Dependable Products From People You Trust

Twin-Cell Ultrasonic Cement Analyzer

Part No. 120-51

Instruction Manual

Updated 10/7/2011
Ver. 1.5

OFI Testing Equipment, Inc.
11302 Steeplecrest Dr. · Houston, Texas · 77065 · U.S.A.
Tele: 832.320.7300 · Fax: 713.880.9886 · www.ofite.com

Table of Contents

Intro

By measuring the change in velocity of an acoustic signal, the Ultrasonic Cement Analyzer provides a continuous non-destructive method of determining compressive strength as a function of time.

Description

The cement slurry to be tested is placed in an autoclave unit with temperature and pressure adjusted to simulate downhole conditions. An acoustic signal is then transmitted through the cement sample. As the strength of the cement increases over time, the acoustic signal travels faster through the sample.

A computer running customized Windows® software measures the transit times of the signal over time and interpolates the compressive strength values. This data is available in real time onscreen and is also stored in an Excel® spreadsheet for easy graphical viewing and printing.

The Twin-Cell UCA features two test cells in a single enclosure. Both units share electrical power; air, water, and drain plumbing; and PC to UCA connectivity. All other systems (heating, pressurization, etc.) are completely separate.

Features

- Cement samples are not destroyed
- Additional autoclaves are available
- Programmable temperature control (up to 400°F or 204.4°C)
- Self-venting regulators provide extensive pressure control (up to 5,000 PSI or 34.5 MPa)
- Data is available instantly onscreen and is automatically converted to Excel® spreadsheet format

Specifications

- Size: 24" × 18" × 12" (61 × 46 × 30 cm)
- Air Supply: 100 PSI (690 kPa) Recommended; 150 PSI (1,035 kPa) Maximum; ¼" NPT Connector
- Water Supply: Standard Tap Water; ¼" NPT Connector
- Power Supply: 115-Volt / 230-Volt, 50 / 60 Hz Power
- Computer: Windows XP or higher, RS-232 Serial Port (or Serial to USB Adapter), Minimum Screen Resolution: 1280 × 720

Components

#120-25-043	Pressure Relief Valve, Qty: 3
#120-50-006	Power Supply, Qty: 1
#120-50-037	Air Regulator, Qty: 1
#120-50-TR	Transducer, Set of 2, Qty: 2
#120-51-001	Eurotherm Model 2408 Temperature Controller, Qty: 2
#120-51-002	SSR Without Heat Sink, 30-Amp, Qty: 2
#120-51-019	Heater, 550-Watt, 240-Volt, Qty: 2
#120-51-03	Gauge, 2⅕", 0 - 5000 PSI, Qty: 3
#120-51-1	Cell Body, Qty: 2
#120-51-2	Bottom Cell Cap, Qty: 2
#120-51-3	Top Cell Cap, Qty: 2
#120-57-002	80 mm Fan, Qty: 1
#122-004	Thermocouple Assembly, Qty: 2
#123-011	Cell O-ring, 75 Durometer, 2½" × 2¾" × ⅛", Qty: 8
#127-00-001	Pump, Qty: 1
#127-00-241	Compression Fitting, 83 Series, Three-Way Ball Valve, ¼", Stainless Steel, 6000 PSI, Qty: 1
#127-00-242	Compression Fitting, 83 Series, Two-Way Ball Valve, ¼", Stainless Steel, 6000 PSI, Qty: 1
#130-81-019	2-Way Solenoid Valve, 240-Volt, Qty: 3

Optional:

#120-51-SP Spare Parts for One Year

#120-51-019	Heater, 550-Watt, 240-Volt, Qty: 2
#120-51-020	Thermocouple Assembly, Qty: 2
#122-074-1	5-Amp Fuse, Qty: 8
#123-011	Test Cell O-ring, 75 Durometer, Qty: 120
#123-023	Low-Temperature Acoustic Couplant (250°F), Qty: 6
#123-024	High-Temperature Acoustic Couplant (600°F), Qty: 4

Setup
UCA

1. Begin by making sure all switches are off and all pressure knobs are turned completely counter-clockwise.

2. Connect the **AIR**, **WATER**, and **DRAIN** connectors on the back of the unit to their appropriate source and plug in the power cord.

3. Turn the “Main” switch on.

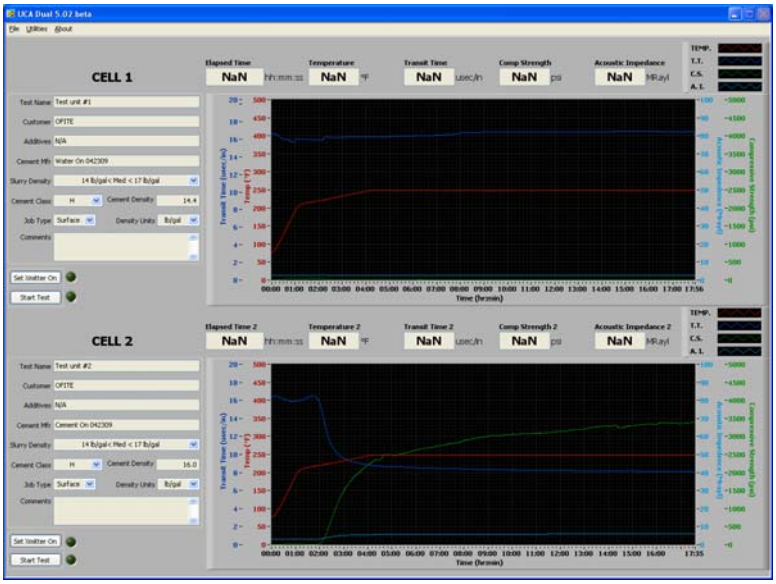
Setup
Software

Before you begin your test, you must prepare the PC to record the data.

1. Connect the PC to the unit with the serial cable (supplied) and turn the PC on.

2. Open the “OFITE UCA” software by double-clicking the icon on the desktop.

3. The main screen of the software shows a graph of the temperature, transit time, compressive strength, and acoustic impedance with respect to time. Above the graph, the current value for each of these variables is displayed. To the left of the graph is the user-defined information about the test.



4. From the “Utilities” menu, click “Setup”:

   “COM Port” - Select the COM port the PC is connected to.

   “Temp Unit” - Select °F or °C

   “Pressure” - Select PSI or MPa

   “UCA #” - Enter an ID number for the UCA unit. This number will print on the chart at the end of the test.

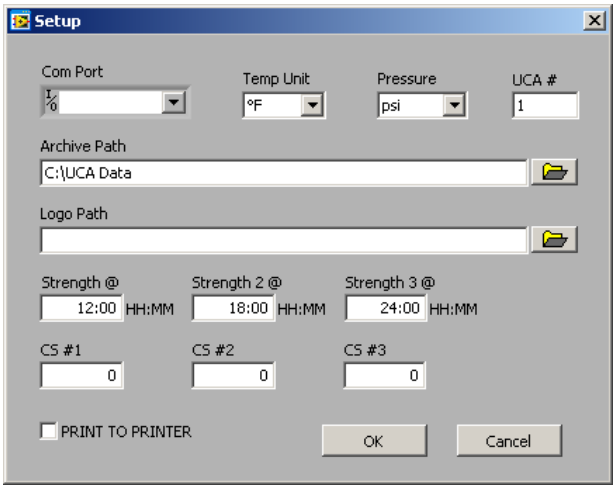
   “Archive Path” - Choose a location to save archive files

   “Logo Path” - Select a logo file (.jpg format) to print on the chart.

   “Strength @”, “Strength 2 @”, “Strength 3 @” - Enter a time in each of these fields. The software will record the compressive strength of the sample of each of these times and print it on the chart.

   “CS #1”, “CS #2”, “CS #3” - Enter a compressive strength value in each of these fields. When the cement reaches that compressive strength, the software will record the elapsed time and print it on the graph.

   “Print to Printer” - When this option is selected, a graph of the test results will automatically print to the default printer when a test is complete.



5. Before starting a test, select “Load Cell Infos” from the “Utilities” menu. Enter the necessary information and click “OK”.

   This information is for reference only. It will print on the graph at the end of the test. It will not affect the test itself.

Operation

Temperature Controller

The temperature controller allows you to program a temperature profile for your test. This profile will be divided into at least two segments. Each segment controls a portion of the test and determines the temperature, time, and behavior of the test cell during a specified time period.

The four buttons along the bottom of the display provide access to the temperature profiles. Begin by pressing the “PAGE” button three times. The display will read "Prog List". Now, press the “SCROLL” key repeatedly until the setting you wish to change is shown on the display. Then press either arrow key until the appropriate value is displayed. Once you've chosen a value, press the “SCROLL” key again to select a new setting.
The first group of settings should read as follows:

Setting	Value
Prg1	1
Hb	OFF
Hb.u	0.0
Rmp.u	min
Dwl.u	min
Cyc.n	1

Important

These settings will be the same for every test. Do not change them.

1. Begin by defining the first segment of the test.
    a. Press the “SCROLL” key repeatedly until “Seg” appears on the display.
    b. Press either arrow key repeatedly until “1” appears on the display. You are now editing segment 1.

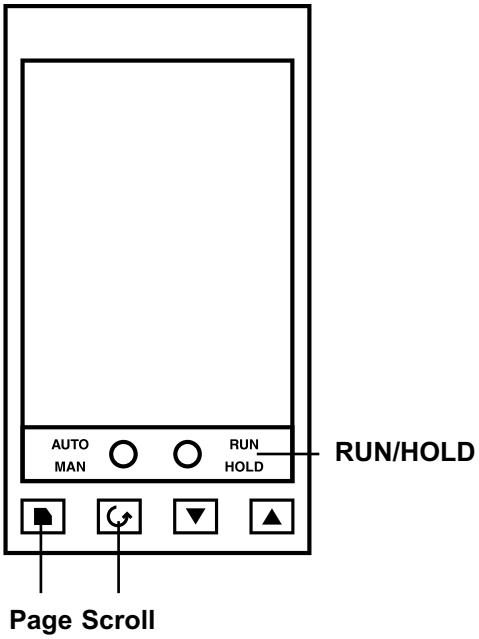
2. The first setting is “Type”.
    a. Press the “SCROLL” key until the word “Type” appears on the display.
    b. The available options are “rmp.r”, “rmp.t”, or “dwell”. Press either arrow key until the appropriate value appears on the display.

    Rmp.r programs the controller to steadily increase the temperature by a specified rate (degrees per minute). If you choose this value, your next option will be “Tgt”, which is your target temperature and then “Rate” which is the rate you want the temperature to increase.

    Rmp.t increases the temperature over a specified time interval (minutes). If you choose this value, your next option will be “Tgt” (target temperature) and then “Dur” (duration in minutes).

    Dwell holds the temperature at its current setting for the duration specified.

Temperature Controller



3. Now define the second segment.
    a. Press the “SCROLL” key until “Seg” appears on the display.
    b Press either arrow key until “2” appears on the display. You are now editing segment 2.

4. Continue this process with each segment in the test.

5. When you reach the last segment, set the “Type” to “end”. The next setting will be “End.t”.

    If you choose “**sop**”, the heat will be turned off and the test ended.

    If you choose “**dwell**”, the heat will be held at the current temperature indefinitely.

Example 1:

Heat the sample at 2.5° per minute and stop at 150°. Hold at 150° for 180 minutes and then stop the heat.

Setting	Value	Description
Prg	1	
Hb	OFF	
Hb.u	0.0	
Rmp.u	min	
Dwl.u	min	
Cyc.n	1	

Seg	1	Segment 1
Type	rmp.r	Increase temperature at a specified rate
Tgt	150	Heat to 150°
Rate	2.5	Increase temperature at 2.5° per minute
Seg	2	Segment 2
Type	dwell	Hold on the current temperature
Dur	180	Hold for 180 minutes
Seg	3	Segment 3
Type	end	This is the last segment
End.t	sop	Stop the heat

Example 2:

Heat the sample to 200° over a period of 90 minutes. Then increase the temperature to 300° at a rate of 3° per minute. Hold that temperature until the unit is turned off.

Setting	**Value**	**Description**
Prg	1	
Hb	OFF	
Hb.u	0.0	
Rmp.u	min	
Dwl.u	min	
Cyc.n	1	
Seg	1	Segment 1
Type	rmp.t	Increase temperature for a specified time
Tgt	200	Heat to 200°
Dur	90	Increase temperature for 90 minutes
Seg	2	Segment 2
Type	rmp.r	Increase temperature at a specified rate
Tgt	300	Heat to 300°
Rate	3	Increase temperature at 3° per minute
Seg	3	Segment 3
Type	end	This is the last segment
End.t	dwell	Hold at the current temperature indefinitely

Operation

Preparing the Test Cell

1. With both cell caps removed, examine the inside of the test cell from both ends. Below each set of threads is a small groove. The end with the smaller groove is the bottom of the test cell.

2. Apply high-temperature grease to a cell cap o-ring and place it around the cell cap. Wipe off any excess grease from the inside surface of the cell cap.

Top Cell Cap

Bottom Cell Cap

3. Apply a very thin layer of grease to the inside surface of the cell cap and the test cell.

Note

Any surface that will come into contact with the cement should be coated with grease. This will make cleaning easier when the test is complete.

4. Carefully screw the bottom cell cap onto the test cell. The cell cap should turn smoothly in the test cell threads. If you encounter resistance, stop turning and unscrew the cap slightly. Then continue turning until the cap is completely tightened.

5. Once the cap is completely tightened, unscrew it one quarter turn. This will facilitate disassembly later.

6. Turn the test cell over and begin filling it with the cement slurry. Place the fill gauge on top of the test cell. Fill the cell until the cement touches the bottom of the fill gauge.

Important

It is important that you begin the test no more than five minutes after adding the cement slurry to the test cell.

7. Prepare the top cell cap just as you did the bottom cell cap. Remember to apply high temperature grease to the seal ring, o-ring, and inside surface.

8. Carefully screw the top cell cap into the test cell, just as you did with the bottom cell cap.

9. Make sure the transducers and the transducer holes in the cell caps are clean and free of debris. If they are not, they can be cleaned with a rag or paper towel. You can also use alcohol if further cleaning is necessary.

10. Apply a thin coat of an ultrasonic couplant to the two transducers. Screw the top transducer into the hole in the cell cap and tighten it with a wrench.

Note

Two types of ultrasonic couplant are provided to you. The low-temperature gel should be used for temperatures up to 260°F (126.7°C). The high-temperature gel is suitable for higher temperatures. Carefully read the label before using either of these gels.

Operation

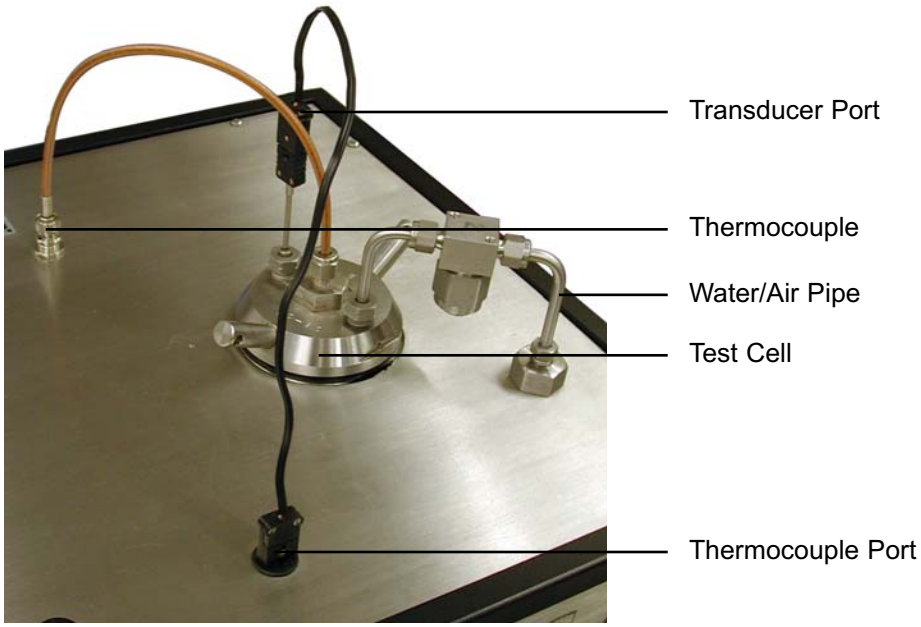
Performing the Test

1. Carefully place the cell into the heating jacket. Make sure the bottom transducer is inside the hole in the cell cap before lowering the cell.

2. Connect the water pipe to the test cell and to the unit cabinet and tighten with a wrench.

3. Attach the thermocouple to the test cell and hand tighten.

4. Connect the transducer cable to the transducer port.



5. Make sure the “Cell Pressure” regulators are closed by turning them completely counter-clockwise. Turn the “Cell Isolation” valve to “Operate”.

6. Slowly turn the “Water Control” valve to “Fill”.

   Watch for water to leak from the thermocouple. When the water starts to leak, immediately turn the “Water Control” valve to “Operate”. With a wrench, tighten the thermocouple to seal the cell. This will ensure that all air has left the cell.

7. Turn the “Main Power” and “Pump” switches on.

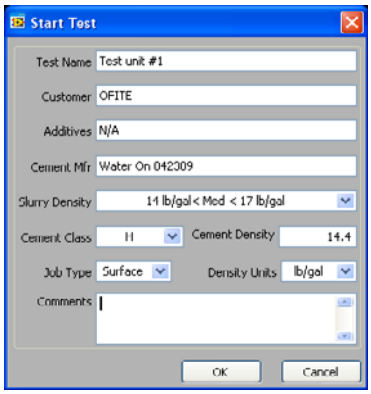
8. Turn the “Pump Pressure” regulator clockwise to increase the pump pressure. Set the pressure above the maximum pressure of your test.

9. Slowly turn the “Cell Pressure Regulator” clockwise to set the cell pressure.

Tip

Add pressure to the cell in 1,000 PSI increments. At each increment, wait for five minutes to ensure no leaks are present. Observe the “Cell Pressure” gauge. If the pressure begins to fall, release pressure and check for leaks in the plumbing.

10. Once the cell is fully pressurized, it is time to start the test. In the UCA software, select “Start Test” from the “Operate” menu. Enter any comments in the “Comments” field and confirm the “Data File Name” and “DAQ Time”. When you click the “OK” button, the software will begin recording data.



After 30 seconds, the “Test Time”, “Temperature”, “Transit Time”, and “Compressive Strength” fields will begin to display readings.

“Test Time” - Time since the test began (HR:MIN)

“Temperature” - Temperature within the test cell. (°F or °C, depending on the settings in the Options screen)

“Transit Time” - Time required for the sound wave to travel through the sample (Milliseconds)

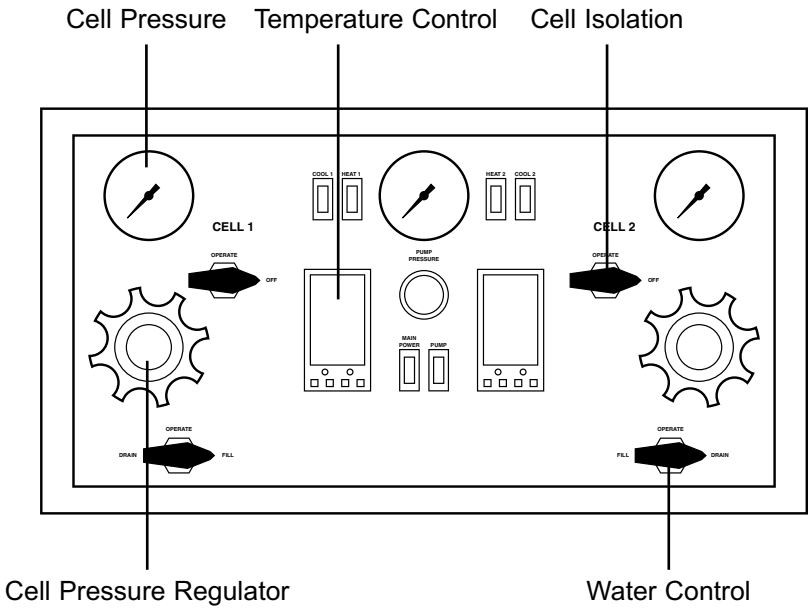
“Compressive Strength” - Calculated compressive strength of the sample (PSI or MPa)

Important

Solid particles and air bubbles within the cement slurry can adversely affect the results of your test. The first Transit Time reading should be at least 10 µs. If it is less than 10 µs, wait a few minutes to see if the problem corrects itself. When you see a Transit Time greater than 10 µs, restart the test by clicking the “Stop Test” button and then clicking the “Start Test” button again. If the problem does not self-correct, you will need to remix your slurry and start the test again. To avoid this problem, carefully follow the mixing procedure in API Specification 10.

11. Turn the “Heat” switch on.

12. Push the “RUN/HOLD” button on the temperature controller to begin heating.



Control Panel

1. When the test is complete, click “End Test” on the “Operate” menu. The data file will be automatically saved in the folder specified on the “Options” screen.

2. Push the “Run/Hold” button on the controller and hold it until both lights are off.

3. Turn the heat off.

4. Turn the “Cool” switch on and allow the test cell to cool completely.

5. When the cell has cooled, turn the “Cool” switch off.

6. Slowly release the cell pressure by turning the “Cell Pressure” regulator counter-clockwise.

7. Turn the “Water Control” valve to “Drain”. Water will begin to drain from the cell and out the drain port on the back of the unit.

8. Release the pump pressure by turning the “Pump Pressure” regulator completely counter-clockwise.

   Tip

   If both “Cell Pressure” regulators are completely closed, the pump pressure will not drain. Simply open one of the “Cell Pressure” regulators enough to release the remaining pressure.

9. Remove the thermocouple, pipe, and transducer from the test cell.

10. Remove the test cell from the heating jacket.

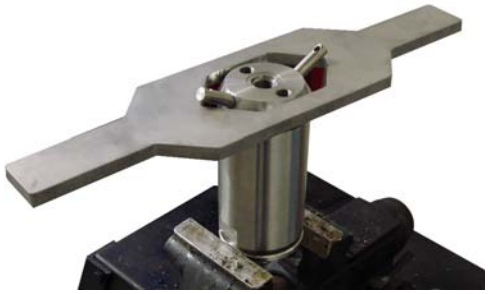
Note

Tip

11. Remove both cell caps and pour off any excess water.

    The cell caps will be too tight to remove by hand. To remove the cell caps, place the cell in a vise. Use the grooves on the body and cell caps to anchor it in the vise. Use the special wrench provided to loosen and remove each cell cap.

    If the test cell will not turn, remove it from the vise and hit the bottom cell cap with a mallet to loosen the cement inside. Then return the cell to the vise and try again.

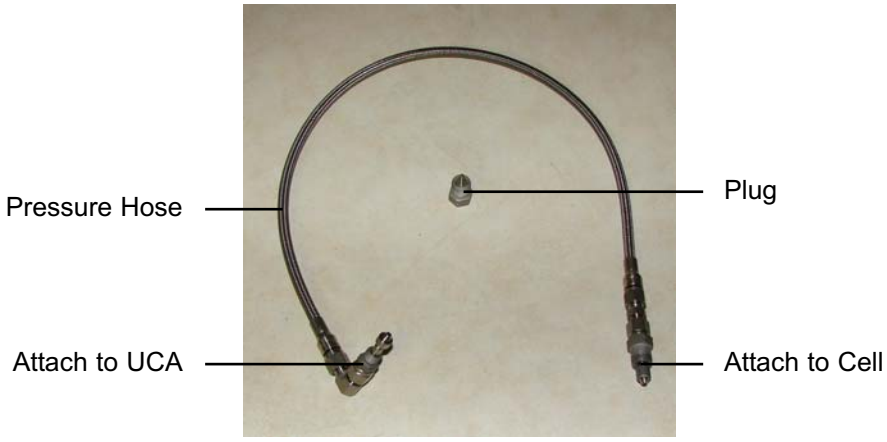


To remove top cap

To remove bottom cap

12. Screw the top cell cap back onto the top of the test cell.

13. Screw the plug into one of the holes in the cell cap. The two holes are interchangeable.



14. Attach the pressure hose to both the UCA unit and the test cell.

15. Plug the thermocouple into the unit. The unit will not function if the thermocouple is not plugged in.

16. Turn on the pump.

17. Very slowly increase the cell pressure.

18. When you hear the block of cement pop out of the test cell, release the cell pressure and turn off the pump.

Important

The cement block may be propelled out of the test cell with great force, causing serious injury and damage. Be sure to always point the test cell away from people or equipment.

19. Disconnect the pressure hose.

20. Remove the cell cap and thoroughly clean the test cell.

Maintenance

1. After every test, completely disassemble the test cell and thoroughly clean all surfaces with soap and water. Any cement left on the test cell will harden and could damage the equipment.

2. Before every test, inspect the o-rings for damage or wear. O-rings should not be cracked, split, or brittle. Replace any damaged pieces before beginning a new test.

3. Ensure that the transducer holes in both cell caps are clean and free of debris. Also, be sure to clean the bottom surface of the transducers. This will help ensure a strong signal with minimal interference during a test.

Appendix

Calibration

Your UCA unit has been calibrated at the factory, and should not need to be calibrated again. However, if any part of the test cell, transducers, control card, or software are changed, a calibration will be necessary.

1. Begin by filling the test cell with distilled water and placing it in the unit as described in the “Preparing the Test Cell” section on page 9.

2. Wait for the sample temperature to reach 70°F (21.1°C).

3. Click the “Set Xmitter On” button.

4. Select “Calibrate Cell” from the “Utilities” menu.

5. The transit time should be about 17. If it is not, the unit will have to be serviced by an OFITE technician. If the transit time is close to 18, click “OK” to save the calibration and continue.

6. Click the “Set Xmitter Off” button to turn off the transmitter.