



STANDARD OPERATING PROCEDURES

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OPERATION OF THE EM61 HIGH SENSITIVITY METAL DETECTOR

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1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to outline the methods for locating buried ferrous and non-ferrous metal using a Geonics EM61-MK2 High Sensitivity Metal Detector.

2.0 METHOD SUMMARY

The EM61-MK2 is a time-domain, electromagnetic (EM), geophysical survey instrument. The EM source consists of two 1.0 meter (m) x 0.5 m coils which are mounted one above the other. One coil is a powerful transmitter that generates a pulsed primary magnetic field, which induces eddy currents in nearby metallic objects. The eddy current decay produces a secondary magnetic field that is measured by two receiver coils mounted in the coil assembly. This assembly can be pulled along on integrated wheels when terrain permits, or carried by a single operator from a shoulder harness. The data logger that records and graphically displays the responses may be set to record at fixed increments of time when being carried, or the odometer mounted on the axle of the trailer wheel can automatically trigger the data logger to record the measurements. The collected data are processed with the EM61-MK2 software and plotted in profile form or contour maps.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

This section is not applicable to this SOP.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Power lines, buildings, metal fences, and any surface metal objects will interfere with electromagnetic readings. Pipelines and buried utilities can also create strong interference, if they are not the intended target. Survey lines should be run perpendicular to any known interference. The location of any metal objects that are present in the survey area should be noted in the field book in order to avoid misinterpretation of the data. Since the EM61 is sensitive to very small metallic objects, the instrument operator should not wear large metal belt buckles, watches, or steel-toed boots.

5.0 EQUIPMENT/APPARATUS

- EM61-MK2 system, consisting of the coil assembly, backpack with battery and processing electronics console, and digital data recorder
- EM61-MK2 system compatible personal computer (PC)

6.0 REAGENTS

This section is not applicable to this SOP.

7.0 PROCEDURES

7.1 Trailer Mode Assembly

1. To assemble the trailer, place the top coil (smaller of the two) upside down on the ground with the small four pin inter-coil connection facing up. Insert the four stand-off posts so that the shoulders are seated and tighten the wing nuts. Mount the bottom coil upside



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down on the posts in the same manner making sure the inter-coil connectors are aligned. Select the wheel assembly with the short cable and place on the side of the bottom coil with the corresponding connection for the odometer. Place the second wheel assembly on the opposite side of the coil and secure both wheels with the clamps. Turn the coil assembly over.

2. Insert the boom into the aperture on the bottom coil by rotating the knob counter-clockwise so the expansion ring collapses. Lock the expansion ring by rotating it clockwise. Be sure that the four-pin lock ring is positioned so the data logger holder is facing up. Connect the wheel cable to the odometer connector on the bottom coil frame. Interconnect the top and bottom coils with the short coil interconnection cable. The data logger may be mounted on the boom or carried by hand.
3. Insert a charged battery in the backpack and connect the "REC" connector on the electronic console with the data logger cable. Connect the "COIL" connector on the console to the coil connector box on the lower coil. Fit the backpack to the operator and adjust the straps.
4. For a survey that does not allow for the passage of the 1-m width of coil assembly, the wheels may be mounted on the alternate sides of the coil assembly to allow for the narrow edge of the coils to be the leading edge.

7.2 Shoulder Harness Mode

Where the terrain does not allow for the use of the trailer mode, the coils may be carried by the operator with the four nylon straps on the hip belt of the shoulder harness clipped into the main coil frame. The straps should be adjusted so that the lower coil is about 40 centimeters (cm) from the ground surface.

7.3 EM61-MK2 Console Settings

The Master/Slave (M/S) control switch allows for the synchronous operation of two or more EM61-MK2 units. For the single unit operation, the switch should be set on "M". The mode switch allows for operation of the instrument in the four channel (4) mode or in the differential (D) mode. In the "4" mode, the instrument records four gates of bottom coil response only, at 216, 366, 660 and 1266 microseconds (Fs). In the "D" mode, three gates of bottom coil response are recorded at 216, 366, and 660 Fs, with one gate of top coil response at 660 Fs. The benefits of calculating differential data is to reduce or remove the effects of noise associated with surface and near-surface metal, and a calculation of the apparent depth to the target. For more on multiple time gate measurements see section 7.8.4

7.4 Survey Layout

The survey grid should be laid out with measuring tapes according to site geometry and survey objectives. If the direction of the expected target is known (such as a buried pipe), the survey lines should be perpendicular to that direction. If the target position or shape is not known, the survey lines should be laid out parallel to the site's longest dimension. The base line (0) should be established through the origin point (0,0). Survey lines are referenced according to their coordinates at the baseline. Coordinates are given either a positive or negative value or cardinal



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ordinates of north-south (N-S) or east-west (E-W). Tie lines should also be established at about 10 to 20 times the survey line spacing. These tie lines help keep the grid “square” and provide data for detecting long objects that may be missed with the regular survey lines. They may also be used as a basis to correct instrument drift or level shifts. Adequate notes, markings, and landmarks must allow re-location of the grid at a later date.

7.5 Survey Line Spacing

A large number of data points must be collected for accurate interpretation. The optimal separation between the survey lines is three feet. Additional survey lines may be added when searching for 100 percent (%) coverage.

7.6 Instrument Performance Check

Press the power button on the field computer with the EM61MK2 software installed. At the c:/ prompt, type “em61mk2a” and press the <Enter> key. Select Monitor/Null from the Main Menu that appears after the software program is started. Shortly, four channels will be displayed with a value in millivolts (mV). The four channels should have decreasing values from channels 1 through 4 in the “4” mode or channels 1, 2, 3, and T in the “D” mode. To perform the “null” or zero level of the instrument press the function key “F1”. The computer takes 25 readings and calculates the instrument offset. This procedure must be repeated several times in different parts of the survey area until lowest readings are obtained. The same position must be re-located for grids that are surveyed over the course of two or more days. This may also be necessary to compensate for instrument drift during a single day or if multiple grids exist at a site. After the instrument is zeroed, it should be pushed over or near metal. An increase in the readings will confirm that the instrument is performing correctly. This calculated offset is applied to all readings that follow this performance check. To exit the Monitor/Null option, press the function key “F2”.

7.7 Logger Setup

From the Main Menu, select Setup Logger. Several parameters such as date, time, units, serial port, audio option, pause key, and display are entered during the logger setup. A choice of text display or a graphical representation of the data is available.

7.8 Data Acquisition

7.8.1 Creating a File

This option can be executed before or after the Survey Setup parameters are specified. From the Main Menu, select the Acquiring Data option. Select Create File from the Acquiring Data screen. The name of the file consists of the month, day, and hour (mm/dd/hh) and one alphabetical character followed by a .R61 extension. Create by pressing “F1”.

7.8.2 Survey Setup

Select Survey Setup to specify the survey parameters. Alternatively, Preset Surveys can be configured and saved by the user for future use. Select one of the three modes



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available for data collection using the up/down (>?) or left/right (<=) keys. In the Auto Mode, readings will be triggered automatically at a specified time increment. In the Wheel Mode, readings will be triggered by a counter attached to the wheel. The wheel increment is 20 cm or 0.64-foot for the wheel equipped with the EM61-MK2. In the Manual Mode, a reading will only be taken when the manual trigger is pressed. For complete operation of the software, refer to the Geonics Operating Manual.

7.8.3 Data Logging

Select LOG DATA from the Acquiring Data option. If the instrument is on, the program will display the Log Data screen. Select the data collection mode by pressing the <Enter> key. Data will be logged in the mode selected in the Survey Setup menu. Logging of data will end when the Pause key is selected. The LOG DATA menu returns to the Standby mode.

7.8.4 Data Channels

The EM61-MK2 provides multiple measurements of the decay of the secondary magnetic field associated with any metallic object. Data is available from as many as four time gates, geometrically spaced in time from 216 Fs to 1,266 Fs. The earlier time gate is best for detection of small objects. A mid-range time gate is useful as it provides a response equivalent to the original EM61 for the purpose of comparing an old survey with the new one. The differential data (channel labeled T for top coil) is meant to reduce or remove the effects of noise associated with surface and near-surface metal and enables a calculation of apparent depth to the target.

8.0 CALCULATIONS

The apparent depth to target may be estimated using the EM61 computer software. A form of “data compression” is available for presentation which calculates the square root of the absolute value of the data while retaining the original sign.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

The following general quality assurance (QA) activities apply:

1. All data must be maintained electronically and/or documented in site logbooks.
2. The EM61 must be operated in accordance with the operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan (WP). Equipment checkout activities must occur prior to operation and must be documented in instrument, field, and/or personal logbooks.

The following specific QA activities apply to the implementation of these procedures:

1. Perform the “null” of the instrument with each use to monitor instrument performance, the condition of the instrument battery, and setting the zero level or “null” of the instrument. This location is noted in a logbook and the null must be repeated once a day during a survey. In addition, a calibration run may be performed over known objects at the beginning of each survey



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day.

2. All raw data files shall be maintained electronically in the project-specific folder located in the REAC administered I:Shared drive.

10.0 DATA VALIDATION

Data collected by the EM61-MK2 are not formally validated. Data validation is performed continually on a qualitative basis by the operator. The presentation of the data either in profile or contour form is peer reviewed prior to release of the data to the client.

11.0 HEALTH AND SAFETY

An EM61-MK2 survey is considered non-invasive. No digging, disturbing or handling of the soil is required during a survey. Therefore, no additional safety precautions beyond the site-specific Health and Safety Plan (HASP) is needed.

12.0 REFERENCES

Geonics Limited. 2002. *EM61-MK2 4 Channel High Sensitivity Metal Detector Operating Manual*.

13.0 APPENDICES

This section is not applicable to this SOP.