

TI 226C Calibration

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1. PURPOSE AND APPLICABILITY

The purpose of this SOP is to describe the calibration procedures used during field maintenance for all IMPROVE network sites.

2. SUMMARY OF THE METHOD

The field technician performs a calibration of the modules after completing an audit and general cleaning of the equipment. The calibration corrects current flow rates and equations in the event of any drift since the last maintenance visit due to equipment malfunction or new equipment installation.

3. CAUTIONS

Make sure that the magnehelic is set to zero (while the dial is vertical) and that the tubing for the device is straight before beginning the calibration.

4. EQUIPMENT AND SUPPLIES

A black, hard-cased audit kit should contain the following:

- Magnehelic and Probe
- One calibration cartridge for each module, four total (or five if a double "C" cartridge has been added)
- One 5/32" hex key
- NIST-certified thermometer

The field technician should also have a prepared, site-specific audit/calibration sheet.

5. PROCEDURES

5.1 Preparing the Modules and Controller for the Calibration

- 1) Open the controller door and press the "Enter" button, which will bring up the main menu.
- 2) Remove the sampling cartridges from the modules. Make sure that final readings have already been taken.
- 3) Insert each calibration cartridge into its corresponding module.

5.2 Recording Temperature, Max Orifice, and Zero Values

- 1) In the audit device case, there will be a NIST-certified thermometer. Please take the thermometer out of the case and place it in the shade next to the "C" module. Turn the power switch to the "On" position and the unit switch to "C°." Do not remove the tip cover from the thermometer, as this can cause the reading to become unstable. Disconnect the temperature probe from the "C" module and place the tip of the probe next to the thermometer. Allow the thermometer to equilibrate for approximately ten minutes.

- 2) To take the temperature reading from the probe, press the "1" key. The millivolt reading will be on the left-hand side of the display. Record this value in cell A25. Then, record the value reported by the thermometer in cell B25.
- 3) To take Max Orifice (or MxORI) values, make sure the display is showing the main menu. Press "2." All the pumps should turn on. After running for a few seconds, MxORI values will appear for each module. Record the values for each module in cell E25 for each sheet.
- 4) To take zero values for the ORI and CYC of each module, go to the main menu and press "F3" for the advanced menu. Enter the code "9051" and then press "F2" for "Get Zero Flows." Note that if the system was sampling upon arrival, going to the advanced menu will halt sampling. The controller display will show the zero values for the "A" module. Enter the values in cells F25 and G25 of the "A" module sheet. Cycle through the modules by pressing "Enter" and record the values in the appropriate sheets and cells. When finished with the last module, press "Enter" to return to the advanced menu. Press "Enter" again to return to the main menu.

5.3 Preparing the "A" Module and Magnehelic

- 1) Place the magnehelic on the inside of the module "A" door. Note that it is important that the dial remains vertical while being read. The magnehelic has a magnet on the back, so it will stay attached. Make sure that the magnehelic reads "0." If not, adjustments can be made using the two knobs in the lower left corner of the device. First, loosen the outer knob, which is the smaller of the two. Then, turn the larger knob (which is between the two metal pieces) to adjust the pitch of the device until it reads "0."
- 2) Once the device reads zero, tighten the smaller knob down to the metal so that the outer metal piece is held in place by the two knobs.
- 3) Inside the "A" module, locate the stack plug and the black plastic cap. Remove the cap by pushing down on it from the top, and remove the plug by pulling down on the brass fitting.
- 4) Place the probe into the Tee. Do this by pushing the probe (hose end down) through the bottom of the module and up into the Tee until the probe bottoms out.

Figure 1. Removing the Plastic Cap and Stack Plug

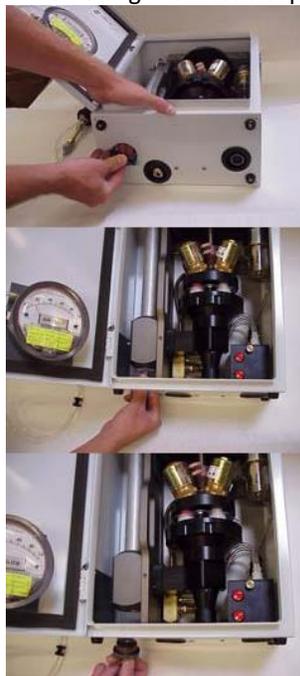




Figure 2. Inserting the Probe into the Tee

5.4 Preparing Module "D"

- 1) In order to calibrate module "D," first raise the stack to accommodate the audit probe. There are two things that need to be loosened before the stack can be raised. First, loosen the locking collar on top of the module by turning it counterclockwise. Then, take the 5/32" hex key and loosen the four screws of the "D" brace. Do not remove the screws.
- 2) Slide the stack up approximately four inches or until it is above the "D" brace. After moving the stack, retighten the locking collar to temporarily secure the stack.



Figure 3. Module "D"

5.5 Setting Zero Flows and Beginning the Calibration

- 1) Return to the controller's display. From the main menu, select "F3" for the advanced menu. The display will ask for a password. Enter "9051." Do not press the "Enter" button after submitting the code.
- 2) Now select "F2" for "Get Zero Flows." A "CYC" value and an "ORI" value will show for Module "A."
- 3) The two potentiometers (pots) on the side of the electronics box (Ebox) will need to be turned until the "CYC" and "ORI" values read 5.0 and 10.0 respectively. In order to gain access to these pots, the Ebox will need to be reconfigured. Disconnect the grey cable underneath the "A" module by twisting it. Now loosen the two thumb screws on the electronics box next to the two red buttons. These screws do not come out; they just loosen. Once the screws are loose, pull the electronics box partially out of the white module case and reconnect the grey cable by routing it through the module door (not the bottom hole as before). Now the Ebox is free to move and the two pot holes are visible and accessible on the side of the box. Use the small flat screw driver from the audit kit case to adjust the pots so that the values on the screen read 5.0 and 10.0 for the CYC and ORI respectively. Please note that most adjustments will only require one full turn. These pots are delicate and should not be turned more than 3 full turns in either direction. If the values on the keypad are not adjusting, make sure that the appropriate module is being worked on by checking the controller display to see what module is currently turned on. (Note, this repositioning of the Ebox will also help with access to the valve in step 1 of section 5.6)
- 4) Repeat step 2 for the "B" and "C" modules, pressing "Enter" to advance from one module to the next.
- 5) The "D" module pots are easily accessible without having to move the Ebox. They can be accessed from the right of the box using the small pot screwdriver provided.
- 6) After setting zero flows, press "Enter" to get back to the advanced menu, and then press "Enter" once more to get back to the main menu.
- 7) From the main menu, press "F3" for advanced menu. This time enter the code "1123" and select "F1" for "Calibration" mode. The module "A" pump will turn on.

5.6 Filling in the Calibration Sheet

- 1) The display will show two values (ORI and CYC). The magnehelic will indicate a value as well. Look at the number in cell B9 ("Q_{SITE}"). If there is no number listed, enter the device constants (which are located on the audit device case) and a number should be generated. Enter the number displayed in cell B9 into cell H25, and then check the value displayed in K25, which is the liters per minute (lpm) that will be generated with that particular magnehelic value. The number in cell K25 should be at least 23.0. If the number is below this, adjust the number in H25 by adding 0.01. Once the flow rate value in K25 is acceptable, the magnehelic needs to be adjusted to reflect that flow rate for position #1. To achieve this flow rate, manipulate the value located at the bottom center of the module (behind the cyclone, with a black knob) until the magnehelic value matches that of the value in H25.
- 2) Look at the controller display. It will show two values for position #1, the Orifice (ORI) and the Cyclone (CYC). Enter these in cells I25 and J25, respectively. If either of the values is

unstable, note the full range of values in the comments section on the bottom left of the calibration sheet.

- 3) Once these values are recorded, press the "F4" button to move to the second position of the calibration cartridge, and record the magnehelic and ORI/CYC values in cells H26-J26. Repeat the previous steps for positions #3 and #4, recording the values in the appropriate cells.
- 4) Repeat steps 1-3 for all four positions for modules "B" and "C" with one exception; the magnehelic value in H25 that produces the appropriate flow rate will already be filled in. All that is needed for position #1 for both the "B" and "C" cartridges is to adjust the magnehelic (by turning the valve behind the cyclone) to the value in H25 and then record the ORI and CYC.

5.7 Preparing the Magnehelic Probe

In order for the probe to fit into the funnel of the "D" module, it is necessary to make two modifications to the probe itself:

- First, locate the spring-loaded coupler, which is between the probe and the probe plug. Push this coupler's outer sleeve down (toward the hose). This will release the probe plug.
- Secondly, locate the 3-inch brass extender bar, which is attached via quick connects. To remove this extender bar, disengage the quick connects by pushing on the buttons and gently pulling the bar away. After removing the extender bar, attach the quick-connect fitting on the hose to the probe quick-connect.

Figure 4. Releasing the Probe Plug



Figure 5. Modifying the Probe

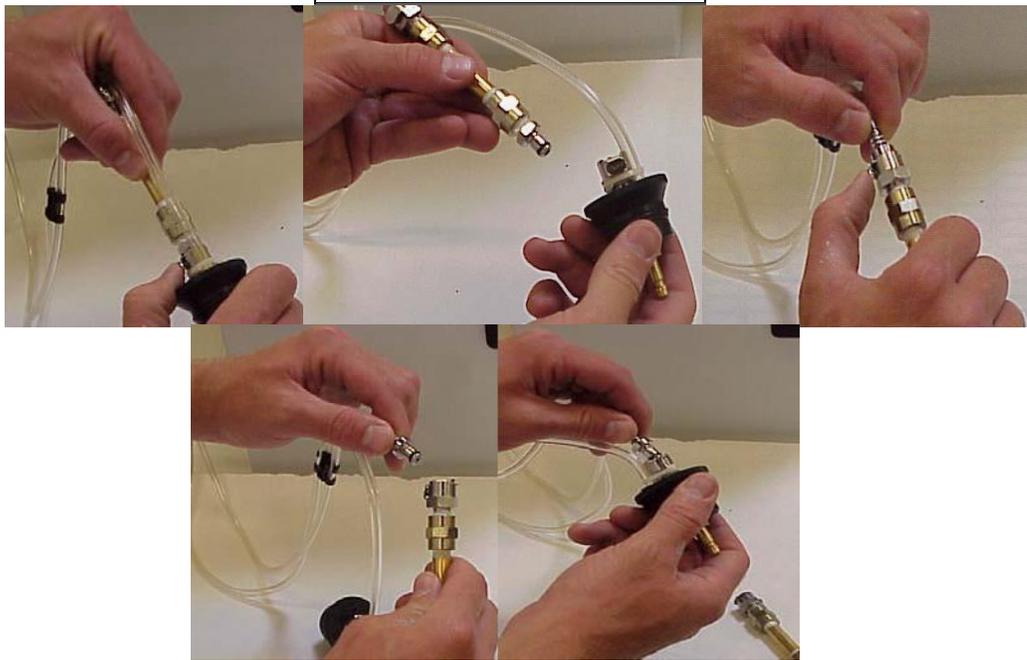


Figure 6. Placing the Probe in Module "D"

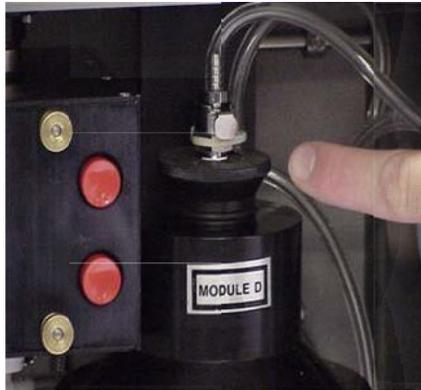


Figure 6. Placing the Probe in Module "D" (con.)

5.8 Calibrating Module "D"

- 1) Place the probe into the top of the funnel (where the stack was previously) and gently push down until it bottoms out.
- 2) With the audit probe in the funnel of the "D" module, the "D" module calibration can now be completed. Repeat the steps in 5.4 for the "D" module with a couple of exceptions. The number listed in cell B9 ("Q_{SITE}") will be different than the one used for the previous modules. This is because "D" modules run at a different flow rate. When entering the value in cell H25, the flow rate in K25 should be 16.9 liters per minute. If it is below that, add 0.01 to the value in H25 until the value is at least 16.9. It is better to be a little over than under. Also, the "D" module does not have a functioning CYC, so only the magnehelic and orifice values need to be recorded for each position.

5.9 Re-installing the "D" Stack

- 1) Remove the "D" funnel's bottom lid. Using both hands with thumbs on the recessed channels of the funnel, pull downwards to separate the bottom lid from the rest of the funnel (Figure 7). Sometimes it is necessary to use a soft mallet to gently tap the bottom lid to separate the two pieces.



Figure 7. Removing the Bottom Lid of Module "D"

- 2) Gently lower the stack back to its original position, making sure that the stack is fully seated into the black funnel. It should rest on an orange O-ring as shown in Figure 8.

- 3) While the “D” funnel’s bottom lid is still removed, verify that the “D” stack O-ring is securely in place and uniformly positioned between the silver stack and the retaining lip of the “D” funnel.

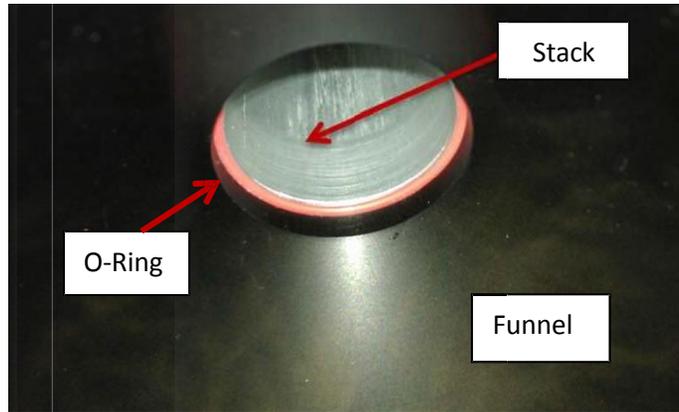


Figure 8. “D” O-Ring Between Stack and Funnel

- 4) Tighten the sleeve collar by turning it clockwise and then tighten the four screws on the “D” brace to secure the stack.
- 5) Replace the “D” funnel’s bottom lid.
- 6) Perform the following steps once calibration is complete:
 - Double-check that all black plastic caps and stack plugs are in their proper position for modules “A,” “B,” and “C.”
 - Reassemble the magnehelic probe to its original configuration.
 - Place all of the calibration components back into the audit kit.
 - Reload the modules with the exposed sampling cartridges. If a sample change needs to be performed, do it now. Record final readings for all modules, install clean sampling cartridges, and take initial readings.

5.10 “X” Modules

Some sites have a fifth module for collocated precision measurements, called an “X” module.” The “X” module is a duplicate of an “A,” “B,” “C,” or “D” module. If there is an “X” module present, determine what type of module it is and perform the calibration accordingly.