

Model 520 HT Ultrasonic Cement Analyzer

Instruction Manual



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Model 520 HT Ultrasonic Cement Analyzer Instruction Manual

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Houston, Texas, USA

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1 Introduction

Cements are a critical element in the drilling, completion, workover, and abandonment of wells. For each application, a cement slurry is designed with specific properties and is given additives that provide predictable slurry density, volume, viscosity, compressive strength, fluid loss, gas migration, and thickening time. The Model 520 Ultrasonic Cement Analyzer (UCA) is used to provide a history of the strength development of a cement slurry as it cures under elevated temperature and pressure.

The UCA transmits an ultrasonic pulse through a cement slurry and measures the travel time of the pulse through the slurry. The travel time of the pulse through the slurry gives an indication of the compressive strength of the slurry. The compressive strength, along with temperature and pressure, are monitored as a function of time for the purpose of providing a strength history of a setting cement slurry.

1.1 Document Conventions

The following icons are used as necessary in this instruction manual.

- 

NOTE. Notes emphasize additional information that may be useful to the reader.
- 

CAUTION. Describes a situation or practice that requires operator awareness or action in order to avoid undesirable consequences.
- 

MANDATORY ACTION. Gives directions that, if not observed, could result in loss of data or in damage to equipment.
- 

WARNING! Describes an unsafe condition or practice that if not corrected, could result in personal injury or threat to health.
- 

ELECTRICITY WARNING! Alerts the operator that there is risk of electric shock.
- 

HOT SURFACE! Alerts the operator that there is a hot surface and that there is risk of getting burned if the surface is touched.
- 

EXPLOSION RISK! Alerts the operator that there is risk of explosion.

2 Safety

Safe laboratory practices and procedures should be observed while operating and maintaining the Model 520. Follow the instructions provided to avoid personal injuries or damage to the equipment.

Always wear appropriate personal protective equipment (PPE) when operating or maintaining the Consistometer.

2.1 Safe Pressurization

This Consistometer has pressurized air, water, and hydraulic lines that present a hazard if not depressurized before maintenance or disassembly.

The hydraulic diaphragm pump and the pressure relief valve require compressed air. Before working on any of these devices or connected air lines, shut off the compressed air supply to the machine, and carefully relieve air pressure from the machine.

2.2 Safe Heating

Before opening the pressure chamber, use the cooling system to lower the temperature to at least 120°F (49°C). The machine uses domestic water as coolant. Shut off the domestic water supply before servicing.

NEVER operate the heater on an empty chamber. The heater element will quickly overheat and fail. To prevent smoke and possible fire, always fill the chamber and pressurize before heating.

2.3 Safe Electrical Operation

Disconnect the power cable before attempting any electrical or mechanical maintenance. Be aware that after the power switch is turned off, the electrical terminals inside the panel will remain electrically energized.

Refer to the electrical schematic before performing any maintenance or troubleshooting.

Always disconnect the power cable before attempting any repair.

3 Features and Specifications

The major features of the UCA are listed below:

- Easy to install.
- Completely self-contained. No need for pressure controllers, control boxes, or computer
- All software is Windows[®]* based.
- Data may be plotted on a standard ink jet printer, stored on a USB flash memory stick, or archived to an external computer via an Ethernet connection.
- Tests are stored as .tdms files and may be retrieved and viewed. Text files (.txt) may also be exported for interfacing with most word processors, text editors, spreadsheets, and database programs.
- Touch screen control panel controls of data acquisition and temperature. Temperature profile is displayed graphically before test starts to reduce mistakes.
- Available with integral pump and relief valve for soak pressure control. It does not require separate pressure controller.
- Unit may be operated with an optional uninterruptible power supply (UPS) that will keep all functions (except heater) of the UCA operating for up to one hour during power outages.

*"Microsoft" and "Windows" are registered trademarks of Microsoft Corp.

Table 3-1 Model 520 Specifications

Category	Specification
Electrical	
Input Voltage	230 VAC (+15%)
Input Power	2500W
Input Current	11 A
Input Frequency	50-60 Hz
Mechanical	
Height	14.5 in. (36.8 cm)
Width	26 in. 66 cm)
Depth	15.3 in. (38.9 cm)
Weight	110 lb. (50 kg)
Environmental	
Operating Temperature	(32 to 120°F) 0-50°C
Operating Humidity	0-95% non-condensing
Heater	
Heater Power	2,000 W
Heater Type	Cast heater with cooling coils
Heater Control	Solid state relay
Utilities – Water and Air	
Compressed Air	100 psig (6.8 bar)
Cooling Water Pressure	100 psig (6.8 bar) maximum
Utility Inlets	¼ inch female NPT

4 Installation

Upon uncrating the instrument, verify that the instrument and any spare parts on the packing list have been received and are undamaged.

Once the instrument has been moved to its desired location, air, water, and electrical connections can be made. The air inlet, water inlet, and water drain connections are each ¼ inch female NPT connections and are located on the lower right rear of the instrument. A number of ¼ inch male NPT to 8mm tube fittings are included for international locations.



It is good practice to leave space behind the instrument so that qualified Fann personnel can have service access. If this is not possible, try to make the unit easy to disconnect and move for service.

Connect the coolant and pressurizing water to the connectors labeled **COOLING WATER** and **WATER INLET**, respectively, on the rear panel of the instrument. Each fitting has a ¼ inch female N.P.T. connection. The water must be clean and free of debris that could cause failure of the pump or relief valve. A water filter is included and must be installed on the water inlet to promote trouble free pump and relief valve operation. Depending on the quality of the water supply, the filter may need to be replaced more frequently. Follow the water filter manufacturer's recommended replacement interval. Neglecting to install the water inlet filter will void the instrument warranty. Water inlet supply water must be filtered at 5 micron or better and have a viscosity between 1–100 cst. Pump performance is affected by many operating conditions. Extreme temperatures, pressures, and high duty cycles will increase maintenance frequency. All units are lubricated at the factory with silicone free semi-synthetic grease. After 2-3 months of normal (50% duty) operation, the standard spool seals should be inspected for wear and re-lubricated. Based on this inspection, future maintenance intervals can be planned and further disassembly and lubrication of other moving seals may be necessary.

4.1 Connecting the Drain Line

Connect drain lines to the connectors labeled **WATER DRAIN** and **COOLING DRAIN** on the rear panel of the instrument. The fittings have ¼ inch female N.P.T. connections. The drain system must be capable of handling hot water up to 212 °F (100°C) and brief surges of up to 500°F (260°C) steam for short periods of time during initial cooling of the instrument. If two or more UCA's are connected to a common drain line, it is recommended that the drain be 3/8 inch (10mm) inside diameter, minimum. It is also recommended that the drain system be all metal.

Connect the air supply to the connector labeled **AIR INLET** on the rear panel of the instrument. The fitting has a ¼ inch female N.P.T. connection. The air should

be dry and relatively free from dirt and oil. The air should be supplied at a pressure of 20-100 psig (1.4-6.8 bar). Compressed nitrogen may also be used in place of the compressed air if necessary. Drive air should be filtered between 5 μ and 40 μ and have a maximum dewpoint of 50°F. Very wet air will wash out lubricant and cause exhaust icing. Very dry air (dew point below 0°F) will dry out lubricant and cause premature failure of spool o-rings.



If high pressure bottles of nitrogen or air are used to operate the instrument, make certain that the pressure supplied to the instrument does not exceed 100 psig (6.8 bar). Applying high pressure gas to the instrument can cause tube rupture and possible injury.

Electrical connections are made using the receptacle on the rear of the instrument. A power cord is supplied with the instrument. Please observe the following precautions when making the wiring connections.



Wiring should be completed by a qualified installer in accordance with local electrical codes.



The instrument should be securely connected to a separate earth ground. The ground wire must be larger in diameter than the supply conductors



An 8BC or larger fire extinguisher to fight electrical and oil fires should be placed within 50 feet of the consistometer.

Some components such as the touch screen LCD monitor may be removed from the instrument prior to shipment and shipped in a separate container to prevent damage. This device must be reinstalled before operating the instrument. The monitor cables include one USB and one VGA cable which must be connected to the control box and one AC power cable which must be connected to the 230 VAC input on the monitor.



Before plugging the monitor into the rear of the UCA, make certain power to the instrument is off.

If a printer is included with the instrument, it may be connected to the control box. Connect the USB connector on the printer cable to the control box. The printer must also be connected to a suitable power source. Refer to the printer documentation for power requirements.

4.2 Connecting an Uninterruptible Power Supply (UPS)

This is applicable only if there are two receptacles on the rear of the unit labeled UPS that may be used to connect an uninterruptible power supply (UPS). In the event of a power failure, the UPS will operate all functions of the UCA, except the heater, for up to one hour to prevent loss of test. To connect the UPS, select the power cord supplied with the UPS and connect one end to the UPS input and the other end to the UCA. The cord will fit only one receptacle. Locate the other power cord supplied with the instrument and connect one end to the output of the UPS and the other end to the other UPS receptacle on the rear of the UCA. Press the ON button on the UPS. A green light will appear on the UPS when it is operating properly. If the unit beeps and a red light comes on, a power failure has occurred and the unit is being powered by the UPS. Note that if the POWER switch is turned OFF and the UPS is not turned OFF, the instrument will not power down.



If a UPS is not used, the cord must be installed between the two rear panel receptacles or the instrument will not operate.

Before attempting to operate the instrument, it is recommended that the operators read the remainder of the manual to become familiar with the UCA operation.

5 Using the Touchscreen Software

Touch screens were created to provide operators with an easy to use interface. They allow the user to input and view data without a keyboard or mouse. The touch surface is able to detect contact for selecting options.

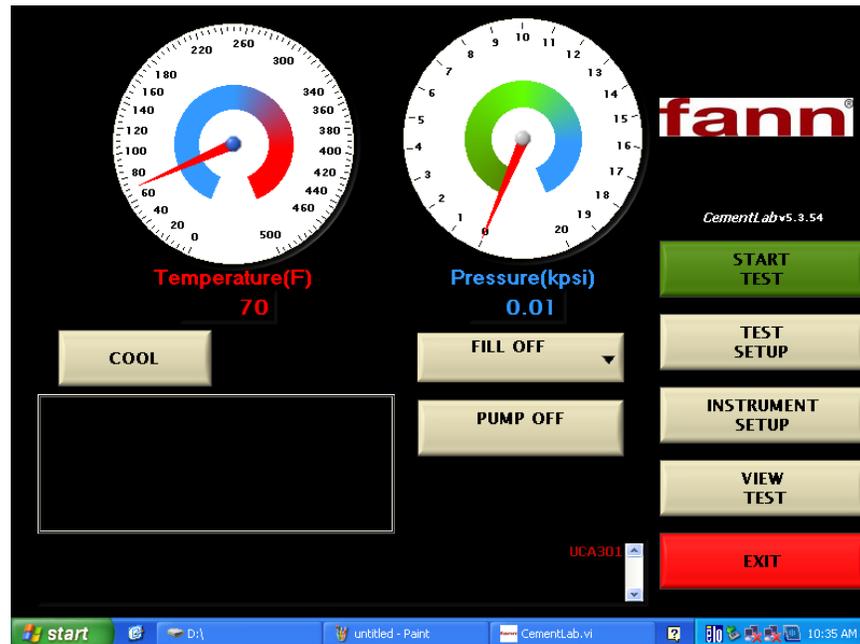
Most any object may be used on the touch-screens. Experimentation will quickly show which objects will activate the screen and which will not. It is important to note the touch surface does NOT use pressure to detect input. A light touch is all that is needed. In addition sharp instruments (such as pencils, pens, screwdrivers, etc.) should not be used as they may damage the touch surface.

The purpose of the touch screen is to provide the user with a single interface to the instrument. Temperature control, instrument setup, and current test data are accessed through the touch screen. This eliminates the need to individually program separate temperature controllers or other off-site software to begin running a test. Additionally, the touch screen allows the user to access current information from the instrument during a test. Each instrument is complete and requires no additional software or hardware to function.

The software is designed to be intuitive to the user. In addition to the options, the different screens include directions and helpful hints to allow the user to quickly setup and run the instrument. The first-timer will find an easy to follow path to set up a test. Most users will become highly proficient within a very short time.



5.1 The Main Menu



The main menu is the starting point for the instrument. From here, users may start new tests, setup test parameters, setup instrument parameters, or view an old test. Located at top left is the current temperature reading for the thermocouple. Current pressure is also displayed. The Exit button is used to stop the UCA software and go into the Windows[®] operating system.

As noted in the instructions on the screen, all the user needs do is touch a button to begin.

START TEST – Pressing this button begins a test. The instrument takes the current test parameters and begins a new test. If a temperature profile has been programmed, a screen will prompt the user to turn on the heater. Once a test has started the main testing screen will be displayed.

TEST SETUP – This button takes the user to the Test Setup Screen. Here the user may enter test parameters for the instrument. Test name, cement parameters, UCA algorithm, and Temperature Control are all accessed through this screen.

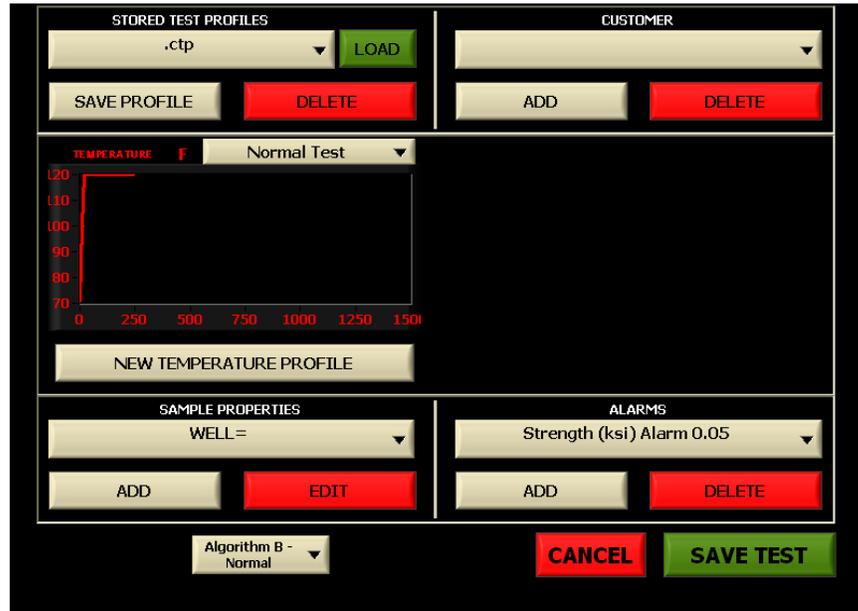
INSTRUMENT SETUP – This button takes the user to the Instrument Setup Screen. From this screen the user may verify transducer signal, calibrate the instrument, or archive the data to a USB memory module or network drive.

VIEW TEST – This button allows the user to view any previously stored test. The software looks for the tests in the C:\Fann directory and you will be prompted to

select a file. Use care when choosing a file name so you will be able to retrieve it if desired.

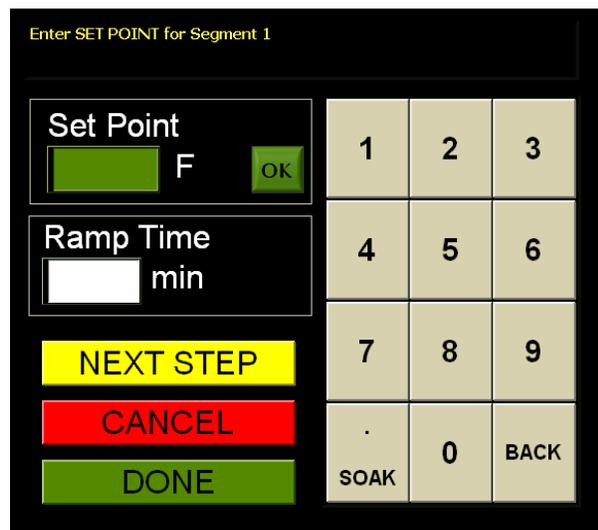
5.2 Test Setup Menu

From this menu the user can setup the parameters for the next test.



5.3 New Temperature Profile

On the temperature setup screen is a standard numeric keypad. On the left side are three values that define a ramp. Once a ramp is entered the user may advance to the NEXT STEP or press DONE to finish.

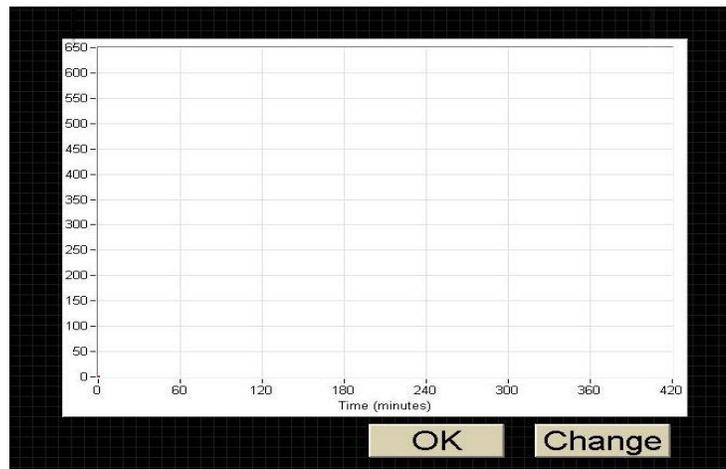


When finished, a graph of the desired temperature ramp is displayed. The user may

accept the current profile and continue or cancel to make further modifications.

Once the first ramp has been entered, press the NEXT STEP button to proceed to the next ramp or DONE to end the profile programming. If you end the programming at this point and start the test the temperature will reach set point and then fall because there was no second ramp or soak entered.

From this screen a second ramp may be entered or the user can enter a soak. To initiate a soak the user must use the Soak keypad button in the Ramp Time box. This will tell the computer to hold continuously at the programmed temperature. If you enter Soak as the time, the Start Value temperature and the End Value temperature must be the same. After entering all of your ramps and soak, you may press Done to complete the programming process. If you press Done, a graph will be displayed showing exactly what you have entered for your temperature profile as shown below:

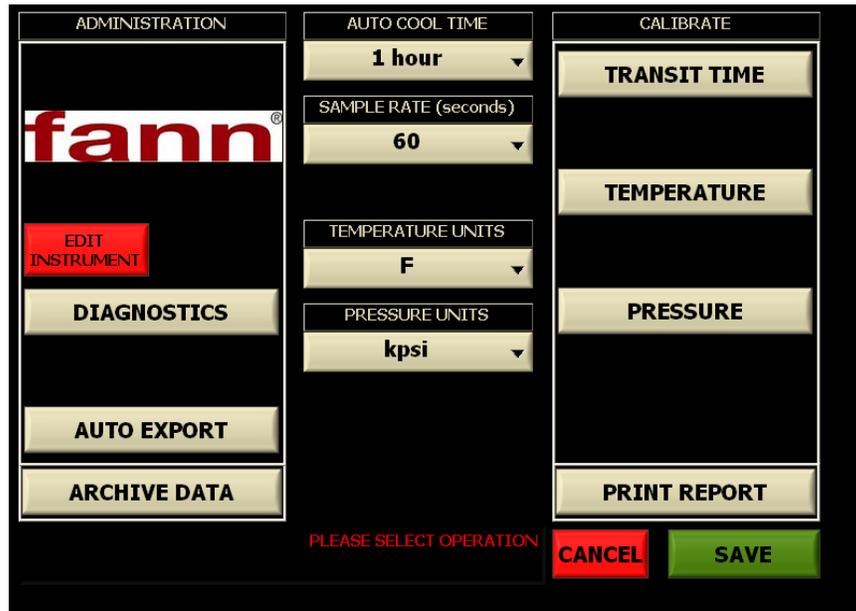


From this screen the user may press OK if the graph is correct or Change to go back to the programming screens to correct any programming errors. If Accept is pressed the TEST SETUP screen will be displayed again. From here press DONE and the main menu will appear. Press START TEST to begin the test or any of the other buttons to change alarm values, slurry type, etc.

5.3.1 Alarm Values –

The Alarm Values Button allows the user to enter unlimited alarm values for compressive strength and test time. The PC will notify the user when these values have been reached and at what time they were reached. The highest value entered here will become the default AUTO-SHUTDOWN value during a test.

5.4 Instrument Setup Menu

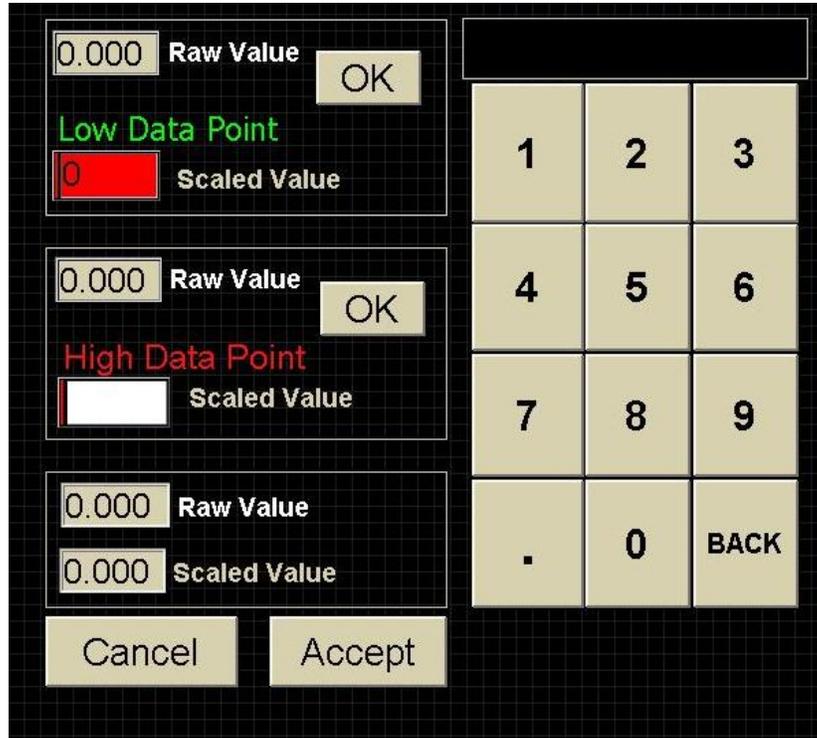


From this menu the user can run diagnostics on the ultrasonic transducer circuitry to determine if everything is functioning properly. This menu is also used to move data files from the UCA computer to another PC in order to free space in the UCA memory.

ARCHIVE DATA FILES – Select this command to move tests from the UCA to the USB memory module. If the instrument reports a “Disk Full” message, it will be necessary to do this before additional tests may be run. After this step is completed, the stored tests on the UCA are moved then deleted. After this button is pressed a message box will appear indicating which files were copied from the UCA to the storage device.

CALIBRATE – The Calibrate button gives the operator the option of calibrating temperature, pressure, or transit time.

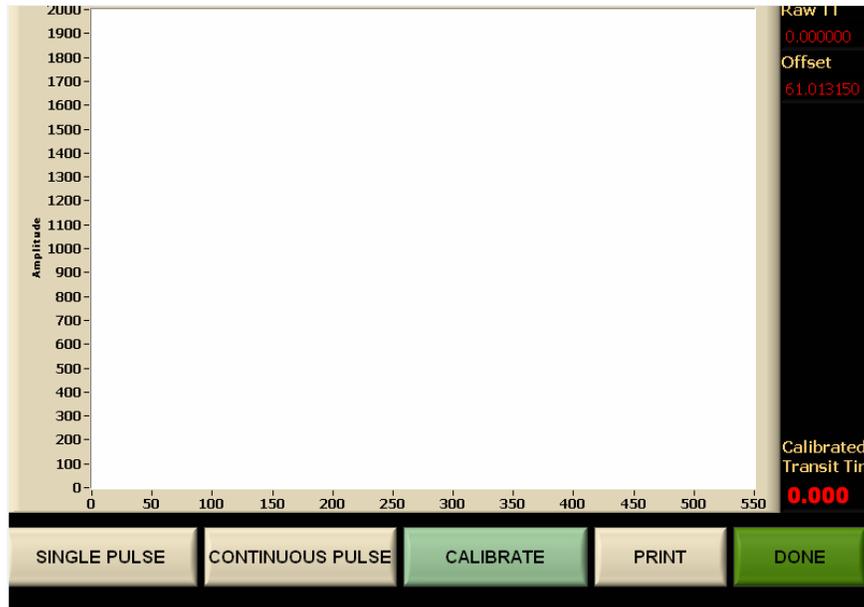
To calibrate the transit time, the cylinder must be **COMPLETELY** full of water with no air bubbles inside the cell.



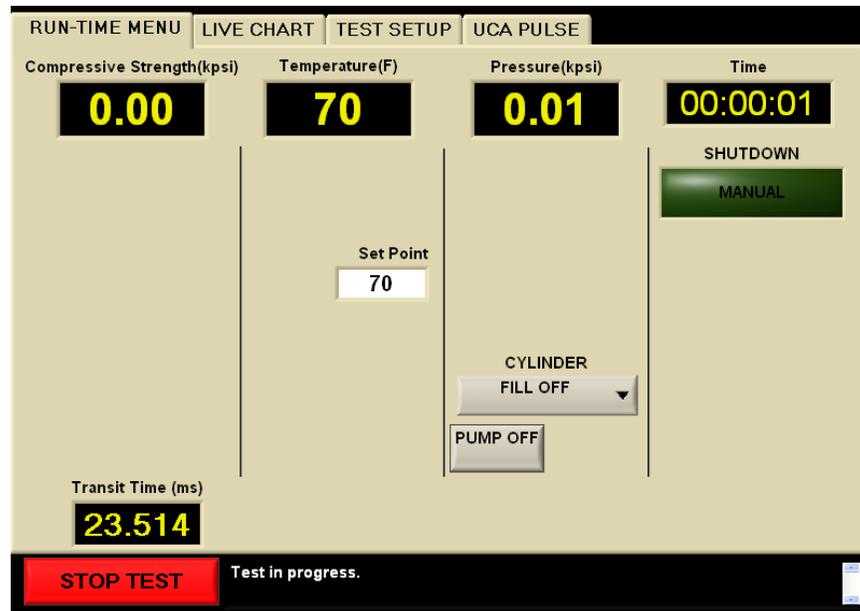
Never calibrate transit time with a cement slurry or steel bar from other devices.

5.5 Diagnostics

The Diagnostics button displays a diagnostic screen where the user may pulse the transducer and display the waveform on the screen. This tool allows the user to quickly verify transducer operation. The peak of the transducer should be well above 200 with water in the vessel. If the pulse amplitude is less than 200 with water in the cell, the UCA will not function properly and an error message will be displayed.



5.6 Running a Test



Once a test has begun, a RUN-TIME MENU of current values will be shown. The user may control all available parameters of the instrument from this menu.

Under the Pressure column, the user can turn the water supply to the pressure vessel on or off and can turn the pump on when the cylinder is filled.

Under the Temperature column, the user can select between AUTO and MANUAL temperature control. When in MANUAL mode, the user can adjust the temperature set point as well as turn cooling on/off.

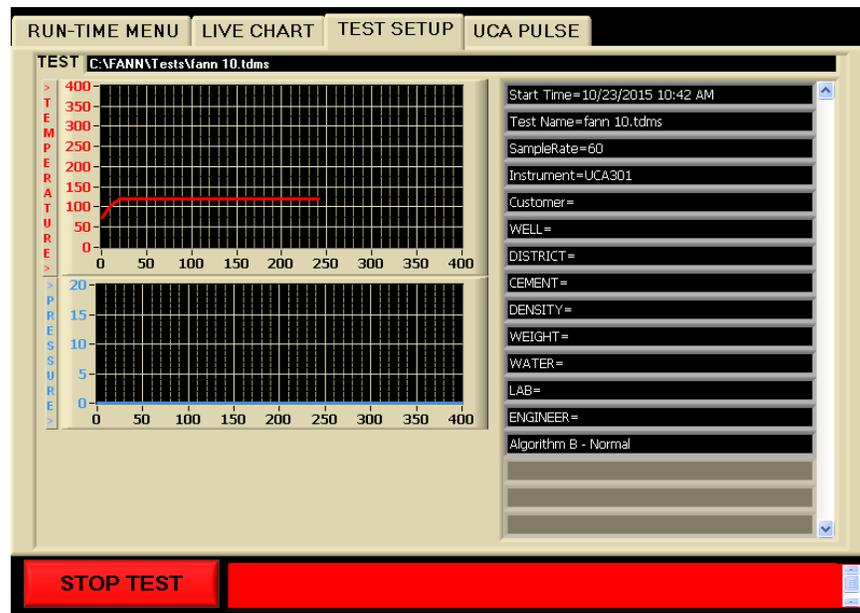
Under the Time column, the user can STOP TEST or select SHUTDOWN parameters for the Auto Shutdown feature. The user can select between Time (hr) or Compressive Strength and adjust the target value using the Shutdown Value control. When the test reaches the Shutdown Value the test will be stopped and cooling automatically turned on.

By selecting the VIEW LIVE CHART tab at the top of the screen, the user can view real-time data in chart form. From this screen, the user may print the chart at any time by pressing the PRINT button located at the bottom of the screen. (Please note that a printer must be connected to the instrument before trying to print.) Pressing the PRINT button displays the full TEST VIEWER screen where the user may select specific printing options such as header/footer information before printing to any installed printer.

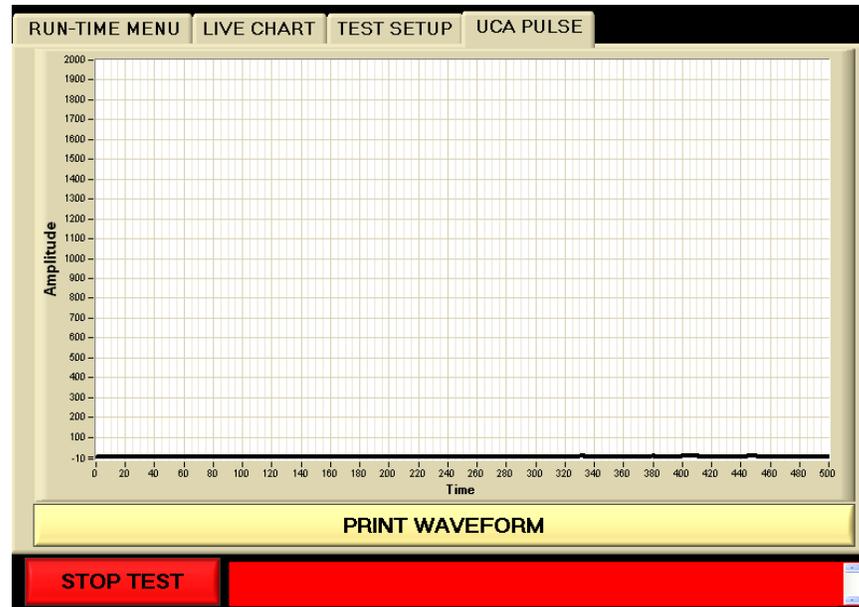
A complete table of numerical data can also be viewed here by selecting the DATA tab located on the left side of the screen in the Test Viewer.

Return to the test controls by selecting CLOSE. This will not have any effect on the actual testing process and can be opened / closed at any time.

The TEST SETUP tab is simply a review of parameters entered during the TEST SETUP and cannot be changed.



If there is some question as to whether the instrument is producing the desired ultrasonic waveform, the user may press the PRINT WAVEFORM button



This will display a waveform similar to the one shown below. It may take up to a minute for the waveform to be displayed since the software waits for the next pulse to occur. Note that the amplitude of the first waveform peak must be greater than 20 or an error will occur. If the waveform amplitude is less than 20, the instrument may have a faulty cable or ultrasonic transducer or the ultrasonic transducers may not have enough ultrasonic couplant (grease).

5.7 Stopping a Test

To stop the current test, the user must press the STOP TEST button on the RUN-TIME MENU screen. Once the test has been stopped, no further data will be logged and no further temperature control will be provided. You may view the last test or any test stored on the UCA by pressing the VIEW TEST button and selecting the appropriate file name.

5.8 Using the USB Memory Module

The UCA operates under a version of the Windows[®] operating system. This allows the use of certain Universal Serial Bus (USB) peripherals, such as USB flash memory modules. These USB memory modules may be used to archive or move UCA test files to another computer. The USB memory modules may be used without special drivers on any Windows[®] XP or Windows[®] 2000 based computers. The memory module will simply appear as another disk drive when inserted into the USB port on the computer.

To archive the stored tests on the UCA to the memory module, follow the steps below.

1. Connect the memory module to the USB port on the UCA control box. No

cables are required.

2. Press the ARCHIVE DATA button on the UCA touch screen.
3. Navigate to the USB drive and select the desired save location on the pop-up window.
4. The files will be copied to the USB memory module and deleted from the UCA.
5. Once the files are copied to the USB memory module they may be moved to a desktop PC.



Once the UCA data files are archived, they are still longer available for retrieval on the UCA. Deleting files from the UCA must be done manually by selecting the files and moving them to the trash bin in Windows[®].

5.9 Networking

The UCA may be connected to any Ethernet network (LAN). This makes it convenient to move UCA data files from one computer to another on the network. It is also possible to view a UCA test in progress or an old test from another computer networked to the UCA using the UCA Remote Viewer software. This will allow personnel to view a test in progress from home or on location, provided they have access to the network to which the UCA is connected.

Since the UCA operates under Microsoft[®] Windows[®] 98 or later, the instrument can be easily connected to a network. It may be necessary to assign an IP address to the instrument in some instances and this can be done in the usual way through the system setup



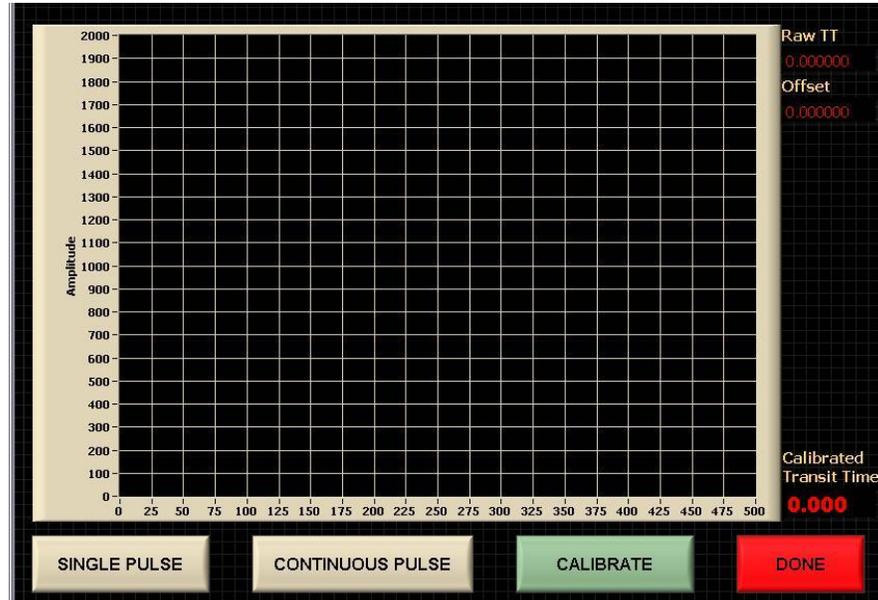
The UCA should always be kept behind a secure network firewall to prevent unauthorized access via the internet or other portal. Allowing UCA access via the internet is not recommended.

5.10 Transit Time Calibration

Checking the transit time calibration is very easy. Follow the steps below.

1. Fill the cell with room temperature water and purge any air trapped in the cell.

2. Apply compressed air pressure of 60-180 psi to the cell.
3. Insert the cell into the instrument and connect the top transducer and thermocouple cables.



4. In Instrument Setup, select CALIBRATE TRANSIT TIME from the touch screen menu. When the calibration screen appears, press the CALIBRATE button. If the waveform appears acceptable, press DONE to save the new calibration values. In general, the peak amplitude should be 600 or greater with water. If an acceptable waveform is not displayed, check the transducers and cables and recalibrate.

Transit time calibration is different from older UCAs. The steel calibration bar is no longer required. The unit is now calibrated with water. It is imperative that there be no air in the water during calibration or while a test is in progress.

Incorrect or improper calibration values are the most likely reason for the UCA to report incorrect strength values. The calibration should be checked whenever the transducers are removed or if the compressive strength values become suspect.

6 Front Panel Controls

The controls can be divided into three categories: hydraulic controls that control the pressure inside the reservoir, pneumatic controls that control the air pressure to the pump, and the switches that control the electrical components of the instrument.

6.1 Hydraulic Pressure Controls

This section consists of the following controls: the PRESSURE RELEASE valve, the PRESSURE REGULATOR, the REGULATOR BYPASS valve, and the WATER SUPPLY switch. Components that make up this section are used to control the flow of water used to pressurize the cylinder.

The PRESSURE RELEASE valve is used to release pressure from the pressurized cylinder. This valve must be closed during testing except when it is necessary to manually release pressure. This valve must also be closed when removing the pressure vessel with cooling water circulating or cooling water may back up and leak out the pressure port in the top of the instrument.

The PRESSURE REGULATOR may be used to set the upper limit on the system pressure up to 10,000 psig/680 bar. When the hydraulic force on the regulator exceeds the spring force of the regulator, the regulator valve will open and release pressure until the hydraulic and spring forces balance again. The regulator will then close preventing any additional pressure release until the hydraulic force again exceeds the spring force. Turn the PRESSURE REGULATOR knob clockwise to increase pressure and counterclockwise to reduce pressure.

The pressure regulator is only usable at pressures up to 10,000 psig/680 bar. To operate the UCA at pressures above 10,000 psig/680 bar, the REGULATOR BYPASS must be turned clockwise to the closed position. For automatic operation at pressures below 10,000 psig/680 bar, the PRESSURE REGULATOR SHUTOFF valve must be turned counterclockwise to the fully open position.

The WATER SUPPLY valve is used to control the flow of water to the pump and test cell. This valve must be closed any time the test cell is not installed. This valve must be open to fill the pressure vessel with water or to operate the pump. Opening this valve when the test cell is not connected will cause a serious water leak.

6.2 Pneumatic Controls

The pneumatic section consists of the AIR TO PUMP gauge and the AIR TO PUMP regulator. The components in this section are used to power the air driven hydraulic pump that applies pressure to the sample.

The AIR TO PUMP gauge indicates how much air pressure is being supplied to the instrument. If there is no pressure indicated on this gauge, the pump will not

operate. The pressure should be between 20 and 100 psig (1.4 and 6.8 bar) when the pump is not in use. It is normal for the inlet air pressure to drop when the pump is in operation. If the air pressure drops significantly and the pump seems unable to achieve the desired pressure, it may be because the compressed air system is not capable of delivering enough air to operate the pump.

The AIR TO PUMP regulator is used to control the air pressure to the air driven hydraulic pump. Higher hydraulic pressures require higher air pressures. To adjust the pressure of the air supplied to the pump, pull the knob on the regulator out to unlock it. Turn the regulator knob clockwise to increase the pressure and counterclockwise to decrease the pressure. When the adjustment is finished, push the knob in to lock it in place.



If the PUMP AIR PRESSURE drops off significantly when the pump is operating, an air line may be blocked or the compressor may be insufficient to deliver the volume of air required.

This regulator is used to control the pressure of the air supplied to the pump. The hydraulic pressure output of the pump is directly proportional to the air pressure supplied to the pump. As the air pressure increases, the hydraulic pressures increases and vice versa. Air pressure to the pump may be decreased by turning the AIR TO PUMP regulator knob counterclockwise or increased by turning the knob clockwise. If the regulator is set to a value and the pump switch is turned to the ON position, the pump will increase pressure until the pneumatic force of the air (air pressure multiplied by pneumatic piston area) equals the hydraulic force of the pressurizing water (water pressure multiplied by pump piston area). At this point the hydraulic and pneumatic pressures will be in equilibrium and the pump will cease to stroke. If the water pressure falls for some reason, a force imbalance will be created between the pneumatic and hydraulic sides of the pump and the pump will begin to stroke and increase the hydraulic pressure until it is balanced with the pneumatic pressure, then it will stop pumping. In this way, the pump may be used as a pressure control device (combined with the relief valve) to establish the lower pressure limit for a test.

6.3 Electrical Controls and Displays

The only front panel electrical controls are the POWER, and WATER SUPPLY switches. These controls are discussed in detail below.

The switch labeled POWER controls electrical power to the entire instrument. Nothing else is operable if this switch is not on. ..

The WATER SUPPLY switch supplies water to the UCA test cell, pump, and cooling water. It should be in the ON position when the instrument is running.

7 Operation

To prepare the test cell, follow this procedure:

1. Apply a light coating of grease to the inside of the test cylinder, including the top and bottom plug surfaces that are in contact with the cement slurry. Coating the threads with grease or anti-seize lubricant is also recommended.
2. Screw the bottom plug into the bottom of the pressure cylinder. The top of the cylinder is stamped TOP on the wrench flats.



Do not overfill the test cell or cement will be forced into the pressure and/or thermocouple ports and plug them.



A small gap between the top and bottom plugs and the cylinder is advisable. Overtightening does not cause better sealing; it only causes plug removal difficulty.

3. Add cement to the test cell until the proper fill level is obtained using the Slurry Level Gauge. The slurry should touch the lower tab marked WET but not the upper tab marked DRY. Be careful not to get cement into the threads. If cement sets up in the threads it may make plug removal and installation difficult or impossible.
4. Gently pour a small amount of water into cylinder on top of the cement-- just enough to reach the water fill line on the Slurry Level Gauge. Try not to mix the water and cement.
5. Screw the top plug in place. Do not tighten with a wrench. Hand tight or hand tight less 1/8 turn is optimal. A small amount of water should come out the pressure or thermocouple port when the top plug is in place.
6. Wipe the cylinder assembly clean and gently place in autoclave chamber. Make certain the electrical contacts in the bottom of the cabinet and plug are free from corrosion and debris. Rotate cylinder clockwise if necessary. To insure the banana connection on the bottom the cylinder assembly has good contact, make certain the test cell is pushed down firmly inside the heating jacket. Do not turn the test cell assembly counterclockwise or the plugs may come unthreaded.
7. Connect the one end of the coaxial cable to the BNC connector on the top

plug and the other end to the connector on the rear panel labeled TRANSDUCER.

8. Align pressure port in top plug with high pressure fitting on top of autoclave assembly. Rotate test cell in a clockwise direction only. The top or bottom plugs may come unscrewed if the test cell is rotated counterclockwise.
9. Attach the high pressure tube from the cabinet to the test cylinder. Place the U-shaped tube in place. Tighten fittings on both ends of U-tube finger tight only. When the U-shaped tube is in place, complete tightening using a 5/8 inch open end wrench.
10. Connect the thermocouple cable to the connector on the rear of the autoclave labeled J THERMOCOUPLE.
11. Install the thermocouple into the remaining high pressure port in the top plug of the test cell until the fitting is finger tight.
12. Slowly open the water supply valve until water begins to come out the thermocouple connection vent hole. Tighten the thermocouple with a 5/8 inch open end wrench. It is recommended a rag or paper towel be placed near the thermocouple vent hole to collect the spilled water and prevent it from running down inside the instrument or into the sensor cavity.

7.1 Setting Up Automatic Pressure Control

This section describes the steps used to control pressure in the Model 520 UCA. Use of the internal pump and pressure regulator will also be discussed.

Follow the steps below to configure the pump and pressure regulator for automatic pressure control.

1. Make certain the test cylinder is installed properly, the HIGH PRESSURE INLET port on the rear of the instrument (if equipped) is plugged, the PUMP and COOLING WATER is in the ON position in the software and the COOLING WATER is in the OFF position in the software, and the instrument is supplied with compressed air.
2. Turn the AIR TO PUMP regulator clockwise until air pressure is sufficient to raise pressure to the desired pressure set point. The air pressure should not exceed 100 psig (690 kPa).
3. Turn the blue PRESSURE REGULATOR knob clockwise until the regulator pressure is sufficient to prevent the regulator from opening at the required pressure set point.
4. Turn the AIR TO PUMP knob clockwise and increase pressure until the pressure exceeds the desired set point. Turn the PUMP switch OFF in the

software. Make certain the system is holding pressure before proceeding. The pump contains metal-to-metal inlet and outlet check valves that may not be bubble tight, so a small amount of pressure leakage is to be expected. This should not be a problem under normal operation.

5. Turn the blue PRESSURE REGULATOR knob counterclockwise slowly until the test cylinder pressure begins to drop. Continue turning the regulator knob slowly until the pressure in the test cell is at the upper limit of the desired test pressure.
6. Release pressure in the test cell using the PRESSURE RELEASE valve.
7. Turn the AIR TO PUMP regulator counterclockwise until the AIR TO PUMP is approximately zero.
8. Turn the PUMP switch ON in the software.
9. Slowly turn the PUMP AIR PRESSURE ADJUST regulator knob clockwise until the pump actuates. Continue to slowly turn the regulator knob clockwise until the lower limit for the control pressure is reached.

As the test cylinder gets hot, pressure in the test cylinder will increase. When the pressure in the test cylinder exceeds the control pressure upper set point, the pressure regulator will open and pressure will be reduced. If the heating rate is reduced, as during the transition from a temperature ramp to a temperature soak, the pressure in the test cylinder may decrease. If the pressure falls below the control pressure lower limit, the pump will actuate and bring the pressure back within the established limits.

The pump and pressure regulator will have hysteresis or a “deadband” in their operation. For example, if the pressure regulator is set to open at 3000 psig, it may open at 3000 psig, but may not close until the pressure falls to some lower value, perhaps 2900 psig. This 100 psig differential between opening and closing is referred to as the deadband or hysteresis. As another example, the pump may be set to actuate if the pressure falls to 3000 psig, but the pressure may reach perhaps 3100 psig before the pump stops. This 100 psig differential between the initial pressure and the final pressure is also known as deadband or hysteresis. If the upper and lower set points are too close together, this deadband may overlap and cause system instability. The system will then go into a continuous oscillation where the pump increases pressure and the pressure regulator releases all the pressure the pump is able to build. The solution to this problem is to decrease the lower set point, raise the upper set point, or both.

7.2 Stopping a Test

When the test has been completed, follow the steps below to end the test.

1. Press the STOP TEST button to manually stop a test.



WARNING! Failure to maintain pressure at temperatures above 212°F (100°C) may cause water in the test cell to vaporize into steam. Use the pump to maintain pressure on the test cell until the cell is cool.

2. Press the COOLING WATER button to cool the test cell. When the temperature is below 200°F (93°C) the PUMP switch may be turned to the OFF position and the PRESSURE RELEASE valve opened.
3. Turn WATER SUPPLY switch to its OFF position
4. To shut-down instrument, press EXIT and confirm. Next, press the Windows[®] Start button on bottom left of screen and Shut-down computer properly.
5. Turn POWER switch to its OFF position.
6. Close the PRESSURE RELEASE valve (clockwise). Failure to do so will result in water leakage if cooling water is circulating when the U-tube or thermocouple are loosened.
7. Remove the U-shaped high pressure tubing connecting the test cylinder to the bulkhead fitting on the top of the instrument.
8. Disconnect the transducer cable.
9. Disconnect the thermocouple cable.



Before touching the test cell wait until the surface has cooled to below 120°F.

10. Lift the test cell from the instrument.

The test cylinder is now ready to be cleaned. Cleanup should be done as soon after completion of a test as possible when the sample is easiest to remove.

7.3 Cleaning the Test Cell

When the test cylinder has been cooled and removed from the instrument, it should be cleaned according the following guidelines.

1. Place the test cylinder in a vice, topside up. The top of the cylinder is marked on the cylinder wrench flats. Use the wrench flats to clamp the plugs and cylinder and do not scratch or nick the cylinder or plugs.



The spiral retaining ring found on the bottom plug is used to retain the seal ring and o-ring during disassembly. In some cases, it may make removal of the bottom plug more difficult. Its use is strictly optional and may be omitted if desired.

2. Remove the cylinder from the vice and replace in the vice top side down.
3. Unscrew and remove the bottom plug from the test cylinder.
4. Turn the cylinder over and tap the cement sample out of the test cell with a hammer. The cylinder is tapered outward from top to bottom so the cement sample must always be removed through the bottom of the cylinder.
5. Clean the cement and grease from the top and bottom plugs and cylinder.
6. When all traces of cement have been removed, grease the inner surfaces of the test cell, including the seals and o-rings.
7. Replace the o-rings if they were damaged during the test.

8 Interpreting Test Results

An ultrasonic measurement is a nondestructive test method. It predicts relative compressive strength development by comparing transit times of known mechanical compressive strength data to transit times observed in the UCA. Actual data will have points above and below the best fit curve used to develop the algorithm. The closer the slurry being tested is to the actual slurry used to develop the algorithm the closer the data will match.

Algorithm A = Lightweight slurry (<14 lb/gal)

Algorithm B = NORMAL SLURRY (standard, used on almost all applications and should be the default)

Algorithm C = High density slurry (>17.5 lb/gal)

Algorithm A was developed in the 1970's for use with lightweight slurries. However, some modern lightweight slurries may work better on algorithm B. Most of the modern lightweight slurries react like a standard or normal slurry so algorithm B is typically a better choice. Algorithm A is intended for slurries where fly-ash is the major component. The use of algorithm A is recommended in reduced water slurries. Use algorithm C when there is a weighting agent present to get the density above 17.5 lb/gal.

We recommend performing a mechanical compressive strength test to see the actual compressive strength. If the results are within 200 psi then it is considered the correct algorithm. If not, try a different algorithm. You can easily change algorithms using the Test Viewer to see which algorithm best fits your data.

The algorithms developed by Halliburton in the 1970's used data from cement cured at elevated temperatures rather than below ambient temperatures. Algorithms are being extrapolated to a certain extent at lower temperatures. Modern slurry of a certain density may be better represented with a different algorithm than a slurry from 40+ years ago. Having strength values compute a bit low just makes for conservative results. Fann recommends customers use algorithm B unless they have reason to think another algorithm might work better. If the crush data seems to indicate that algorithm A fits a slurry better than algorithm B, then there is no reason not to use algorithm A.

The strength values obtained using either the API/ISO crush test or the UCA are indicative of the integrity of the cement under uniaxial loading. In the wellbore, the cement is subject to complex triaxial loading, and the failure stresses may be substantially different from those observed in the standard compressive strength test.

9 Troubleshooting and Maintenance

9.1 Troubleshooting

Table 9-1 Troubleshooting Guide

Symptom	Cause	Remedy
System builds pressure but will not hold pressure	Leak	Check fittings for leaks and tighten fittings.
	TESCOM Regulator Leaking	Rebuild regulator or replace.
	PRESSURE RELEASE valve is not closed tightly	Close valve tightly.
	PRESSURE RELEASE valve is worn out.	Replace valve stem or entire valve.
POWER circuit breaker switch trips off	Short circuit is system wiring.	Disconnect power to instrument and check for short circuits with an ohm meter.
	Faulty POWER switch.	Replace switch.
Pump strokes but little or no pressure is obtained	PRESSURE RELEASE valve open, severe leak, blown rupture disc.	Locate problem and correct.
	Test cylinder has trapped air.	Open thermocouple connector slightly and release trapped air.
	WATER SUPPLY valve is not open or water is not being supplied to the instrument.	Open WATER SUPPLY valve and check flow of water to the instrument.
	PRESSURE REGULATOR is not holding pressure.	Turn PRESSURE REGULATOR knob clockwise. Overhaul/replace regulator.
	Faulty pump check valve.	Clean and/or overhaul pump check valves.
Instrument not receiving power	UPS Jumper not connected or seated properly.	Install UPS Jumper cable to back of instrument, making sure it snaps into place and is fully seated.
	Instrument not plugged in.	Connect instrument to the correct power source.
	Blown fuse or thrown breaker on circuit supplying power.	Check fuses and breakers on electrical supply circuit.
Heater will not get hot.	Blown fuse.	Check fuses on rear panel. Replace any that are blown.
	HEATER switch not in the ON position.	Turn HEATER switch to ON position.

Symptom	Cause	Remedy
	Faulty heater.	Replace.
	Faulty solid state relay.	Replace.
Temperature display is erratic.	Faulty thermocouple.	Replace thermocouple.
	Loose connection in thermocouple wiring.	Check for loose wiring and correct if necessary.
Software will not start	USB Cable unplugged	Ensure that USB from computer to back of instrument is connected.
	Touchscreen unplugged or power off	Check power plug, make sure power button on right side of screen is on.
Pump will not operate.	Insufficient air pressure to pump.	Check air supply and make certain instrument is supplied with air between 30 and 100 psig. Check air lines for blockage. Adjust PUMP AIR PRESSURE ADJUST regulator to a higher pressure.
	Solenoid valve controlling flow of air to pump is not functioning.	If no solenoid click is heard when the PUMP switch is turned to the ON position, a faulty solenoid valve is likely
Waveform amplitude is too low	Not enough ultrasonic couplant on transducers.	Clean transducers and apply new couplant. Pea size amount is sufficient.
	Pressure is below 1000 psi	Increase pressure above 1000 psi.
	Dirt or debris on transducer faces.	Clean transducers and apply new couplant.
Transit time and compressive strength values are erratic.	Not enough ultrasonic couplant on transducers.	Clean transducers and apply new couplant. Pea size amount is sufficient.
	Dirt or debris on transducer faces.	Clean transducers and apply new couplant.
	Bad coaxial cable.	Replace cable.
	Loose coaxial connector inside control box.	Check connections and tighten if necessary.
	Pressure was below 1000 psi during test	Check data file and make certain pressure remains above 1000 psi during a test
Water comes out of	Faulty high pressure seal.	Replace the high pressure seal and

Symptom	Cause	Remedy
pump muffler.		remove all water from air side of pump. Pump may also be sent back for repair.

9.2 Maintenance

The maintenance requirements for UCA are simple and should consume little time.

The first maintenance item is to check and replace the 2 micron filter element inside the high pressure filter housing periodically. The filter housing is located on top of the instrument cabinet and is connected to the high pressure tubing leading to the test cylinder. The filter housing should be thoroughly cleaned at this time. The high pressure filter is designed to prevent cement particles from entering the PRESSURE REGULATOR and damaging it.

The second maintenance item is to thoroughly clean and lubricate the test cylinder after every test. Be sure to inspect the o-rings for damage and replace if damaged or severely distorted.

It is recommended that the thermocouple and water line connections on the top plug be cleaned periodically to prevent buildup of cement in the bore and threads.



Problems related to corrosion of the lower transducer connection can be minimized by not allowing water to run down the side of the cylinder and into the bottom of the instrument.

Periodically inspect the electrical connector in the bottom of the instrument where the test cylinder rests. If this connector becomes dirty or corroded, the lower transducer may not make good electrical contact. Clean the connector if necessary.

Unlike other UCAs, it is not necessary to coat the ultrasonic transducers with couplant prior to every test. In fact, the transducers should not be removed unless they are believed to be faulty or unless they need additional couplant. The top transducer is sealed to prevent water from entering the transducer chamber during cylinder filling or cleanup.

10 Warranty and Returns

10.1 Warranty

Fann Instrument Company warrants only title to the equipment, products and materials supplied and that the same are free from defects in workmanship and materials for one year from date of delivery. **THERE ARE NO WARRANTIES, EXPRESS OR IMPLIED OF MERCHANTABILITY, FITNESS OR OTHERWISE BEYOND THOSE STATED IN THE IMMEDIATELY PRECEDING SENTENCE.** Fann's sole liability and Customer's exclusive remedy in any cause of action (whether in contract, tort, breach of warranty or otherwise) arising out of the sale, lease or use of any equipment, products or materials is expressly limited to the replacement of such on their return to Fann or, at Fann's option, to the allowance to Customer of credit for the cost of such items. In no event shall Fann be liable for special, incidental, indirect, consequential or punitive damages. Notwithstanding any specification or description in its catalogs, literature or brochures of materials used in the manufacture of its products, Fann reserves the right to substitute other materials without notice. Fann does not warrant in any way equipment, products, and material not manufactured by Fann, and such will be sold only with the warranties, if any, that are given by the manufacturer thereof. Fann will only pass through to Customer the warranty granted to it by the manufacturer of such items.

10.2 Returns

For your protection, items being returned must be carefully packed to prevent damage in shipment and insured against possible damage or loss. Fann will not be responsible for damage resulting from careless or insufficient packing.

Before returning items for any reason, authorization must be obtained from Fann Instrument Company. When applying for authorization, please include information regarding the reason the items are to be returned.

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