4.2 Table 1
Base Station Antenna orientation not appropriate	Sensor light indicates transmission (blue or green flash). None or intermittent transmissions received with weak RF link status at Base Station	Mount antennas in vertical orientation, at height above line of sight obstructions to sensors, if possible. Mount antenna away from metal objects and RF devices, such as other antennas.	5.1.3

Table 4: Sensor Transmissions Not Received

PROBLEM: Sensors stop working after deployment			
Possible Cause	**Visual Indicators**	**Solution**	**Section Reference**
Battery not full at time of deployment	Sensor RF Link in Base Station software displays: 	Battery voltage degrades over use or if left on during storage. Check battery status and replace as required.	6.4.7 9.2
Sensors placed in noisy environment		Move sensor to location away from running water, generators, loud constant noise sources, or sources of vibrations.	6.4
Sensor placed incorrectly		Verify sensor antenna is protruding above the ground.	6.4

Table 5: Sensor Stops Working After Deployment

9 Maintenance

9.1 Computer and Software Upgrade and Diagnostics

It may be necessary to re-install or upgrade the E-UGS User software in the event of a new software release, use of a new computer or corruption of existing software or computer. Contact Technical Support for more computer diagnostics and maintenance information.

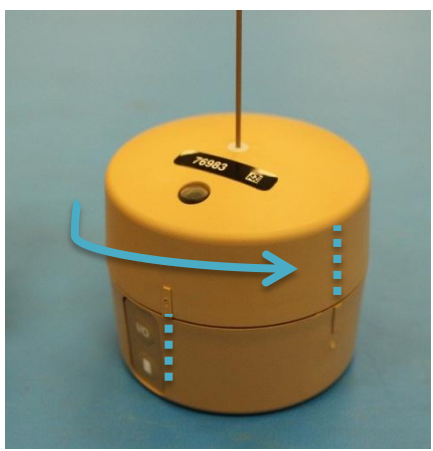
Installation Instructions
Before re-installing or upgrading E-UGS software, the old version must be removed. Depending on the age of the system the software may be located in different directories. Follow the directions below to install the software.

1) Turn on the computer.
2) Locate the existing E-UGS software directory by right clicking on the E-UGS desktop icon, select the view Properties window and the Start In field.
3) Navigate to this location in Windows Explorer and copy the Maps directory out of the E-UGS folder to the computer Desktop.

4) Open Windows Control Panel, Add/Remove Programs and uninstall the E-UGS software if it is listed. If not, delete the program folder in Windows Explorer.
5) Delete any old copies of the user manual and quick start card, usually found on the desktop
6) Insert the E-UGS software CD into the computer.
7) Browse and run E-UGSInstaller.msi
8) Follow the prompts, including installing Microsoft .NET, if asked. If .NET is installed re-run the E-UGSInstaller.msi file when it is completed.
9) Move the contents of the Maps folder from the desktop into the new E-UGS program directory Maps folder.
10) Copy the new User Manual and Quick Start Guide from the disk to the computer desktop.
11) Run the software and test communication and sensor events with a receiver and sensor. Refer to the Base Station Functional check section of this manual for instructions.

9.2 Sensor Battery Replacement

1. To open: rotate the sensor lid counter-clockwise approximately ¼ turn until lid and base marks align.



2. Carefully lift lid to expose interior of base and lid.

NOTE

In Step 3, make sure to pull the connector straight out of the socket to prevent damage to the connector or socket.

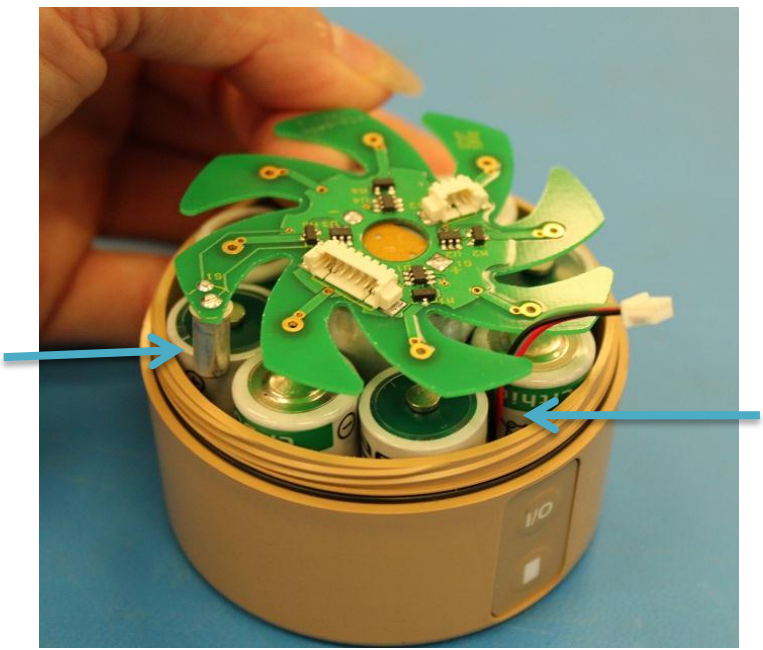
3. Locate the wire harness leading from the lid to the base circuit board. Grasp all of the wires as near to the connector as possible and pull straight back to disconnect the harness from the base.

4. Locate the wires leading from the power switch to the connector on the base circuit board. Grasp all of the wires as near to the connector as possible and pull straight back to disconnect the harness from the base.

5. Move the wires out of the way and slide the circuit board and geophone assembly straight up and out of the base.

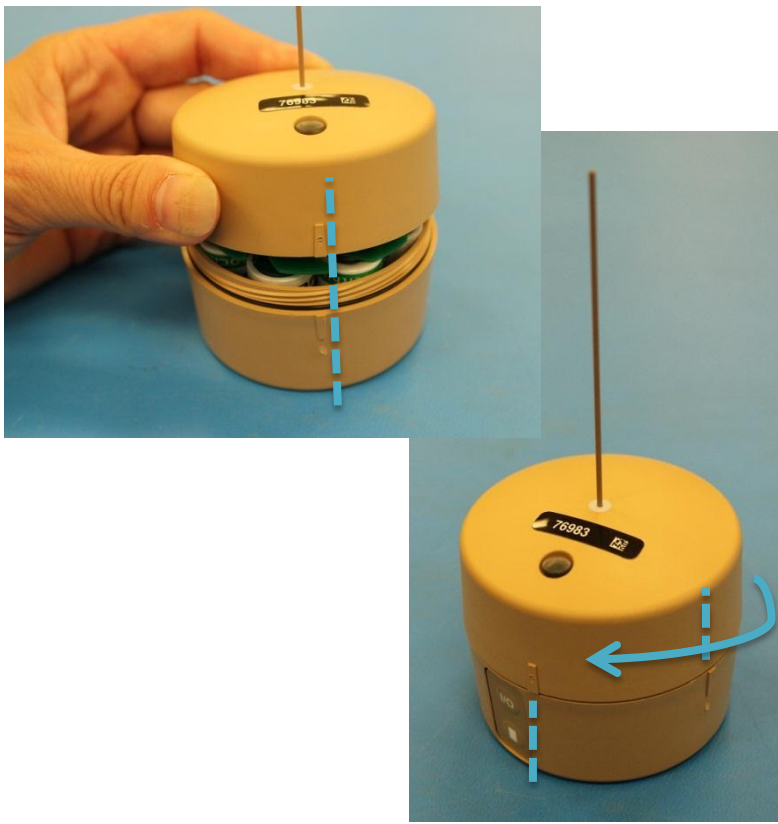
6. Remove and replace the batteries in the **EXACT** orientation and polarity shown.

7. Place the geophone assembly back into the base with the wires and protruding tilt sensor in the locations shown. Keep the wires to the outside of the batteries.



8. Plug the base and lid wiring harnesses back in to the circuit board.

9. Taking care not to pinch any wires, align the lid with the base, using the alignment indicators, and screw into place.



10 Safety Summary

10.1 General Safety Instructions

This manual describes physical and chemical processes which may cause injury or death to personnel, or damage to equipment if not followed properly. This safety summary includes general safety precautions and instructions that must be understood and applied during operation and maintenance to ensure personnel safety and protection of equipment. Prior to performing any task, the warnings, cautions, and notes included in that task shall be reviewed and understood.

10.2 Safety Signals

The safety signals used in this manual comply with ANSI standard Z535.6-2006 and/or ISO 3864-2:2004(E). Safety signals consist of four parts: heading (Signal Word or Icon), a statement of the hazard, minimum precautions, and possible result if disregarded.

10.2.1 Signal Words

Signal Words are used in this manual to highlight operating or maintenance procedures, conditions, or statements which are considered essential to protection of personnel or equipment. Signal Words immediately precede the step or procedure to which they apply. The headings used and their definitions are as follows:

The text used for signal words is a different font from the normal document text so that safety messages stand out in the document.

WARNING: Indicates a potentially hazardous situation, which if not avoided, will result in death or serious injury. Hazards identified by the signal word WARNING present a lesser degree of risk of injury or death than those identified by the signal word DANGER.

CAUTION: Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. CAUTION may also be used to alert against unsafe practices associated with events that could lead to personal injury.

NOTICE: indicates a potentially hazardous situation, which if not avoided, may result in damage to property, destruction of equipment, or loss of mission effectiveness.

10.2.2 NOTE

NOTEs are used in this manual to highlight operating or maintenance procedures, practices, conditions, or statements which are not essential to protection of personnel or equipment. NOTEs may precede or follow the step or procedure, depending upon the information to be highlighted. In this manual a note will be presented as shown below.

NOTE

Highlights an essential operating or maintenance procedure, condition, or statement.

10.3 Hazard Icons

Icons are used in this manual to identify dangers associated with hazards. The icons used and their definitions are as follows.

MANUAL – Do not operate unless you have read and understand the instructions and warnings in the Operation and Maintenance Manual.

MAINTENANCE PROCEDURE - Do not work on the system unless you have read and understand the instructions and warnings in the Operation and Maintenance Manual. Failure to follow the instruction or heed the warnings could result in injury or death.

CHEMICAL – Drops of liquid on hand shows that the substance will cause burns or irritation to human skin or tissue.

AVOIDANCE – Do not place hand in this area.

HEAVY OBJECT – Human figure stooping over heavy object shows physical injury potential from improper lifting techniques.

ELECTRICAL – Electrical wire to arm with electricity symbol running through human body shows that shock hazard is present.

EXPLOSION – If a battery is giving off gases, it can explode and cause injury to personnel.

RADIO FREQUENCY (RF) EXPOSURE – Radio frequency/non-ionizing electromagnetic radiation hazard/alert.

PUNCTURE HAZARD – Sharp object can puncture hand or other body parts.

ELECTROCUTION/SHOCK HAZARD – Contact with live overhead wires can cause shock or electrocution.

PROPER WASTE DISPOSAL - Improperly disposing of waste can threaten the environment. Obey all regulations for the disposal of materials.

DO NOT THROW AWAY IN TRASH – Some substances and materials can be unsafe to discard in the trash.

10.4 Safety Precautions

The following safety precautions shall be observed while performing procedures in this Operation & Maintenance Manual.

10.4.1 Trained Personnel


- For overall safety, only properly trained personnel shall be allowed to operate and perform maintenance on the system.

10.4.2 Environmental Factors

- Personnel may become ill or injured when exposed to extreme temperatures, adverse weather, poisonous plants or animals while setting up E-UGS.
- Lightning strike can cause death, disability, or serious injury to personnel and severe damage to equipment.

10.4.3 Electrical Shock

- Personnel may receive electrical shock from improper procedures while connecting system cables or while connecting Base Station equipment to a power source.

- Personnel may be injured or killed by electrical shock if E-UGS Base Station antennas come in contact with power lines or power source during Base Station set up or operation

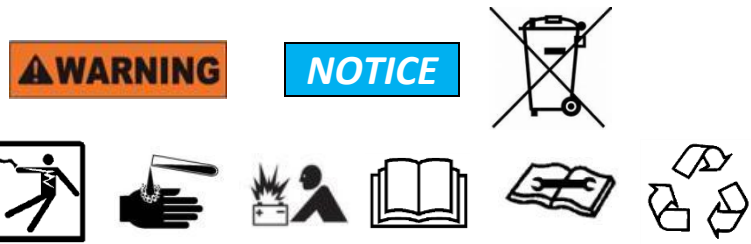
10.4.4 Radio Frequency (RF) Hazards

- The E-UGS system outputs very low RF Signals, 25mW or less. This level does not pose a threat to personnel when equipment is properly used. The E-UGS user manual and training course covers proper procedures for handling and setting up the Base Station, sensors, and antennas.

10.4.5 Ergonomics – Bending, Digging, and Lifting

- Repetitive bending and digging motions required for emplacing sensor fields could cause injury to arms, legs, shoulders, neck, or back.
- Poor posture or technique in lifting E-UGS cases could cause injury to neck, back, arms, or legs. Care should be used when lifting heavy objects.

10.4.6 Battery Hazards



- The E-UGS sensors contain Lithium Thionyl Chloride (LiSOCl2) batteries. Danger of explosion if the battery is improperly fitted. Fire, explosion and burn hazard. Do not recharge, short circuit, crush, disassemble, puncture, crush, force discharge, heat above 100°C (212°F), incinerate, or expose battery contents to water. Replace with equivalent in accordance with manufacturer's instruction. Dispose of used batteries in accordance with manufacturer's instruction.

- The E-UGS LiSOCl2 battery is compliant with IEC 86-4 safety standard and EN 50020 intrinsic safety standard. The LiSOCl2 battery is provided in a sealed package, which, unless damaged, will prevent exposure of the electrode materials and liquid electrolyte.

- The E-UGS module is housed in a watertight enclosure to prevent water or moisture infiltration. The housing material is compliant with the UL 94 flammability specifications.

10.4.7 Sharp Edges – Emplacement Tools

- The E-UGS emplacement tools, consisting of an emplacement tool and soil knife, have moderately sharp metal edges. Improper use of either tool may result in minor to moderate cuts or abrasions.

10.4.8 Puncture Hazard – E-UGS Module Antenna

- Personnel may sustain a puncture injury from the E-UGS antenna.

11 Appendix

11.1 Acronyms and Abbreviations

E-UGS	Expendable Unattended Ground Sensor
GHz	Gigahertz
GPS	Global Positioning System
Hz	Hertz (Cycles Per Second)
ID	Identification
ISO	International Organization for Standardization
km	Kilometer
LED	Light Emitting Diode
LOS	Line-Of-Sight
MHz	Megahertz
MSDS	Material Safety Data Sheet
PCB	Printed Circuit Board
RF	Radio Frequency
UGS	Unattended Ground Sensor
USB	Universal Serial Bus

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or toll free at

1-800-639-6315 (U.S.A.)

APPLIED RESEARCH ASSOCIATES, INC.

WARNING – The US Department of Commerce, Bureau of Industry and Security, has classified the E-UGS as ECCN 6A999.c (Commerce Control List, Part 774, Supplement No.1). This means the E-UGS system must not be exported or re-exported to embargoed or sanctioned countries, to parties of concern, or in support of prohibited end-uses (in the case of E-UGS, the prohibited end-use is Antiterrorism)