

STANDARD OPERATING PROCEDURE

DATA ACQUISITION USING THE C1 MEMOCONE SYSTEM

REVISION DATE: OKT 21, 2011

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STANDARD OPERATING PROCEDURE

DATA ACQUISITION USING THE C1 MEMOCONE SYSTEM

PURPOSE

This Standard Operating Procedure (SOP) describes a procedure for collecting CPT data using the Memocone and C1 data logger.

BACKGROUND

Groundwater assessment and remediation projects require determination of the direction and rate of groundwater and contaminant flow. Monitoring wells are typically used to estimate these parameters. However, detailed three-dimensional groundwater and contaminant flow pathways cannot be delineated using conventional monitoring well data because screens are typically set to a single depth range that does not allow for measurement of head values at discrete depths.

A piezocone is a direct push sensor probe consisting of a porous element connected to a customized transducer that converts pore pressure to water level. A high-resolution piezocone (U.S. Patents 6,208,940 and 6,236,941) is a recently developed sensor probe capable of generating highly resolved hydraulic head values (plus or minus 1 inch of water level) while simultaneously collecting critical cone penetrometer test (CPT) soil information.

The data acquisition system consists of three main parts:

1. The Envi datalogger C1 incl. depth transducer (typically a wheel-on-the-rod solution, but several alternatives are possible)
2. The Memocone CPT probe. The Memocone can be corded or cordless. When using a cordless Memocone you can either the Envi acoustic system for wireless transfer of real time data or the system can be run in memory mode without real time data presentation
3. A laptop running the C1 software application.

The procedure of collecting data is presented in the following sections.

DEFINITIONS

Cone Penetrometer Test (CPT) – Hydraulic rams on the CPT truck are used to push an instrumented probe into the ground. The probe collects cone pressure and sleeve friction data. This test relates cone pressure and sleeve friction to soil behavior classification. CPT data can be used to objectively describe physical soil properties.

Pressure Dissipation Curve – The pore pressure dissipation curve represents observed changes in pressure over time as measured via a transducer in the high-resolution piezocone for a specific depth. The final pressure represents the hydrostatic pressure, which is a reflection of the weight of water measured at that specific depth. The rate of dissipation can be used to determine the hydraulic conductivity of the soil adjacent to the probe during the dissipation test. The examples of pressure dissipation curves are plotted below.



Push – The act of using the CPT truck to push a probe into the soil. A push is the result of this action.

APPARATUS AND MATERIALS

- CPT truck, rig or pusher
- Data logger (Envi Logger C1 or CS1)
- USB A to B cable for connecting the logger and PC
- Portable depth transducer if any and cable for connecting it to logger
- Power cable for data logger
- Preferably a separate 12 volt battery (type car battery) for powering the data logger
- Memocone to Logger cable
- Battery plug
- Spare batteries of type C (5 or 6 depending on type of battery tube)
- Expendable materials including:
 - At least one spare 36 mm diameter slot filter
 - O-rings
 - Grease for the slot filter
 - Oil or other suitable fluid for the cone pore pressure chamber

PROCEDURES

Memocone preparation

1. Remove/Unscrew cone



2. Remove the front seal O-rings from the sleeve (see arrow above)

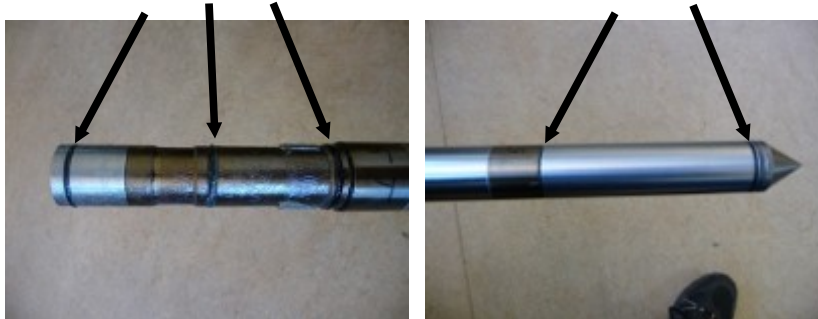
3. Remove sleeve



4. Check all O-ring assemblies

5. Remove any soil or dirt

6. Replace O-rings as necessary. O-rings in left picture replaced when dented/worn and O-rings on right side replaced for every push



7. Apply O-ring lube or Envi CPT grease to all seal seat areas

8. Check for any moisture behind the sleeve assembly

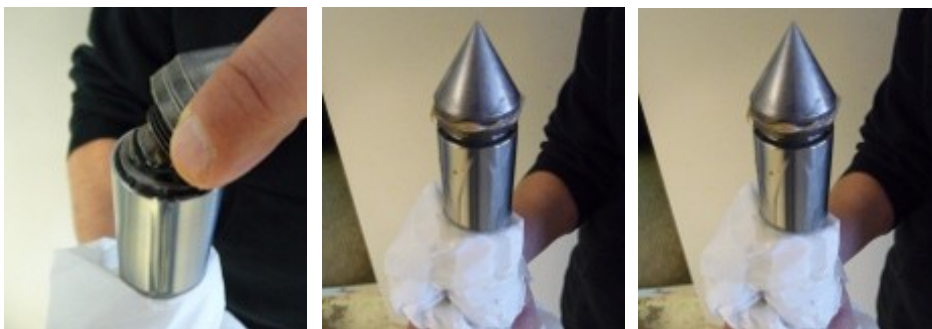
9. Fill the cone tip with grease. Make sure NO air is encapsulated in the grease and that it seeps out around the entire slot. Wipe excess grease off and put aside



10. Be sure that the pore pressure chamber is clean and fill it with CPT oil to $\sim \frac{3}{4}$



11. Using a small probe or dental tool, sweep all interior surfaces to eliminate void spaces or bubbles. It is critical to the data collection process that all of the bubbles are removed from the internal space between the transducer and the filter element
12. Use a substantial amount of paper around the sleeve and hold the probe with it
13. Thread the cone tip in place. Now the surplus oil will cause flooding and the paper is good to have to soak it up together with grease coming out of the cone tip. The cone needs only be tightened firmly by hand or gently using a slip joint pliers or equivalent. If a tool is used be sure not to damage the slot at the cone base when tightening the cone tip



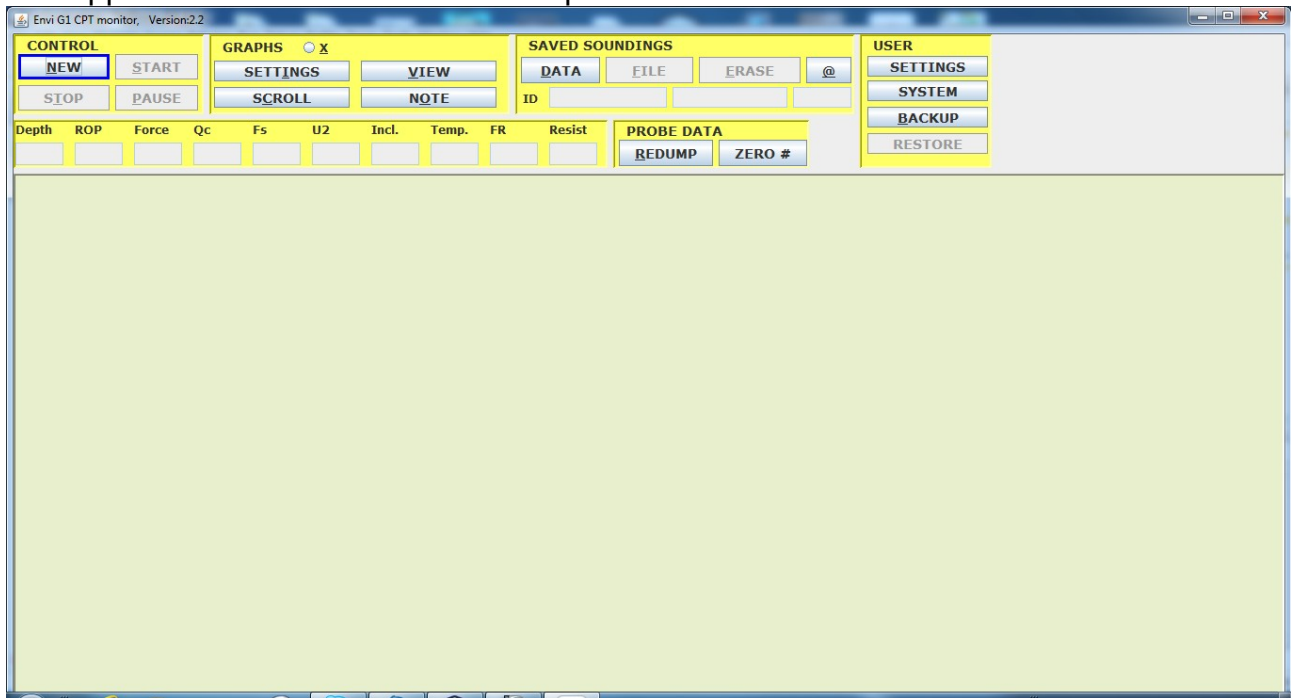
14. In contrast to probes with porous pore pressure filter you can now store the probe in any position without losing saturation

Prepare the Data Collection Software and Collect Data as Follows:

- Connect everything but the PC to the logger and power it up



- Connect the PC to the logger using the USB A to B cable
 - Start the application by double clicking the CPTapplication icon on your desktop.
- The application main window will now open



- Plug the Memocone cable into the logger and Memocone. Be careful to insert the plug correctly and that no pin in the contact is damaged



- With the probe connected to the logger make sure the probe is free from stress on all sensors and keep it vertically
- Create a new sounding by pressing NEW button in logger GUI. You will now get a pop-up window where identifier data for the push can be defined. There are three mandatory fields:
 1. Project ID
 2. Sounding ID
 3. Method
 See ovals marking the three fields in image below.

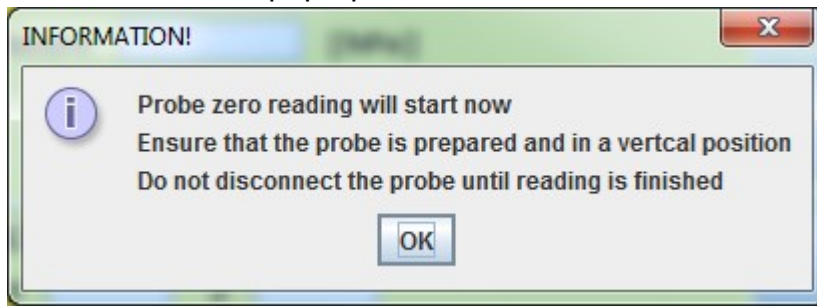
 A screenshot of a software window titled "Set identifier data". The window has a yellow background and is divided into several sections:

- IDENTIFIERS:** Contains text input fields for "Project ID" (value: test), "Sound. ID" (value: 14), "Location" (value: bastukærr), "Company", "Operator", and "Supervisor".
- METHOD:** A dropdown menu currently showing "CPT".
- CLIENT:** Text input fields for "Company" and "Contact person".
- PROBE FACTORS:** Input fields for "A" (value: 0.68) and "B", and a "Sondtyp" section with radio buttons for "Cable" and "Wireless" (selected).
- ENVIRONMENTAL FACTORS:** Input fields for "Ground water table [cm]", "Barometric pressure [hPa]", "Temperature [C]", and "Inclination [Degrees]".
- COORDINATS:** Input fields for "X", "Y", and "Z".

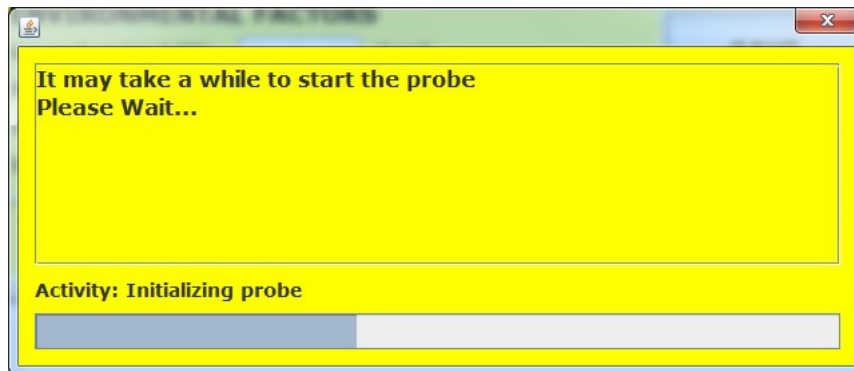
 On the right side of the window, there are three buttons: "SAVE", "CLEAR", and "ABORT". Three red ovals are drawn around the "Project ID" field, the "Sound. ID" field, and the "METHOD" dropdown menu.

- Once you have entered data into the mandatory fields plus those of your desire you can press SAVE to go to the next stage.

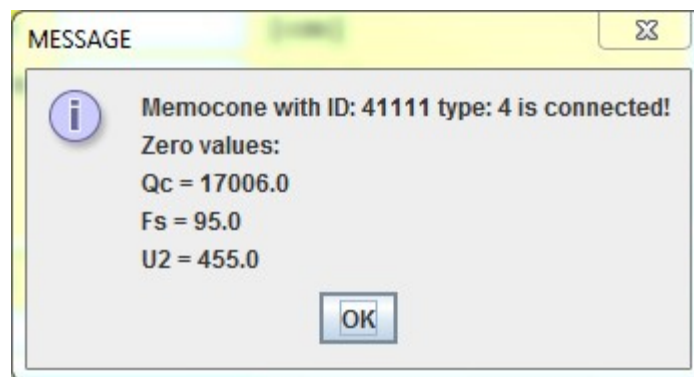
- You will receive a new pop-up with instructions for zero reading:



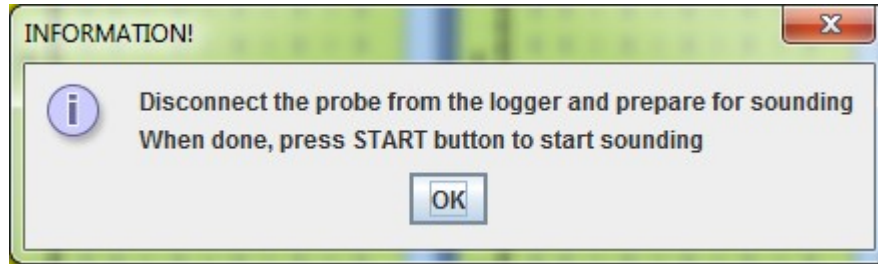
- When the cone is in a good position you can press OK in the pop-up dialogue and zero reading will start. You will get a wait dialogue showing you progress of probe initialization. The first time you use the system the port to use is also determined and will render an extra wait dialogue before this one. This only happens first time when port is determined after that only the below wait dialogue will appear.



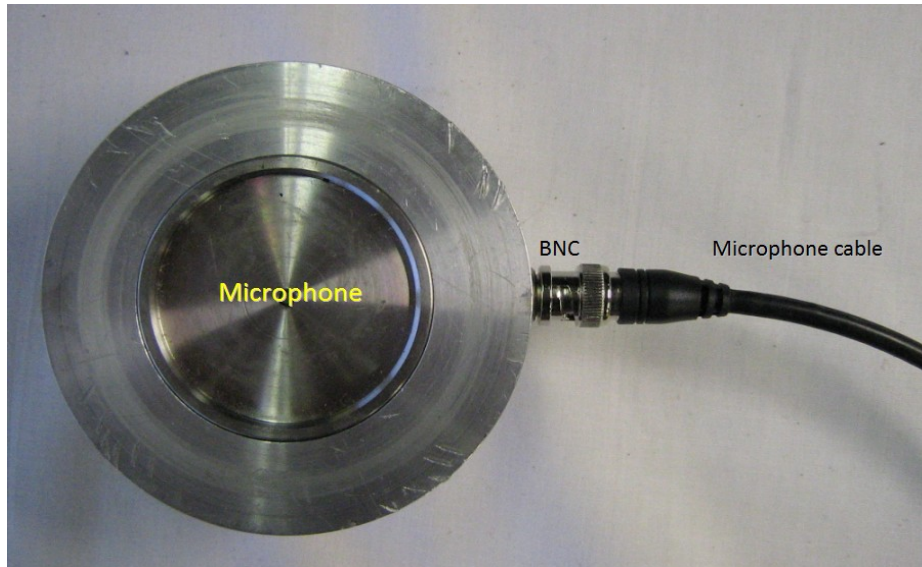
- When the initialization is done you will get a pop-up with the zero values for the different parameters. If any parameter is zero the corresponding sensor is bad and the probe needs overhaul.



- Press OK to close the zero value pop-up.
- You will now have another pop-up telling you to disconnect the probe (if it is wireless) and prepare it for sounding which means advancing it to ground level or the start level of your choice.



- If you use the Acoustic mode, don't forget to connect the microphone to the logger, and use it to push the rods.



- When the Memocone is in position press OK then START button in main window (see red oval in main window image below). You will be requested to enter start level:

- Enter
millimeter.
above). Pre

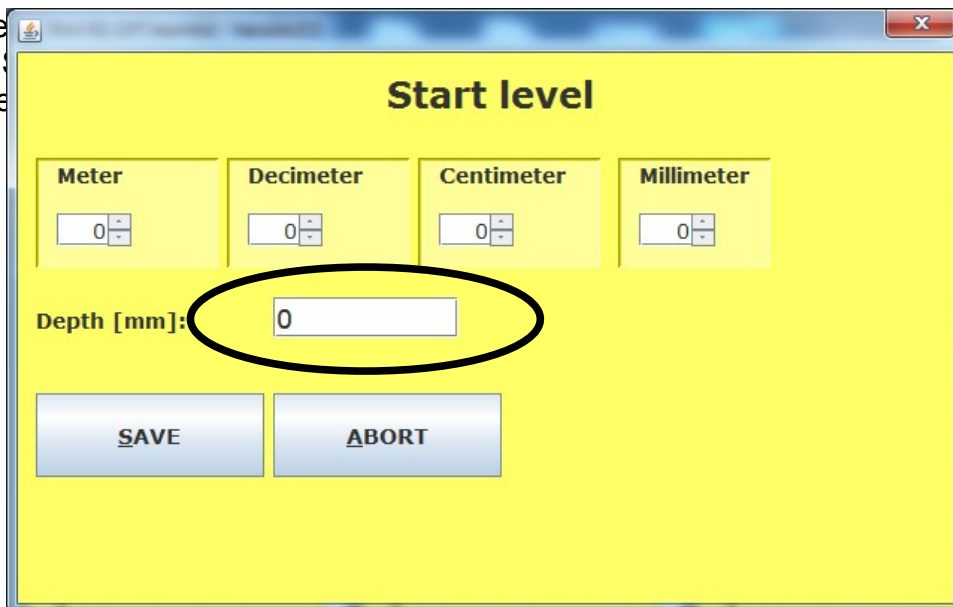
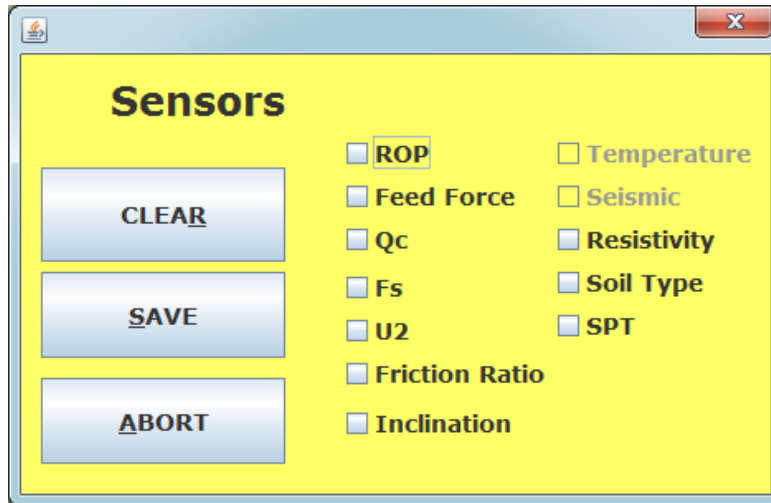
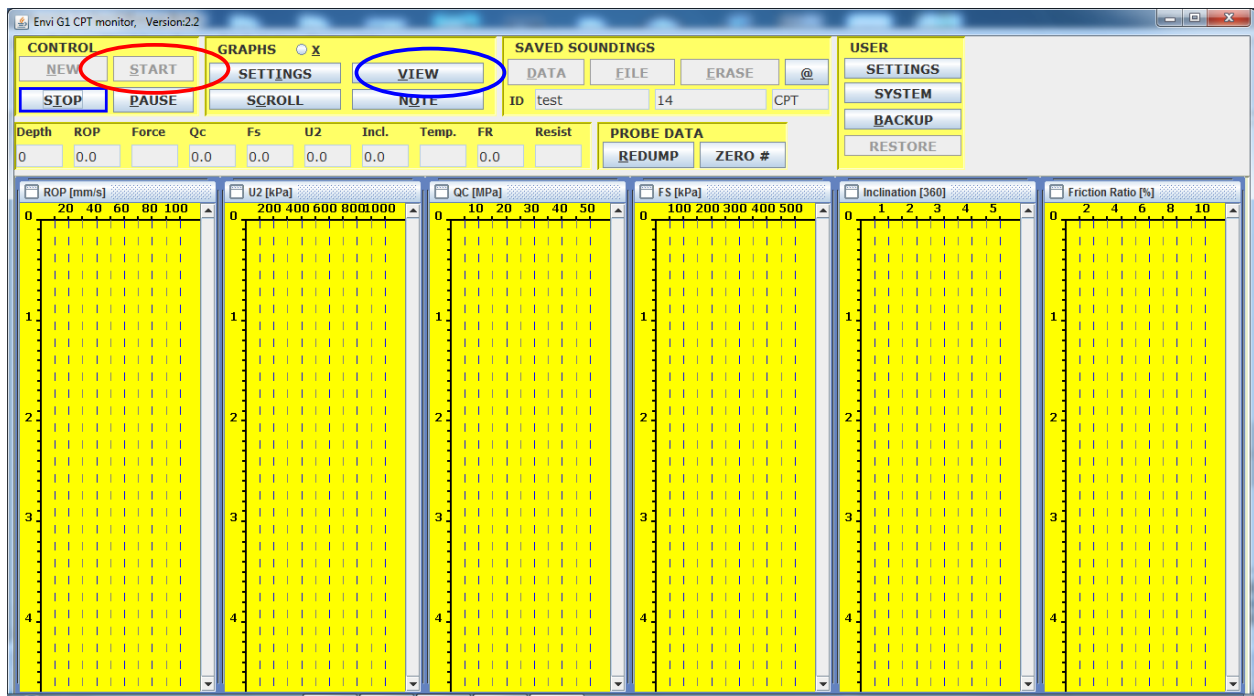


image:

- First time you use the system no graph windows will appear. You must tell the system what graphs you like to see. You do that by pressing button VIEW and check mark the parameters of your desire. The system will remember your choice and open the same graphs next time. You can change this setting at any time.

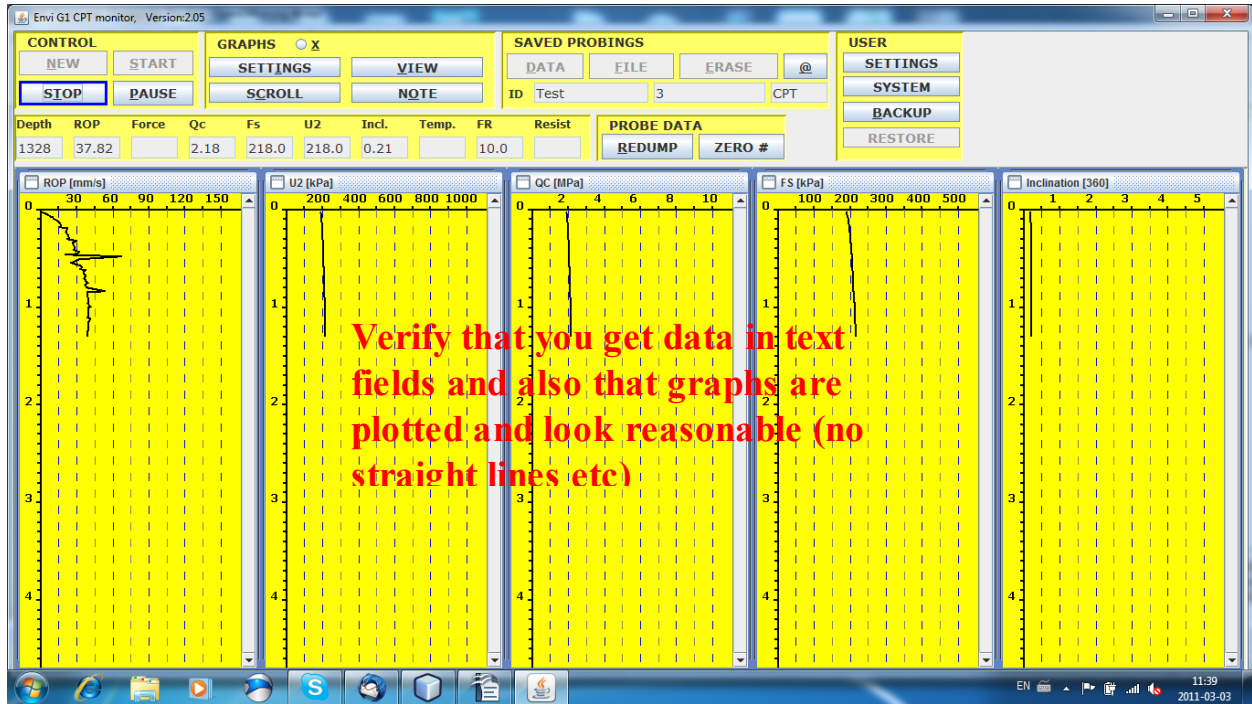


- I selected parameters ROP, Qc, Fs, U2, Friction ratio and inclination, so I got five graph windows. Friction ratio is still a beta release and will be developed together with soil type determination which is also beta at the moment

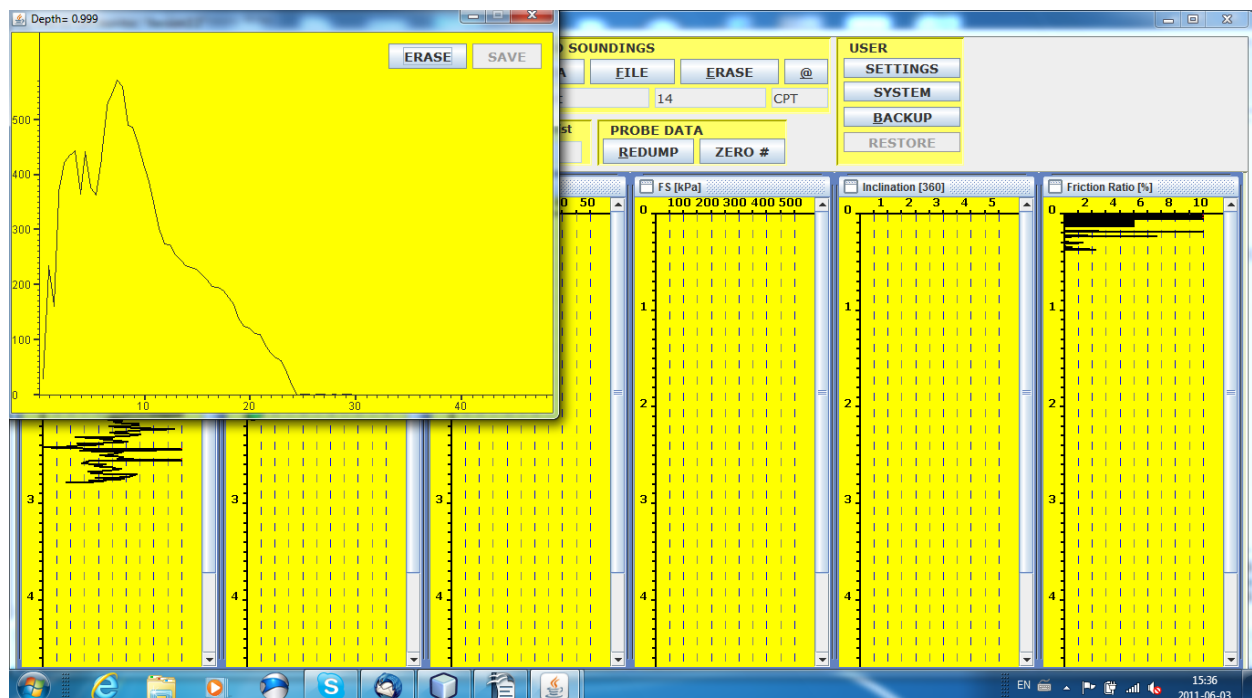


- Begin the push

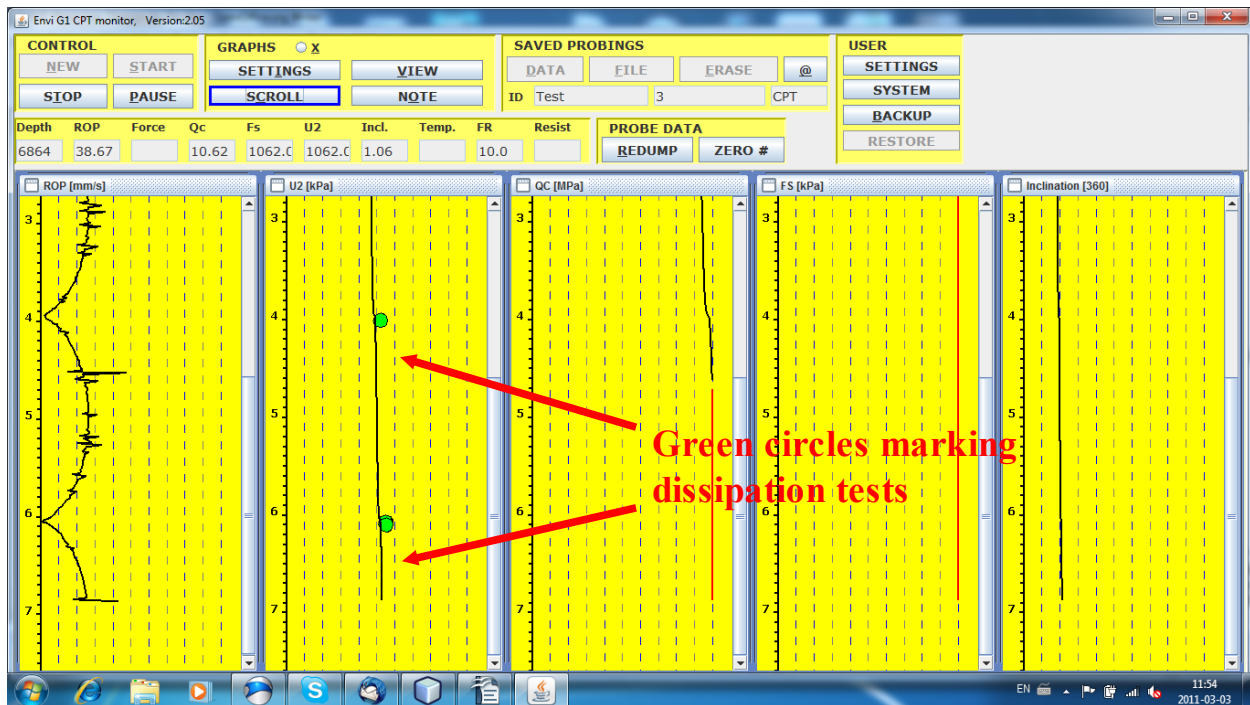
- If you have a real time data acquisition system (Corded or Acoustic), verify that the system is correctly collecting data



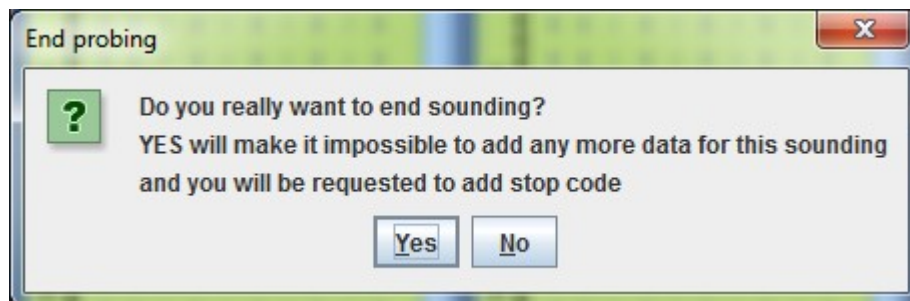
- When the desired depth for dissipation test is reached stop the push and the system will automatically start collecting dissipation data. After a predefined time (see chapter about adjusting settings further down for details) the dissipation window appears and shows the dissipation of pore pressure



The pressure observed will typically start at a high positive pressure and the pressure will dissipate to the ambient hydrostatic pressure. Be sure to save enough dissipation data to be able to determine T50 adequately



- When you are satisfied with the dissipation data collection you simply continue the push and the system will abort and save the dissipation. The dissipation is shown as a green circle in the graph and can be opened for viewing or deletion at any time. If you have received a dissipation that you do not want to keep you can easily erase it by pressing the Erase button in the dissipation window
- When you have reached the desired depth for ending the sounding and having stopped for all desired dissipation depths you can end and save the sounding by pressing STOP in the logger GUI. You need to verify this by pressing OK in a pop-up to ensure that you don't involuntarily terminate a sounding



- Press Yes to confirm and the next pop-up will appear. This new pop-up will allow you to add a stop code defining why the test is stopped:

ADD NOTE

Depth [m]

Code

Your codes

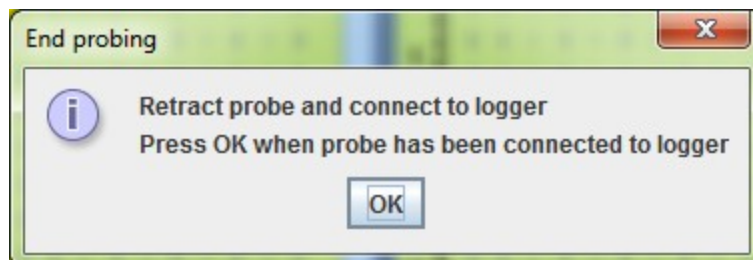
New code of your own

Index *Text*

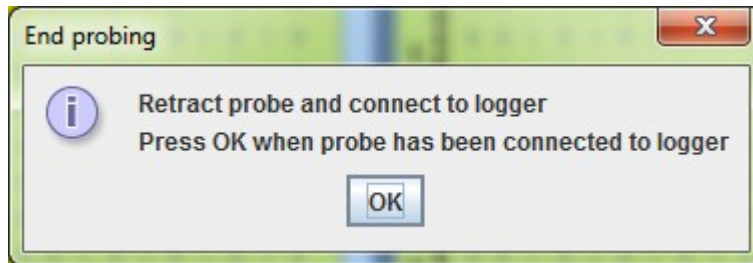
NOTE

Select a stop code or write your own free text code in the NOTE field and press SAVE. The SAVE button will be enabled when you have entered something that the system can use for stop code. if you have no desire to define a stop code you simply press ABORT and no stop code will be added

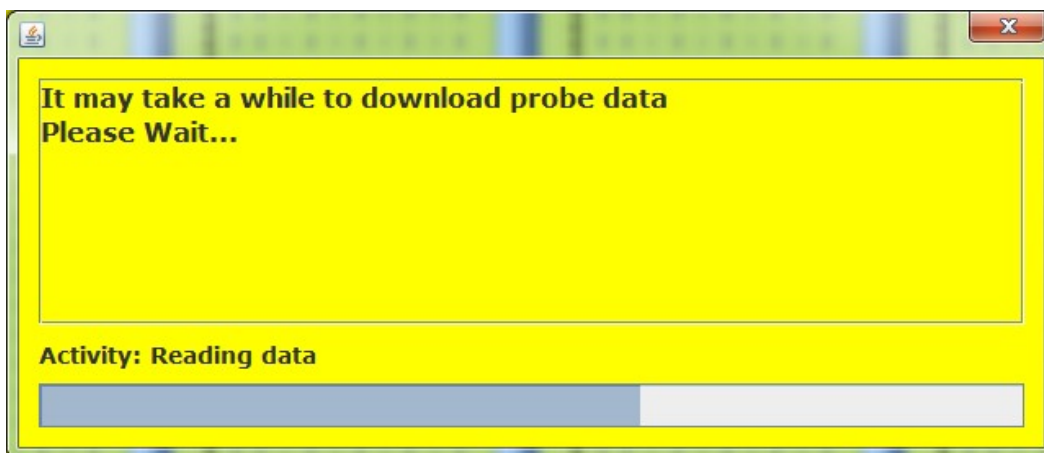
- Next you will be requested by another pop-up to retract the Memocone and reconnect it to the logger. Do not press OK in this pop-up at this stage



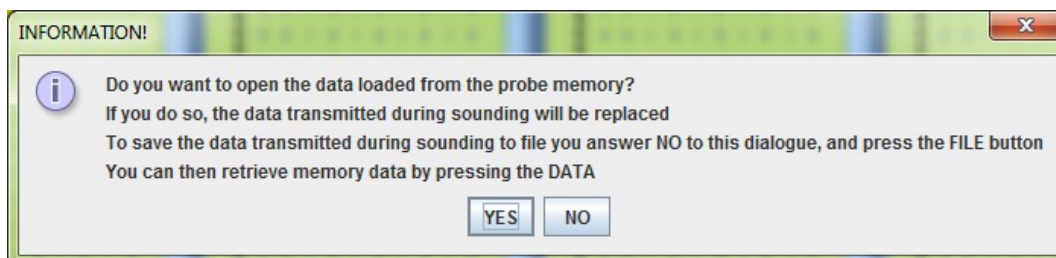
- Retract the probe and when having it on surface remove the battery tube and battery plug from the probe. Then reconnect the probe and make sure you keep it without stress on any sensor and vertically. Press OK in the pop-up in the logger GUI



- Memory data will now downloaded but first probe zero values will be read so you have a complete set of zero values both before and after the test. Until you download memory data you will have the acoustic data on screen. Be sure to allow memory data to replace the acoustic data for best data quality. The system let's you decide if you want to do this (strongly recommended that you do this):

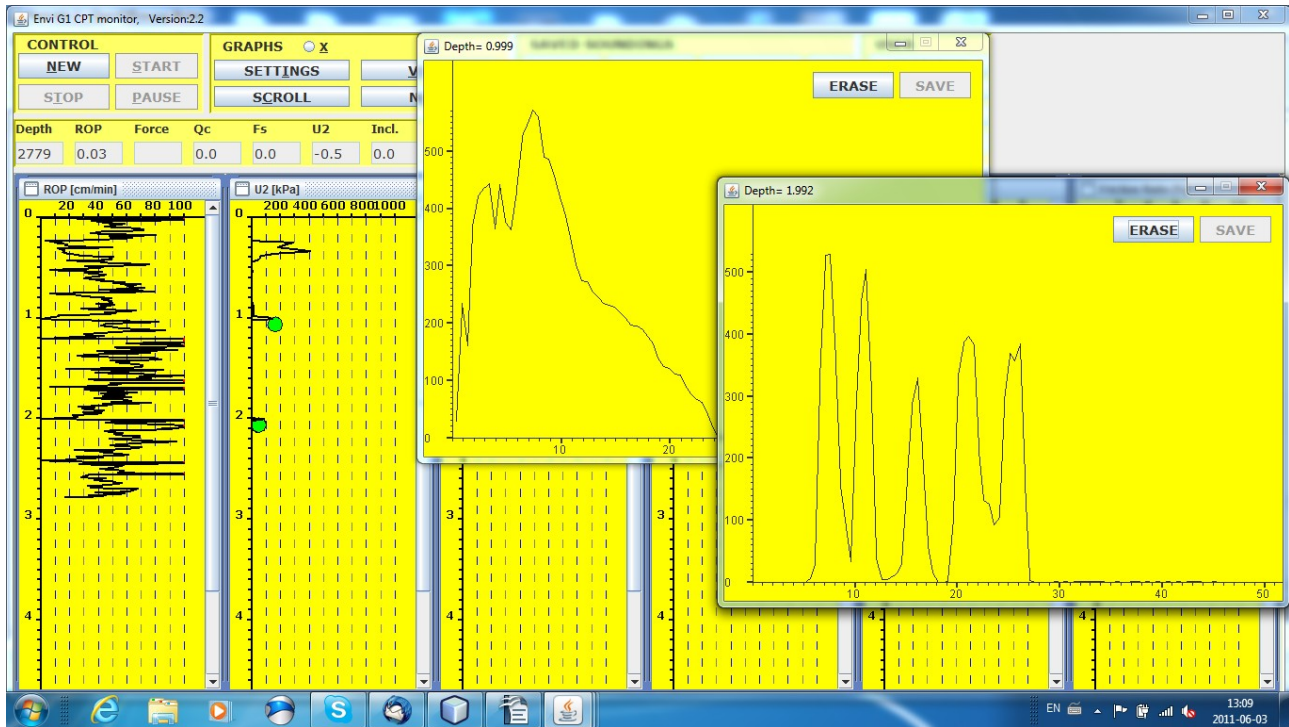


- When data has been downloaded (it can take quite a long time) a pop-up will appear asking if you want to open the downloaded Memocone memory data. Normally you accept this by pressing Yes so data is opened on screen.

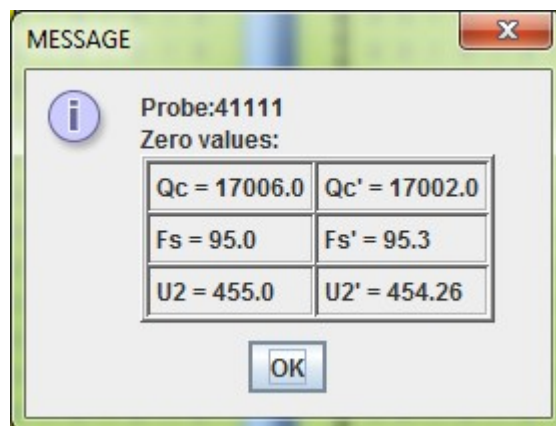


- The system always create file with the data that is on screen, so if you chose not to open memory data and create a file you will end up with a file with real time data. That data is not as accurate as the memory data so this behavior is not recommended.

- If you select Yes a new wait dialogue appears and data is processed and opened for viewing.
- The sounding is opened and the dissipation tests are shown as green circles in the pore pressure graph and can be opened for viewing or deletion by clicking on a circle.

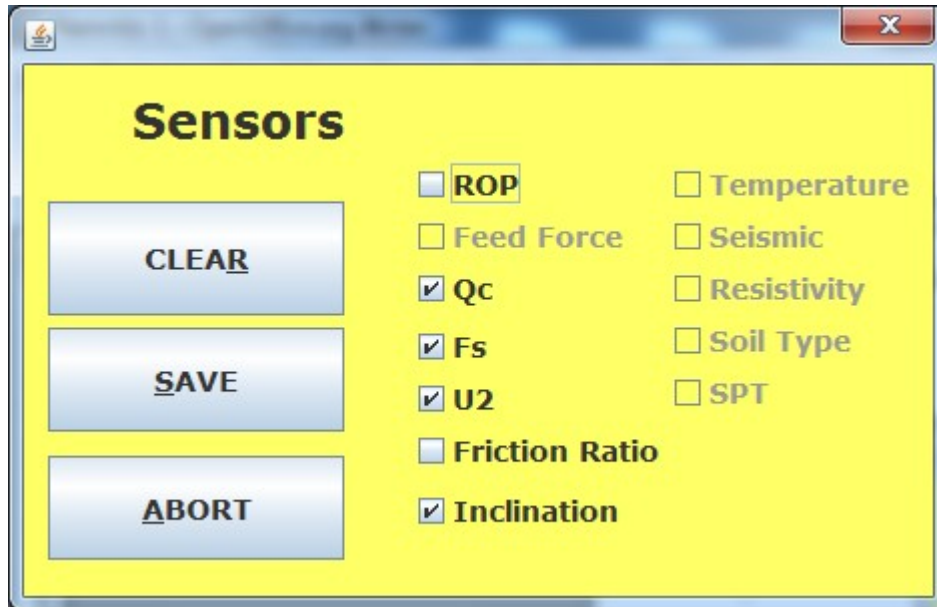


- You can verify that no abnormal zero values have been received by pressing the ZERO button in main window. Only small changes < 10% shall be received.



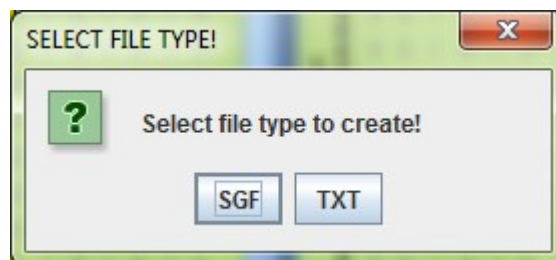
Creating file

- Click the FILE button in main window and select the sensor data you want to have in your file. Normally Qc, Fs and U2 would be sufficient but also ROP and Rf may be selected. Rf is beta so it is not recommended to include in file at this moment.



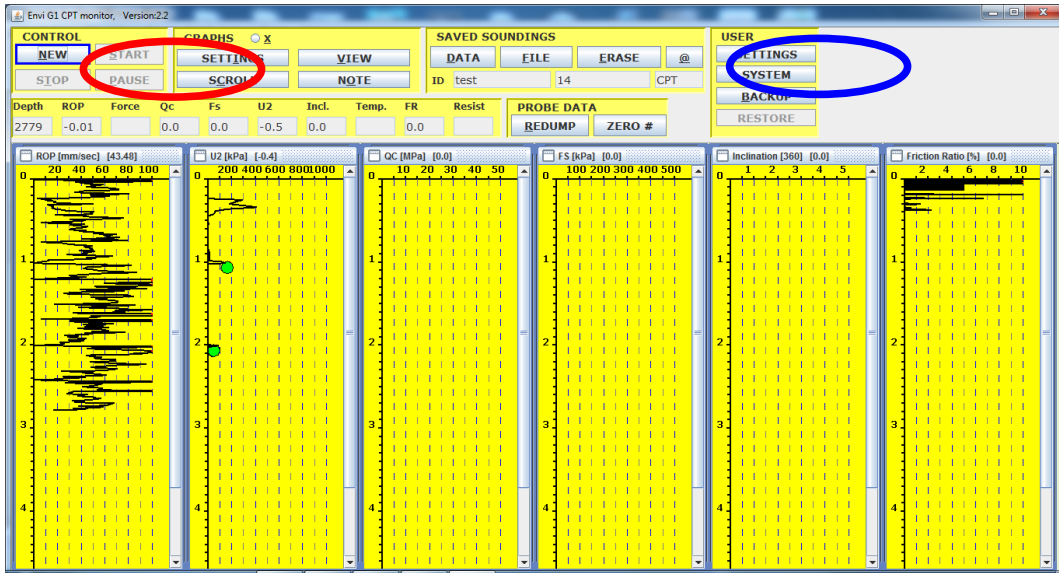
Press SAVE when you have check marked the sensors of your choice.

- A wait dialogue will appear until preliminary file has been created. Then you will have a pop-up window as per below asking for what file type you want to create. Assuming that you want to create a txt-file and then you press TXT button. This file type is a simple tab separated file which can easily be imported to Microsoft Excel or OpenOffice Calc.



Adjust logger settings as Follows:

- If you want to change the settings for graphs (max values, dissipation settings etc) you press SETTINGS in GRAPHS panel (see red oval in image below). You will then have a pop-up window for defining these settings.



- Some settings are available under USER SETTINGS. Mainly static settings such as whether or not to create a separate note file or not. There is also a button "File & Email" (see black oval below) which will open another pop-up

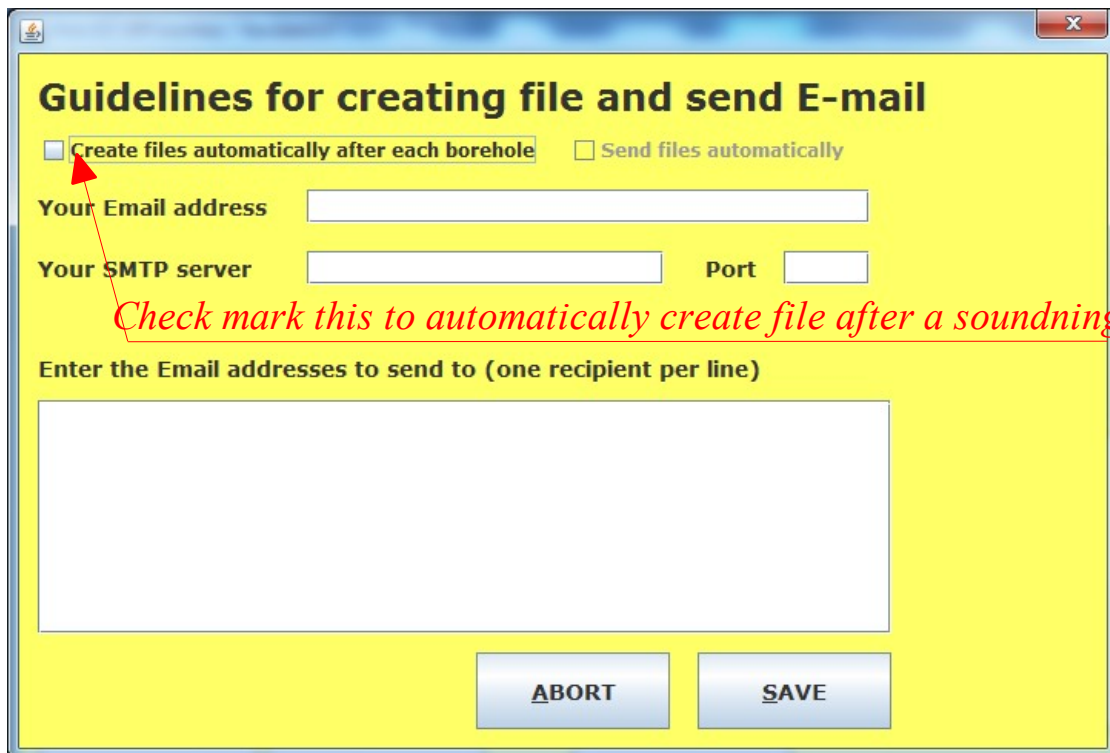
The dialog box is titled "Set presentation parameters for graphs". It contains the following sections:

- RESOLUTION AND MAX VALUE:**
 - ROP, Max: 100 [mm/s]
 - QC, Max: 50 [MPa]
 - Fs, Max: 500 [kPa]
 - U2, Max: 1,000 [kPa]
 - No of meters: 5 [m]
 - Resistivity: 10 [Ωm]
 - Inclination: 5 [Degrees]
 - Force: 200 [kN]
 - Friction Ratio: 10 [%]
 - SPT: 10 [Blows/20 cm]
 - Classification method: None, Robertson 86, Eslami-Fellenius
- APPEARANCE:**
 - Depth in text: Last, Deepest
 - Line width graph: 2 [Pixels]
 - Line width coordinate axis: 2 [Pixels]
 - Size of Note Rectangle: 8 [Pixels]
 - Diameter dissipation circle: 15 [Pixels]
 - Note text: Code, Code + Text, Invisible
- DISSIPATION (circled in green):**
 - Close, Leave open
 - Delay for dissipation test: 20 [s]
- UNITS:**
 - ROP: mm/sec, cm/min

Buttons for ABORT and SAVE are located at the bottom right.

window where you can define if you want the system to create a file automatically when the sounding is stopped or not. You can also define settings for sending Email with the same file. This of course requires internet

connection in order to work. You must specify the same settings as you have in your regular Email client



The image shows a software dialog box with a yellow background and a blue title bar. The title bar contains a small icon on the left and a close button (X) on the right. The main content area is titled "Guidelines for creating file and send E-mail". Below the title, there are two checkboxes: "Create files automatically after each borehole" and "Send files automatically". A red arrow points to the first checkbox. Below the checkboxes, there are three input fields: "Your Email address", "Your SMTP server", and "Port". Below these fields, there is a text label "Enter the Email addresses to send to (one recipient per line)" and a large empty text area. At the bottom of the dialog, there are two buttons: "ABORT" and "SAVE".

Guidelines for creating file and send E-mail

Create files automatically after each borehole Send files automatically

Your Email address

Your SMTP server Port

Check mark this to automatically create file after a sounding

Enter the Email addresses to send to (one recipient per line)

ABORT SAVE