CEMENT TEST EQUIPMENT, INC.

TULSA, OKLAHOMA, USA

Model 2000-5 UCA

Instruction Manual

CEMENT TEST EQUIPMENT, INC.

Model 2000-5 UCA User's Manual

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Rev. D 06.15.2015

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Chapter 1

Introduction

This chapter contains general information about the UCA and its uses as well as detailed specifications for the instrument and installation instructions.

What is a UCA used for?

ICON KEY	
	Important information
	Potential Danger or Safety Hazard
!	Operational Warning

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 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.

Description of Instrument

Our temperature controller and data acquisition system are so easy to operate you won't even need a manual. We've thrown one in anyway, just in case.

The Ultrasonic Cement Analyzer 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.

The major features of the CTE UCA are listed below:

- Easy to install and use.
- Direct replacement for Halliburton or Chandler UCA systems.

- Completely self contained. No need for pressure controllers, control boxes, or PC's.
- 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 PC via an Ethernet connection.
- Has built in, easy to use, touch screen control panel for control of data acquisition and temperature control. No more clunky temperature controllers to program. Temperature profile is displayed graphically before test starts to reduce mistakes.
- Available with integral pump and relief valve for soak pressure control. 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.

A cross-reference list of Chandler and Halliburton part numbers and equivalent CTE part numbers is provided in *Chapter 5, Maintenance and Servicing*.

Instrument Specifications

The specifications below apply to the CTE, Inc. Model 2000-5 UCA.

ELECTRICAL	
Input Voltage:	230 VAC (±15%)
Input Power:	2500W
Input Current:	11 A
Input Frequency:	50-60 Hz
MECHANICAL 2000-5;	
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) maximum
Cooling Water Pressure:	100 psig (6.8 bar) maximum
Utility Inlets:	¼ inch female NPT

Installation

Upon uncrating the instrument, verify that the instrument and any spare parts on the packing have been received and are undamaged. Notify CTE if anything is missing or damaged.

It is a good idea to leave room behind the instrument so that qualified personnel may have service access. If this is not possible, try to make the unit easy to disconnect and move for service.

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.

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 (C-0739) 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 manufacturers replacement interval recommendations. Neglecting to install the water inlet filter will void the instrument warranty. Water inlet supply water must be filtered at 5µ 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 relubricated. Based on this inspection, future maintenance intervals can be planned and further disassembly and lubrication of other moving seals may be necessary.

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) or brief surges of up to 400°F (204°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 5µ and 40µ 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 tubing or fittings to rupture and possible injury.

Electrical connections are made using the receptacle on the rear of the instrument. A power cord (part number C-0156) is supplied with the instrument. Please observe the following precautions when making the wiring connections.

- Wiring should be done 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.

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

Some components such as touch screen LCD monitors 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. 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.

Connecting an Uninterruptible Power Supply (UPS)

If a UPS is not used, the C-0275 cord must be installed between the two rear panel receptacles or the instrument will not operate.

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 (part number C-0275) 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.

Before attempting to operate the instrument, it is recommended that the operators read the remainder of the manual and study the drawings that appear in the Drawings/Schematics section of this manual to become familiar with the UCA operation.

Chapter 2

Using the Touch Screen Software

This chapter contains specific information on how to use the touch screen software plus instructions on how to network the UCA and connect and use the USB Memory Module.

What is a touch screen and how does it work?

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 and send position information back to the processor. Using the touch screen has the same result of using a mouse to point and click. One mouse click is accomplished by one touch of the screen. A double-click is achieved with two quick touches. With this standard method of input, no special software is required to utilize the screen.

Using the Touch Screen

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.

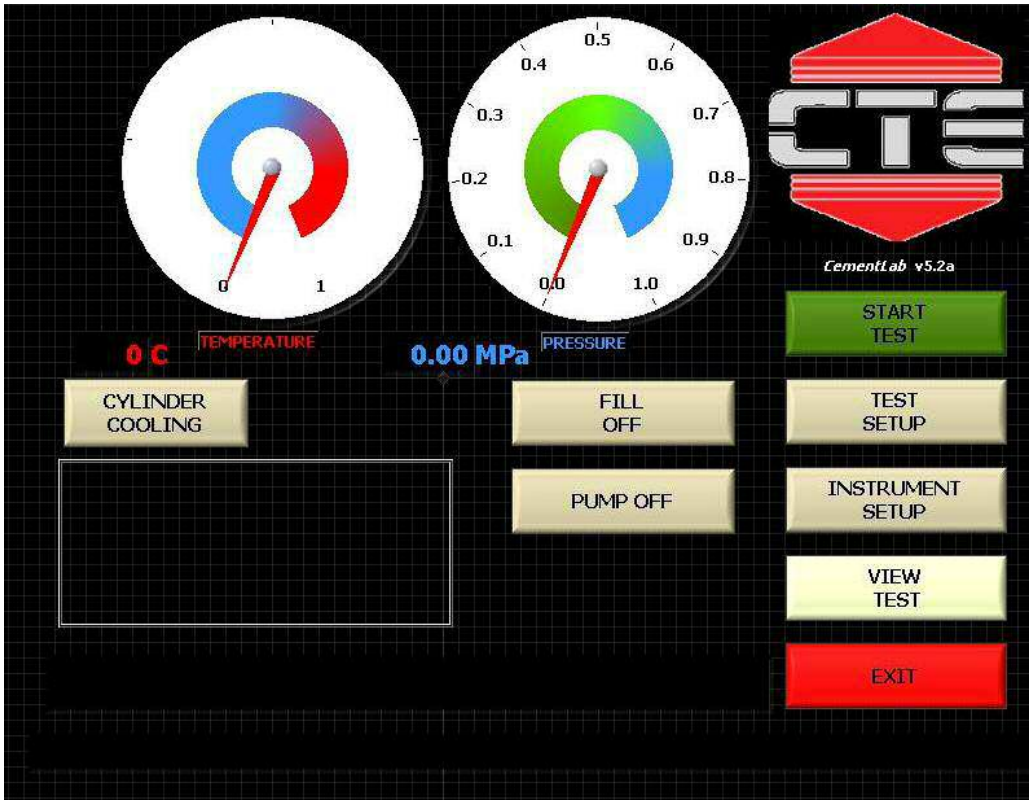
What can you do with the touch screen software?

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 PC 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.

Navigating the software

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.

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.

Please note the software version number underneath the CTE logo. This should consist of a number and perhaps a letter, for example, **5.1b**. This version number is important when calling CTE for support or questions.

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.

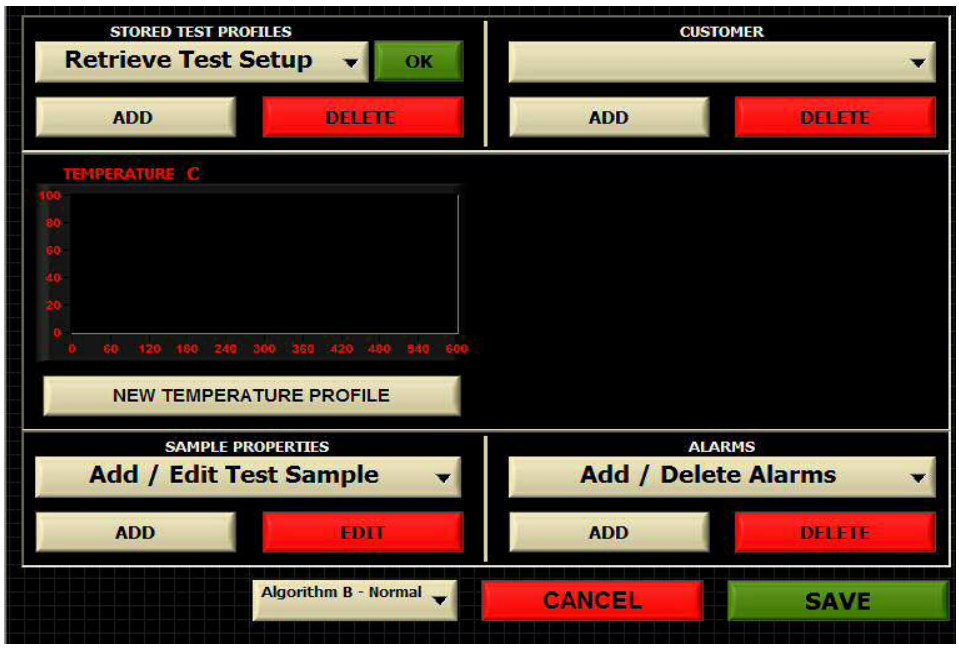
TEST SETUP – This button takes the user to the Test Setup Screen. Here the user may enter test parameters for the instrument. Test name, cement parameters, UCA algorithm, and Temperature Control are all accessed through this screen.

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:\CTE 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.

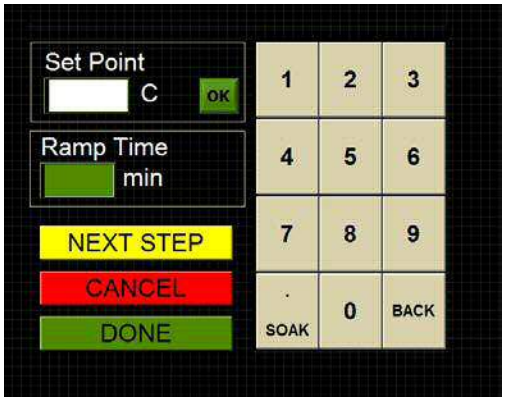
Test Setup Menu

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



Temperature Control

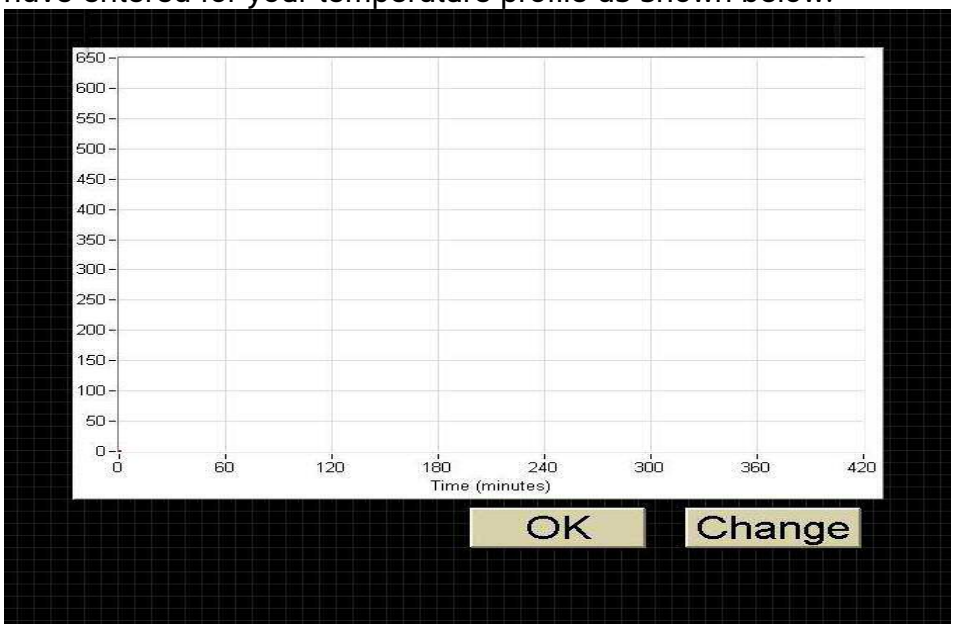
No longer is entering a temperature ramp a confusing process. On the temperature setup screen is a standard numeric keypad. On the left side are three values that define a ramp. Once a ramp is entered the user may advance to the **NEXT STEP** or press **DONE** to finish.



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.

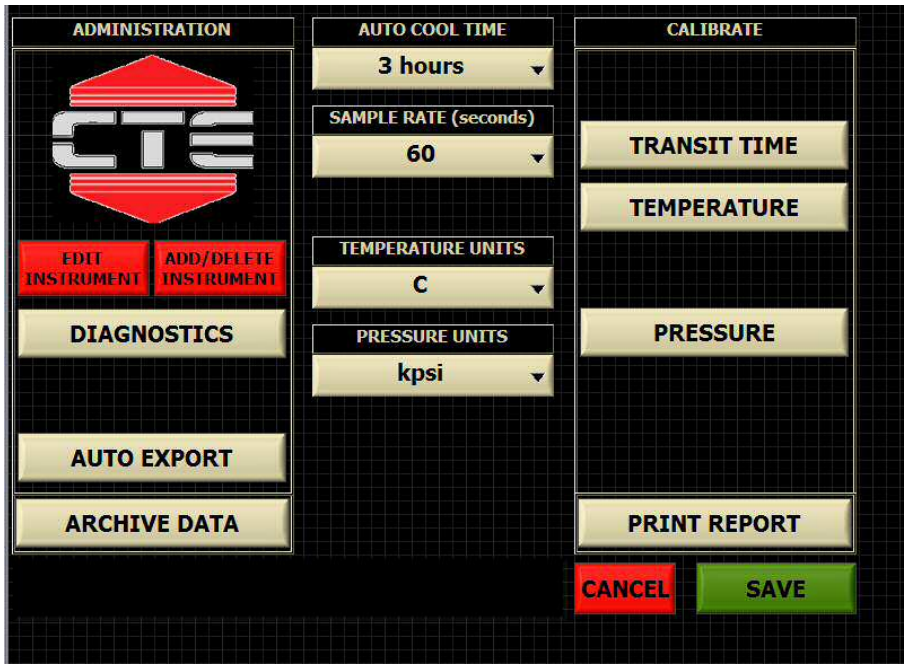


From this screen the user may press **Accept** if the graph is correct or **Change** to go back to the programming screens to correct any programming errors. If **Accept** is pressed the TEST SETUP screen will be displayed again. From here press DONE and the main menu will appear. Press START TEST to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

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.

Instrument Setup Menu

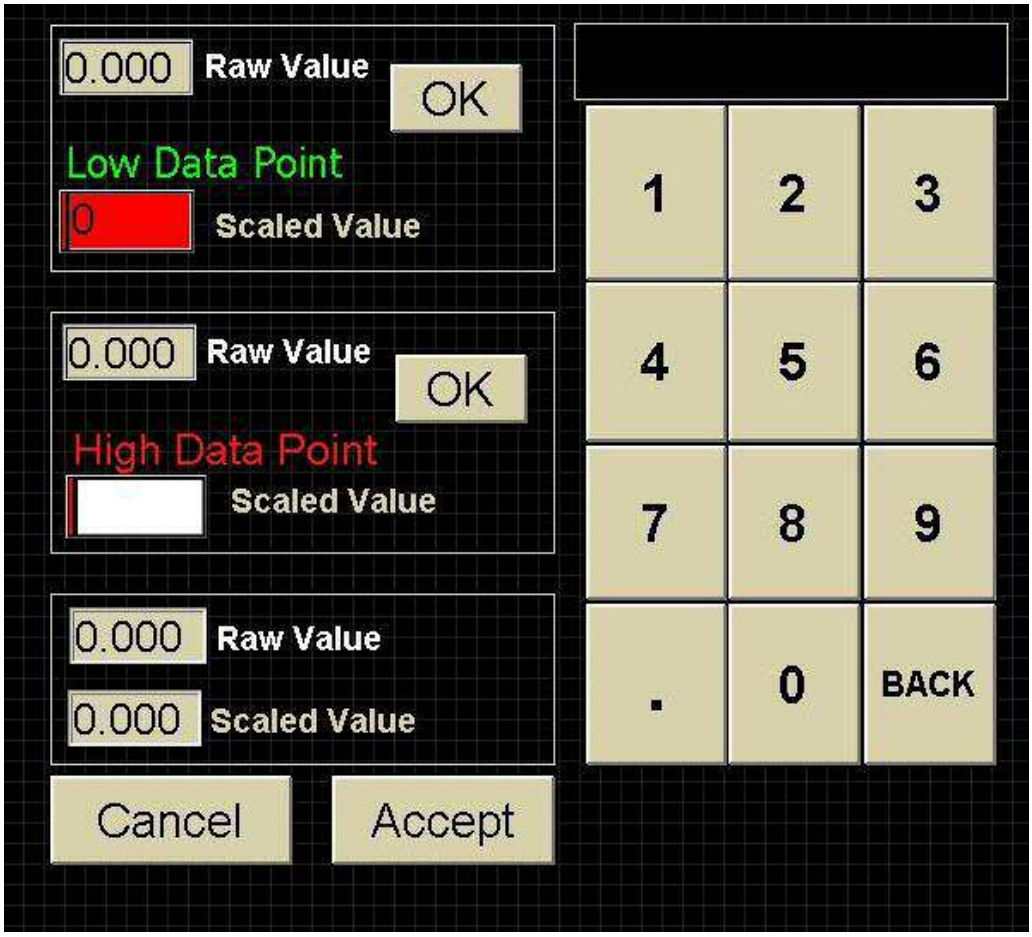


From this menu the user can run diagnostics on the ultrasonic transducer circuitry to determine if everything is functioning properly. This menu is also used move the data files from the UCA computer to another PC in order to free space in the UCA memory.

ARCHIVE DATA FILES – Select this command to move tests from the UCA to the USB memory module or external ZIP™ Drive. 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 similar to the one below 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.

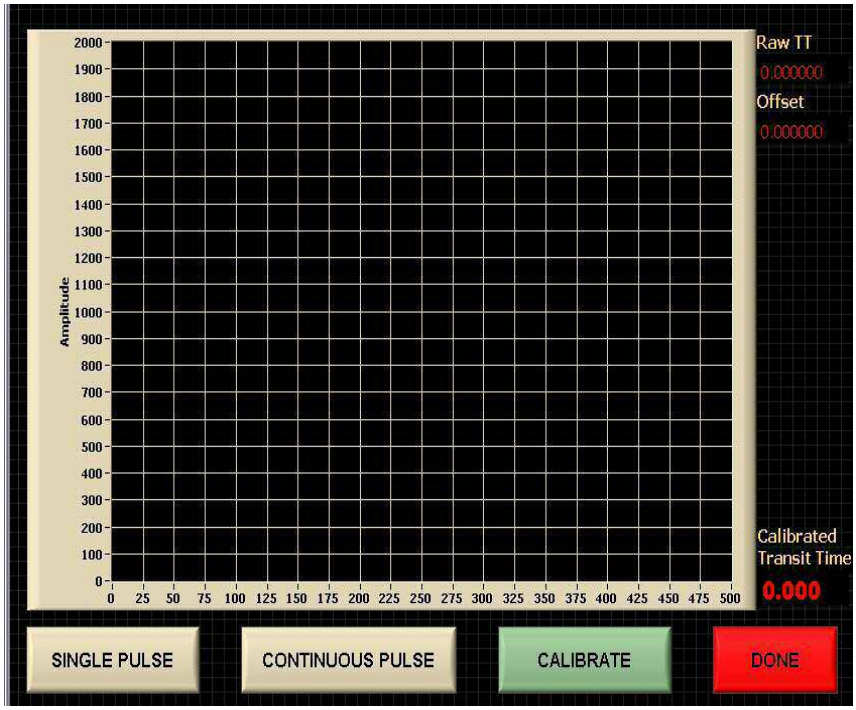
To calibrate the transit time, the cylinder must be COMPLETELY full of water with no air bubbles inside the cell. Calibration of transit time is discussed in more detail at the end of this chapter.



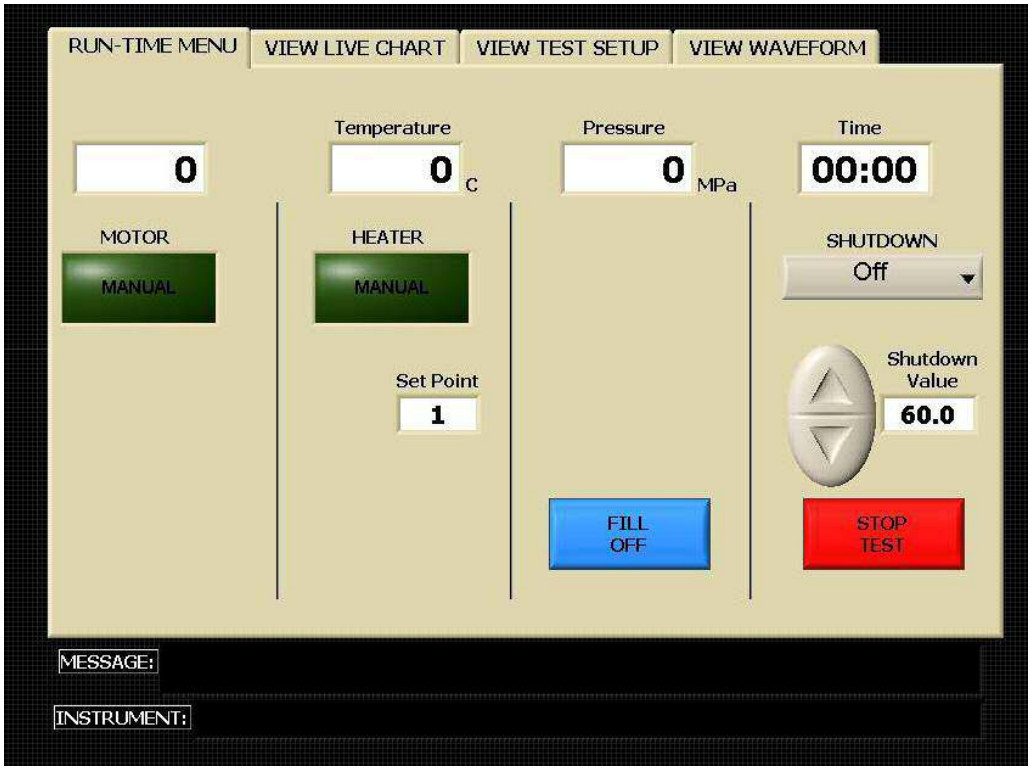
******NOTE: NEVER CALIBRATE TRANSIT TIME WITH A CEMENT SLURRY OR STEEL BAR FROM OTHER DEVICES**

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.



Running a Test



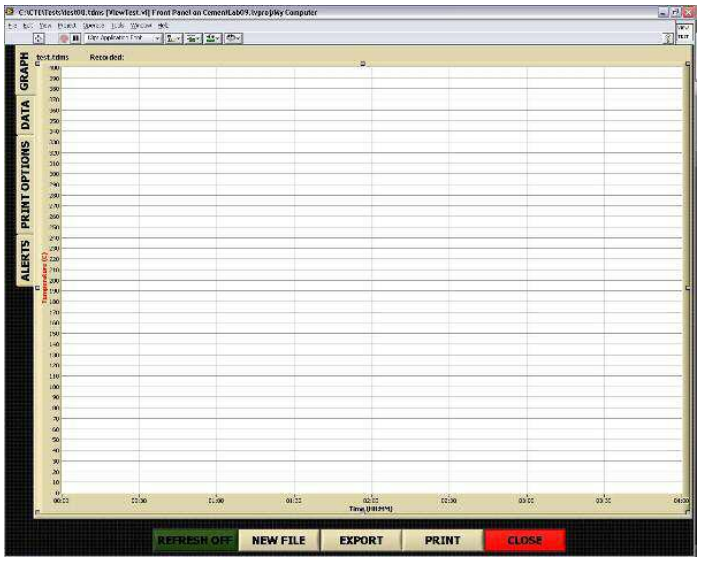
Once a test has begun, a **RUN-TIME MENU** of current values will be shown. The user may control all available parameters of the instrument from this menu.

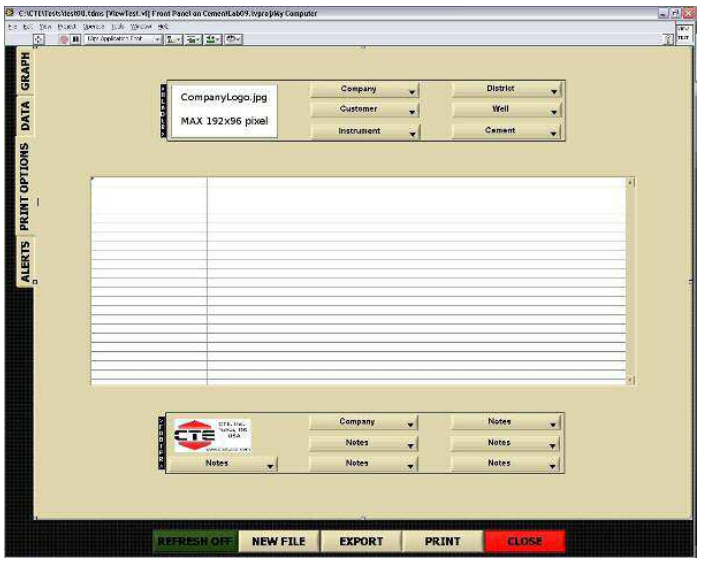
Under the **Pressure** column, the user can turn the water supply to the pressure vessel on or off and can turn the pump on when the cylinder is filled.

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.

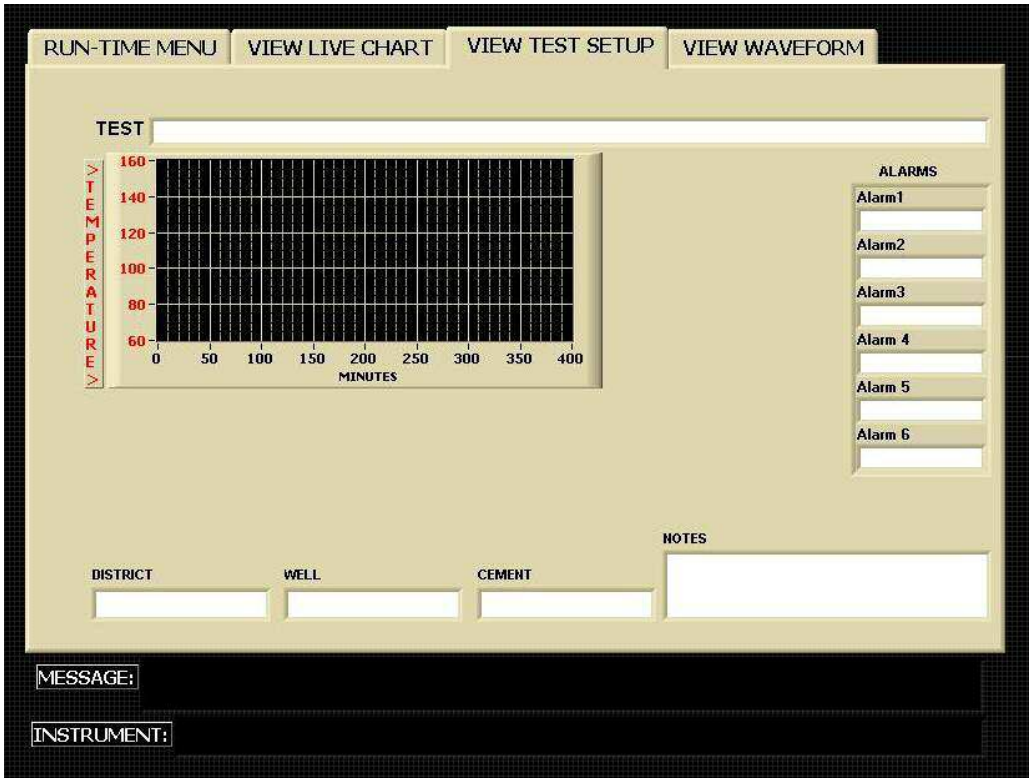




A complete table of numerical data can also be viewed here by selecting the **DATA** tab located on the left side of the screen in the **Test Viewer**.

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 **VIEW 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 **VIEW 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).

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.

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 what the actual compressive strength is. 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. Ordinarily, CTE 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.

Use of 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 based PC's. The memory module will simply appear as another disk drive when inserted into the USB port on the PC.

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. Note that 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.

Networking the Instrument.

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 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.

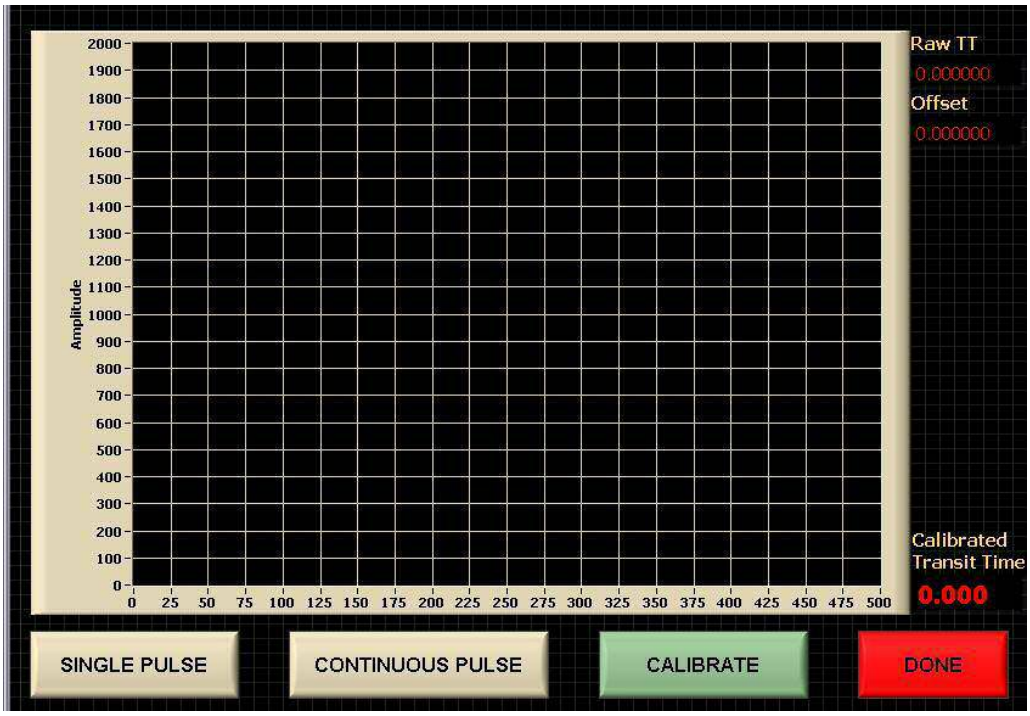
Transit Time Calibration

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

1. Fill the cell with water, making certain there is no air trapped in the cell.

2. Apply compressed air pressure of 60-180 psi to the cell.

3. Connect all cables as at the start of a test.



4. 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 UCA's. 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.

Chapter 3

A Tour of the Front Panel Controls

Chapter 3 will discuss in detail each front panel control found on the UCA.

It may be convenient to refer to the piping drawings in Chapter 6 when studying this section.

The sections below will describe the function of each component found on the front panel. The controls can be divided into four categories: hydraulic controls that control the pressure inside the reservoir, pneumatic controls that control the air pressure to the pump, cooling water controls that control the flow of cooling water to the cooling coils, and the switches that control the electrical components of the instrument.

The Hydraulic Pressure Controls

This section consists of the following controls: the **PRESSURE RELEASE** valve, the **PRESSURE REGULATOR**, 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 part number for the **PRESSURE RELEASE** valve is C-0656.

The **PRESSURE REGULATOR** may be used to set the upper limit on the system pressure up to 5,000 psig/340 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 use of the pump and **PRESSURE REGULATOR** to control pressure automatically will be discussed in *Chapter 4*. The PRESSURE REGULATOR part number is C-0078-3.

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.

The Pneumatic Controls

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

The pressure gauge displays pressure in both English and SI units.

The **AIR SUPPLY** gauge indicates how much air pressure is being supplied to the instrument. The part number for the **AIR PRESSURE** gauge is C-0138. 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 **PUMP AIR PRESSURE ADJUST** 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. The part number of this regulator is C-0021.

This regulator is used to control the pressure of the air supplied to the pump (part number C-0575-3). 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 **PUMP AIR PRESSURE ADJUST** 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. This will be discussed further in *Chapter 4*.

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.

The **PUMP AIR PRESSURE** gauge shows the pressure of the air delivered to the pump. The pressure may be changed by adjusting the **PUMP AIR PRESSURE ADJUST** regulator as described above. The part number of this gauge is C-0138.

The Cooling Water Controls

The only cooling water control is the **COOLING WATER** valve. It is used to control the flow of cooling water to the heating/cooling jacket. This valve must be closed during a test, but should be opened following a test to cool the heater and test cell. Cooling water is turned on/off manually in the software using the touchscreen. Additionally, automatic cooling is used after Auto Shutdown of a test and during testing when serious overshoot occurs.

The Electrical and Electronic Controls and Displays

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

If the unit is operated with an uninterruptible power supply (UPS), turning the POWER switch to the off position will not interrupt power. The UPS must also be turned off.

The switch labeled **POWER** controls electrical power to the entire instrument. Nothing else is operable if this switch is not on. The part number for the **POWER** switch is C-0075-1.

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

Chapter 4

Operation

Chapter 4 will discuss in detail the steps required to run a compressive strength test. Examples will be provided when necessary.

Preparing the Test Cell

The steps that should be used to set up the test cell are listed below.

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.

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 will 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.

3. Add cement to the test cell until the proper fill level is obtained using the Slurry Level Gauge (P/N 4-0058-2). 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.

The instrument is now ready to begin a compressive strength test.

Setting Up a Temperature Ramp

See Chapter 2.

Setting Up Automatic Pressure Control

This section describes the steps used to control pressure in the Model 2000-5 UCA. Use of the internal pump and pressure regulator will also be discussed.

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

1. Make certain the test cylinder is installed properly, the **PUMP** switch is in the OFF position, the **WATER SUPPLY** valve is turned to the ON position, the **COOLING WATER** valve is in the OFF position, and the instrument is supplied with compressed air.

2. Turn the **PUMP AIR PRESSURE ADJUST** 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 **PUMP** switch to the ON position and increase pressure until the pressure exceeds the desired set point. Turn the **PUMP** switch to the OFF position. 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 **PUMP AIR PRESSURE ADJUST** regulator counterclockwise until the **PUMP AIR PRESSURE** is approximately zero.

8. Turn the **PUMP** switch to the ON position.

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.

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.

2. Press the **COOLING WATER** button to cool the test cell. Use the pump to maintain pressure on the test cell until the cell is cool. 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. Failure to maintain pressure at temperatures above 212°F (100°C) may cause water in the test cell to vaporize into steam.

3. Turn **WATER SUPPLY** switch to its OFF position

4. To shut-down instrument, press **EXIT** and confirm. Next, press 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.

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.

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.

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.

The test cylinder is now ready to be used for the next test.

Chapter

5

Maintenance and Troubleshooting

This chapter contains information about the necessary periodic maintenance of the instrument as well as common service and troubleshooting guidelines.

Maintenance

UCA's can be relatively reliable and trouble free—provided they are serviced and maintained properly. Instruments that are neglected and receive infrequent service or are subject to abuse are certain to cause trouble. The maintenance requirements for UCA are very simple and should consume little time.

The first maintenance item is to check and replace the 2 micron filter element inside the filter housing periodically. The filter housing is located on top of the instrument cabinet and is connected to the tubing leading to the test cylinder. The filter housing should be thoroughly cleaned at this time. The 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.

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 get dirty or corroded, the lower transducer may not make good electrical contact. Clean the connector if necessary.

Unlike other UCA's, 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.

Troubleshooting

The following section consists of a table listing possible remedies for the most common UCA problems.

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	Turn **PRESSURE REGULATOR** knob clockwise. Overhaul/replace regulator.

Symptom	*Cause*	*Remedy*
	holding pressure. Faulty pump check valve.	 Clean and/or overhaul pump check valves.
Instrument not receiving power	UPS Jumper not connected or seated properly. Instrument not plugged in. Blown fuse or thrown breaker on circuit supplying power.	Install UPS Jumper cable to back of instrument, making sure it snaps into place and is fully seated. Connect instrument to the correct power source. Check fuses and breakers on electrical supply circuit.
Heater will not get hot.	Blown fuse. **HEATER** switch not in the ON position. Faulty heater. Faulty solid state relay.	Check fuses on rear panel. Replace any that are blown. Turn **HEATER** switch to ON position. Replace. Replace.
Temperature display is erratic.	Faulty thermocouple. Loose connection in thermocouple wiring.	Replace thermocouple. Check for loose wiring and correct if necessary.
Software will not start	USB Cable unplugged Touchscreen unplugged or power off	Ensure that USB from computer to back of instrument is connected. Check power plug, make sure power button on right side of screen is on.
Pump will not operate.	Insufficient air pressure to pump. Solenoid valve controlling flow of air to pump is not functioning.	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. 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. Pressure is below 1000 psi Dirt or debris on transducer faces.	Clean transducers and apply new couplant. Pea size amount is sufficient. Increase pressure above 1000 psi. Clean transducers and apply new couplant.

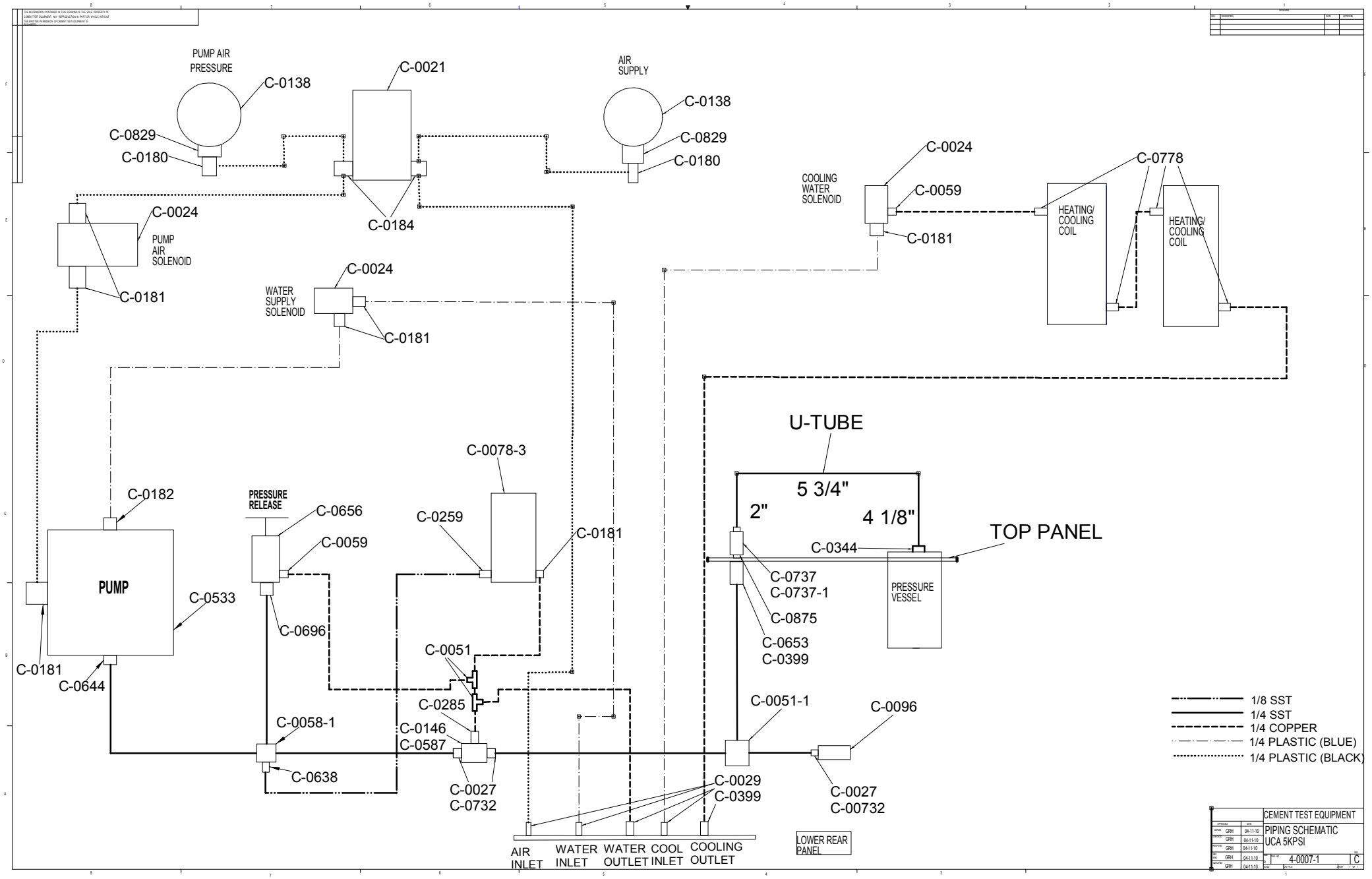
Symptom	*Cause*	*Remedy*
Transit time and compressive strength values are erratic.	Not enough ultrasonic couplant on transducers. Dirt or debris on transducer faces. Bad coaxial cable. Loose coaxial connector inside control box. Pressure was below 1000 psi during test	Clean transducers and apply new couplant. Pea size amount is sufficient. Clean transducers and apply new couplant. Replace cable. Check connections and tighten if necessary. Check data file and make certain pressure remains above 1000 psi during a test
Water comes out of pump muffler.	Faulty high pressure seal.	Replace the high pressure seal and remove all water from air side of pump. Pump may also be sent back for repair.

Parts List and Cross Reference

The following table contains a list of spare parts for the CTE Model 2000-5 UCA. A list of equivalent Halliburton and Chandler part numbers is also listed.

CTE Part Number	Chandler Part Number	Halliburton Part Number	Description
4-0120			Pressure Vessel Assembly
4-0123			Bottom Plug
4-0121			Pressure Vessel
4-0124			Top Plug
4-0026	80-0019	800.30842	Handle, Top Plug
C-0681			O-Ring, Viton
C-0138			Gauge, Pressure, 160 psi
C-0371	C08584		Ultrasonic Transducers (pair)
C-0575-3			Pump
C-0078-3			Pressure Regulator
C-0079	C08582		Bulkhead Fitting, 1/4 HPT-1/4 HPT
C-0656			Valve, Pressure Release
4-0032	80-0022	800.30813	Heating/Cooling Jacket, 2000 W
4-0058-2			Slurry Level Gauge
C-0395			Spring
4-0035	80-0026	800.30824	Heating Jacket Centering Ring
4-0023	80-0024	800.30823	Heating Jacket End Gasket
4-0037			Heating Jacket Bottom Gasket
4-0110			Cable, Ass'y

CTE Part Number	Chandler Part Number	Halliburton Part Number	Description
C-0080			SSR, 240 VAC, 25A, DC Control
C-0132	P-3330	70.80037	SSR, 240 VAC, 25A, AC Control
C-0395-1			Spring
C-0266	P-3359	70.73543	Inlet, Electrical, 20 A, 250 VAC
C-0516			T/C, Type J
C-0024			Solenoid Valve
C-0075-1			Switch, ON/OFF Circuit Breaker, 20A
C-0737			Filter Assembly, SST
C-0587			Rupture Disc
C-0096			Pressure Transducer
C-0737-1			Element, for C-0737 Filter
C-0739			Water Filter
C-0739-1			Water Filter Element
C-0172			Printer Cable
C-0324			Fan
C-0481			Power Supply
C-0156			Power Cord
4-0065			Cylinder Wrench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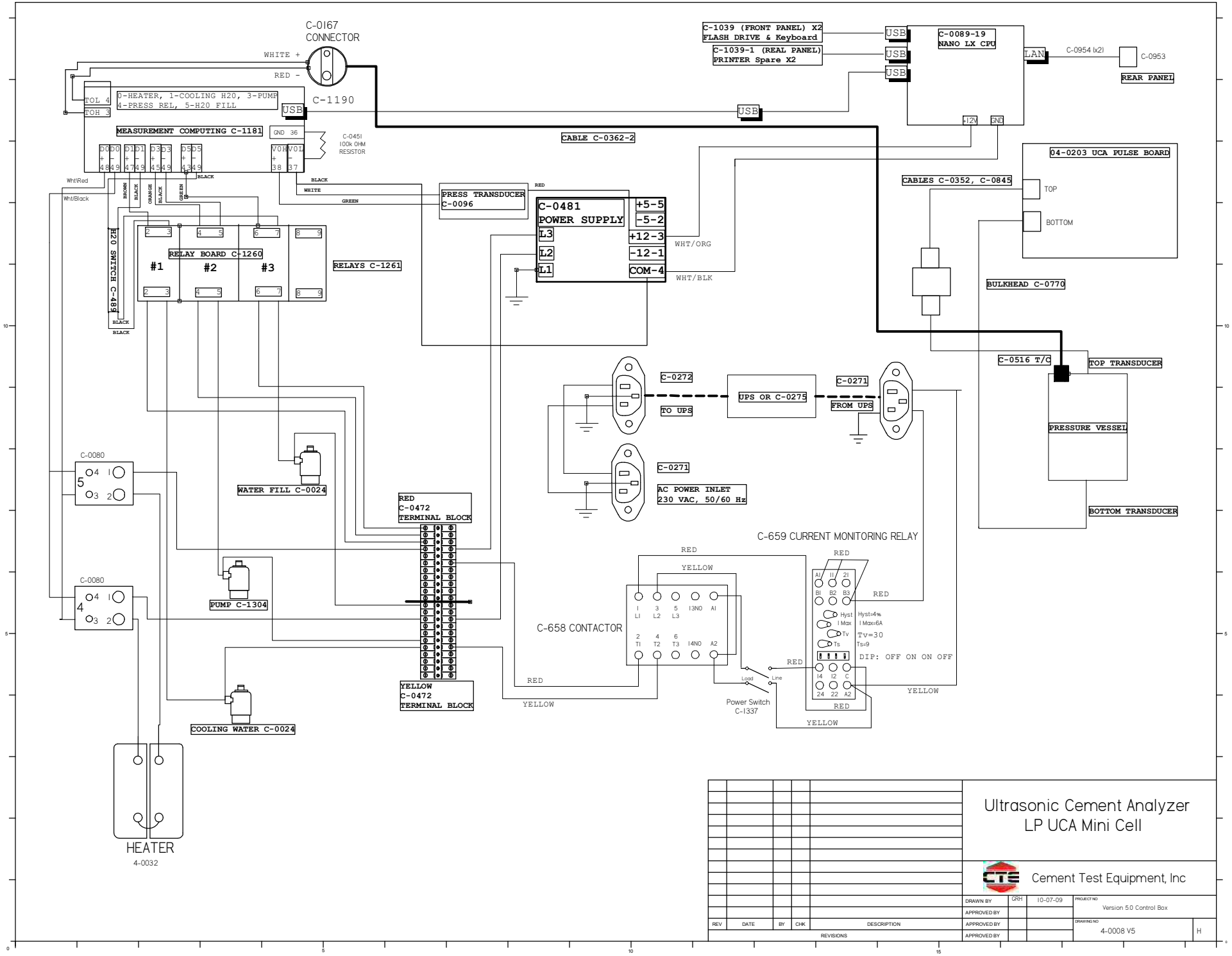
C-0138
C-0829
C-0180
C-0021
C-0184
AIR SUPPLY
C-0138
C-0829
C-0180
C-0024
PUMP AIR SOLENOID
C-0181
C-0024
WATER SUPPLY SOLENOID
C-0181
C-0024
COOLING WATER SOLENOID
C-0059
C-0181
C-0778
HEATING/ COOLING COIL
HEATING/ COOLING COIL
U-TUBE
5 3/4"
2"
4 1/8"
TOP PANEL
C-0344
C-0737
C-0737-1
C-0875
C-0653
C-0399
PRESSURE VESSEL
C-0182
PUMP
C-0533
C-0181
C-0644
PRESSURE RELEASE
C-0656
C-0059
C-0696
C-0078-3
C-0259
C-0181
C-0051
C-0285
C-0146
C-0587
C-0058-1
C-0638
C-0027
C-0732
C-0029
C-0399
C-0051-1
C-0096
C-0027
C-00732
AIR INLET
WATER INLET
WATER OUTLET
COOL INLET
COOLING OUTLET
LOWER REAR PANEL
1/8 SST
1/4 SST
1/4 COPPER
1/4 PLASTIC (BLUE)
1/4 PLASTIC (BLACK)
CEMENT TEST EQUIPMENT
PIPING SCHEMATIC
UCA 5KPSI
4-0007-1
C



REV	DATE	BY	CHK	DESCRIPTION

REVISIONS

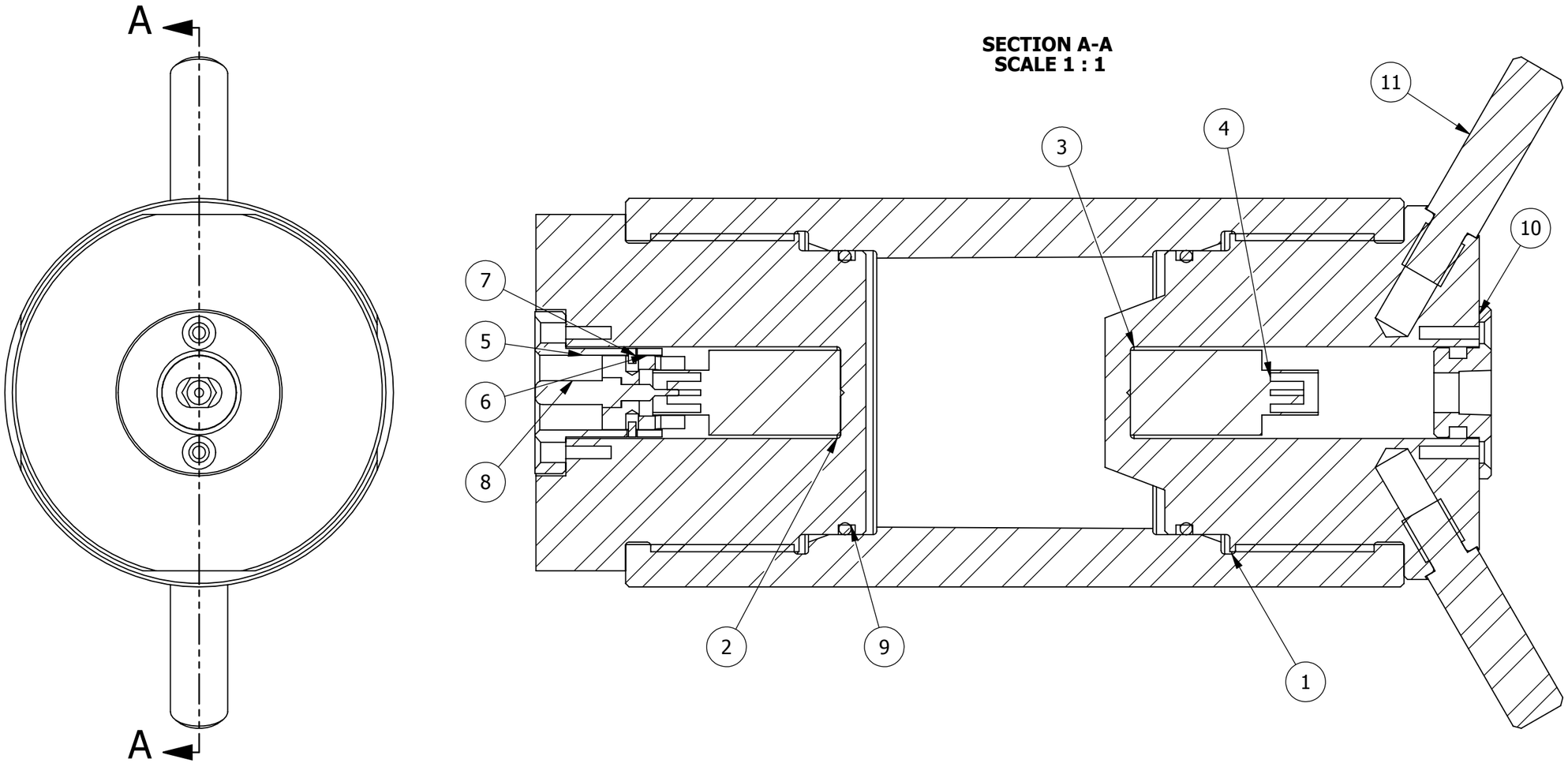
Ultrasonic Cement Analyzer
LP UCA Mini Cell

Cement Test Equipment, Inc

DRAWN BY	GRH	10-07-09
APPROVED BY		
APPROVED BY		
APPROVED BY		

PROJECT NO: Version 5.0 Control Box

DRAWING NO: 4-0008 V5 — H



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1	4-0221	CYLINDER	1
2	4-0223	BOTTOM PLUG	1
3	4-0224	TOP PLUG	1
4	C-0395	SPRING	2
5	4-0083	PLUG HOLDER	1
6	4-0084b	PLUG INSULATOR	1
7	C-0393	PIN	2
8	4-0087	BANANA PLUG	1
9	C-0681	O-RING	2
10	4-0138	CONNECTOR BASE	1
11	4-0026-1	HANDLE	2
12	C-0371	TRANSDUCER PAIR	1

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UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±1/32
ANGULAR: ± 1°
TWO PLACE DECIMAL ±.01
THREE PLACE DECIMAL ±.005

INTERPRET GEOMETRIC TOLERANCING PER:

MATERIAL

FINISH

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	GRH	11-09-12
CHECKED	GRH	11-09-12
ENG APPR.	GRH	11-09-12
MFG APPR.		
Q.A.		

COMMENTS:

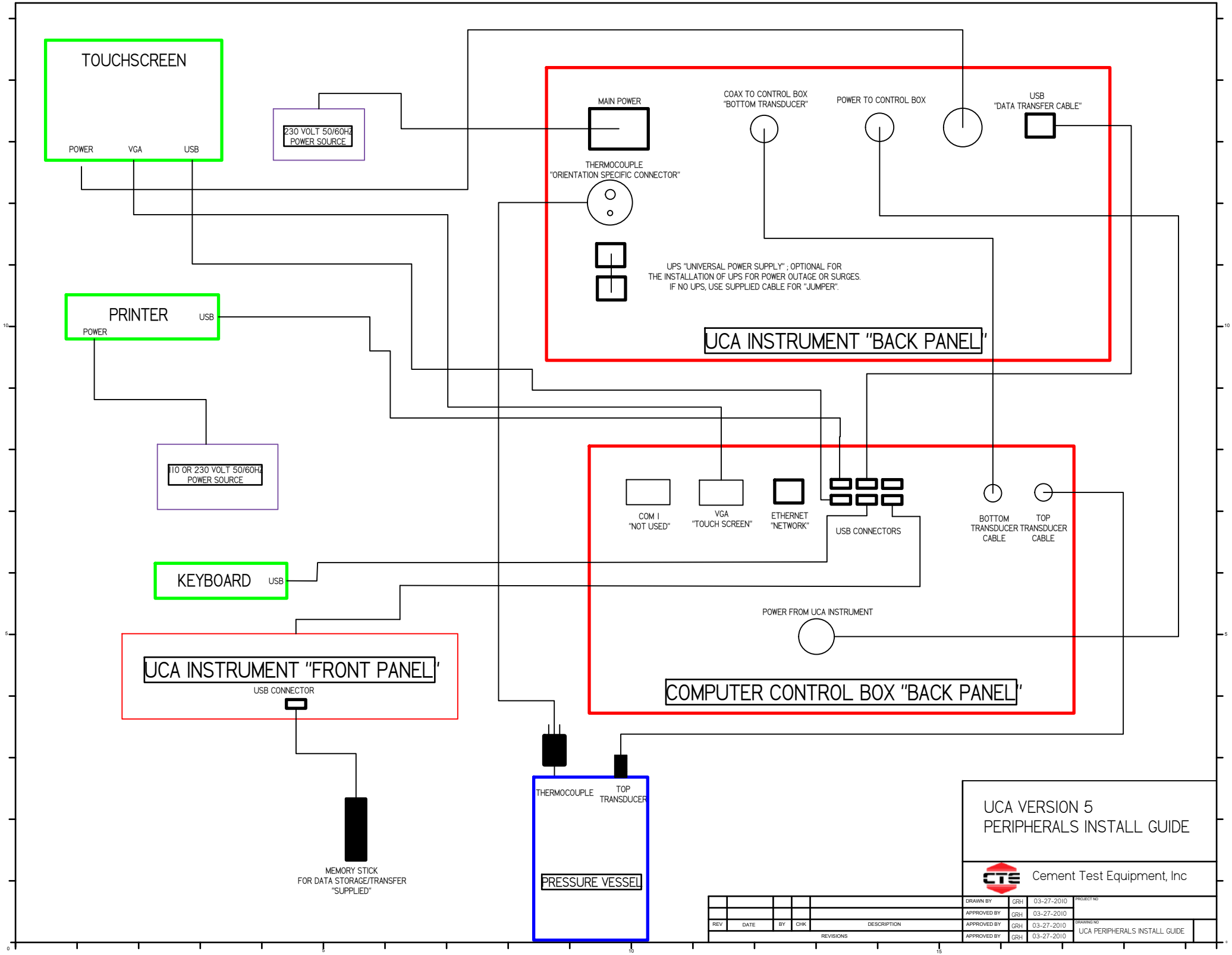
Cement Test Equipment

TITLE:

MINI LP UCA PRESSURE VESSEL

SIZE **B** | DWG. NO. **4-0220** | REV

SCALE:1:4 | WEIGHT: | SHEET 1 OF 1


TOUCHSCREEN
POWER
VGA
USB
230 VOLT 50/60HZ POWER SOURCE
MAIN POWER
COAX TO CONTROL BOX "BOTTOM TRANSDUCER"
POWER TO CONTROL BOX
USB "DATA TRANSFER CABLE"
THERMOCOUPLE "ORIENTATION SPECIFIC CONNECTOR"
UPS "UNIVERSAL POWER SUPPLY" ; OPTIONAL FOR THE INSTALLATION OF UPS FOR POWER OUTAGE OR SURGES. IF NO UPS, USE SUPPLIED CABLE FOR "JUMPER".
UCA INSTRUMENT "BACK PANEL"
PRINTER
USB
POWER
110 OR 230 VOLT 50/60HZ POWER SOURCE
COM I "NOT USED"
VGA "TOUCH SCREEN"
ETHERNET "NETWORK"
USB CONNECTORS
BOTTOM TRANSDUCER CABLE
TOP TRANSDUCER CABLE
KEYBOARD
USB
POWER FROM UCA INSTRUMENT
UCA INSTRUMENT "FRONT PANEL"
USB CONNECTOR
COMPUTER CONTROL BOX "BACK PANEL"
THERMOCOUPLE
TOP TRANSDUCER
PRESSURE VESSEL
MEMORY STICK FOR DATA STORAGE/TRANSFER "SUPPLIED"
UCA VERSION 5
PERIPHERALS INSTALL GUIDE
Cement Test Equipment, Inc
REV
DATE
BY
CHK
DESCRIPTION
REVISIONS
DRAWN BY GRH 03-27-2010
APPROVED BY GRH 03-27-2010
APPROVED BY GRH 03-27-2010
APPROVED BY GRH 03-27-2010
PROJECT NO
DRAWING NO
UCA PERIPHERALS INSTALL GUIDE

CEMENT TEST EQUIPMENT, INC.

BOM NUMBER :04-0201 REV:
BOM DESCRIPTION :Assy, M2000-5 UCA Parts Case, LP
DATE UCA :06/15/2015 03:43:09 PM
QTY :1.0000

EXPLODED LEVEL BOM PIC LIST REPORT

P/B	ITEM	BOM/PART NUMBER	DESCRIPTION	LOCATE	QUANTITY PER ASSY	QUANTITY REQUIRED	UNIT	QTY ISSUED
PART	0040	04-0058-1	Gauge, Cement, LP UCA, V5.1		1.0000	1.0000	Ea	
PART	0042	C-0089-13	Stylus, Touch Screen		1.0000	1.0000	Ea	
PART	0046	C-0181	Elbow, push-on, 1/4NPT x 1/4T		12.0000	12.0000	EA	
BOM	0039	C-0516	Assy, Thermocouple, Low Pressure		1.0000	1.0000	Ea	
PART	0017	C-0587	Disk, Rupture 6000psig, @72F		1.0000	1.0000	Ea	
PART	0016	C-0681	O-Ring, 2-139, Viton, 75 Durometer		12.0000	12.0000	Ea	
PART	0047	C-0698	Ultrasonic Lubricant, High Temp		1.0000	1.0000	Ea	
PART	0018	C-0737-1	Element, Filter, 2 micron		1.0000	1.0000	Ea	
PART	0048	C-0739	Filter, 5 Micron, 1/4 FNPT		1.0000	1.0000	Ea	
PART	0008	C-0798	ADAPTER, BRASS, 1/4MNPTx3/8HOSE, 90		10.0000	10.0000	Ea	
PART	0052	C-0988	Fuse, 10 A, time delay, 1/4 x 1 1/4		4.0000	4.0000	Ea	
PART	0041	C-1078	Clamp, hose, SAE 6, 7/16" TO 25/32"		10.0000	10.0000	EA	
PART	0045	C-1205	Case, plastic, 18 compartment		1.0000	1.0000	Ea	
PART	0051	C-1324	7-Piece Wrench Set		1.0000	1.0000	EA	
BOM	0044	Manual	USB - Manual,Viewer,Drivers,Catalog		1.0000	1.0000		

CEMENT TEST EQUIPMENT, INC.

BOM NUMBER :04-0001-3
BOM DESCRIPTION :Assy, M2000-5 UCA MINI LP Spares & Acc's :06/15/2015
DATE 03:44:18 PM
QTY :1.0000

EXPLODED LEVEL BOM PIC LIST REPORT

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PART 0012 04-0065-1	Wrench, Handy Dandy Multi-Use		1.0000	1.0000	Ea	
PART 0002 C-0156	Cord, power, 3 x 14, 15A, 120VAC		1.0000	1.0000	Ea	
BOM 0003 C-0275	Assy, Power Cord, 3FT		1.0000	1.0000	EA	
PART 0004 C-0362-2	THERMO CABLE EXTENSION, M-F 15"		1.0000	1.0000	EA	
PART 0006 C-0595	PrinterCable, USB maleA-maleB, 3'		1.0000	1.0000	Ea	
PART 0007 C-0596	Printer		1.0000	1.0000	Ea	
PART 0013 C-0599	Keyboard, USB		1.0000	1.0000	Ea	
PART 0008 C-0670-1	Grease/Antiseize, White PTFE Label,		1.0000	1.0000	Ea	
PART 0011 C-1076	Hose, rubber, 3/8" ID, 5/8" OD		25.0000	25.0000	ft	
PART 0005 M-0010	Tubing Polyurethane, Black, 1/4"		25.0000	25.0000	ft	