CEMENT TEST EQUIPMENT, INC.

Tulsa, Oklahoma, USA

Model 300

Gas Migration Apparatus

Instruction Manual

CEMENT TEST EQUIPMENT, INC.

Model 300 Gas Migration Apparatus

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Chapter 1

Introduction

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

What is a Gas Migration Apparatus 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 Model 300 Gas Migration Apparatus (GMA) is used to study gas flow across a small cement sample and predict the likelihood of gas migration through a well bore slurry.

Description of Instrument

The Model 300 Gas Migration Apparatus (GMA) is based on the work of Cheung and Beirute and presented in SPE Papers 11207*, Gas Flow in Cements* and 19522, *A Method for Selection of Cement Recipes To Control Fluid Invasion After Cementing*. It is recommended that the papers, along with this manual, be read prior to operating the apparatus.

The major features of the Model 300 GMA are listed below:

- Easy to install and use.
- Stainless steel construction of all pressurized components.
- Can simulate deviated well bores.

- All software is Windows 7® based.
- Data may be plotted on a standard ink jet printer, stored on a USB flash drive, or archived to a PC.
- Data acquisition is achieved through the use of an integrated PC and touch screen. The software is intuitive and easy to use.
- Pressure is achieved using compressed nitrogen.
- Digital readouts for piston travel and gas flow.
- Archived data includes temperature, piston movement, balance output, slurry pore pressure, hydraulic pressure, formation gas flow, and formation gas pressure.
- Automatic control of hydraulic (overburden) and formation gas pressures.
- Electronic balance with data acquisition and archiving.

Instrument Specifications

The specifications below apply to the CTE, Inc. Model 300 GMA.

ELECTRICAL
Input Voltage: 230 VAC (±15%)
Input Power: 900W
Input Current: 4 A (230 VAC)
Input Frequency: 50-60 Hz

MECHANICAL
Height: 27 in. (68.58 cm)
Width: 27 in. (68.85 cm)
Depth: 12 in. (30.48 cm)
Weight: 95 lb. (43 kg)

ENVIRONMENTAL
Operating Temperature: (32 to 120°F) 0-50°C
Operating Humidity: 0-95% non-condensing

HEATER
Heater Power: 800 W
Heater Type: Rod heater in aluminum sheath
Heater Control: Solid state relay

UTILITIES - AIR AND NITROGEN
Compressed Nitrogen: up to 3,000 psig (204 bar)
Compressed Air: Up to 160 psig (11 bar)
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, nitrogen, air, and electrical connections can be made. Note that if the instrument is not equipped with automatic pressure control, the air connection will not be present. The nitrogen and air inlet are each ¼ inch female NPT connections and are located on the rear of the instrument. A number of ¼ inch male NPT to 8mm tube fittings are included for international locations.

Connect the air supply to the connector labeled **AIR INLET** on the rear panel of the instrument, if so equipped. The fitting has a ¼ inch female N.P.T. connection. The air must be clean and dry and must be supplied at a pressure of at least 105 psig (7.0 bar). The instrument is equipped with a 40 micron internal filter that may need periodic cleaning if the air is dirty. The use of dirty or moist air may cause premature failure of the automatic pressure control valve.

Connect the nitrogen bottle to the connector labeled **NITROGEN INLET** on the rear of the instrument. The fitting has a ¼ inch female N.P.T. connection. Any grade of nitrogen is acceptable as long as it is dry and free from contamination. The nitrogen should be supplied at a pressure at least as high as the desired hydraulic testing pressure, but not to exceed 3000 psig (204 bar).

- Use caution when handling and working with bottles of nitrogen or other compressed gasses. Serious injury can occur if the bottles are not handled properly or if maximum pressure ratings are exceeded.

Electrical connections are made using the receptacle on the rear of the instrument. A 15A 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 instrument.

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 GMA operation.

Chapter 2

Using the Software

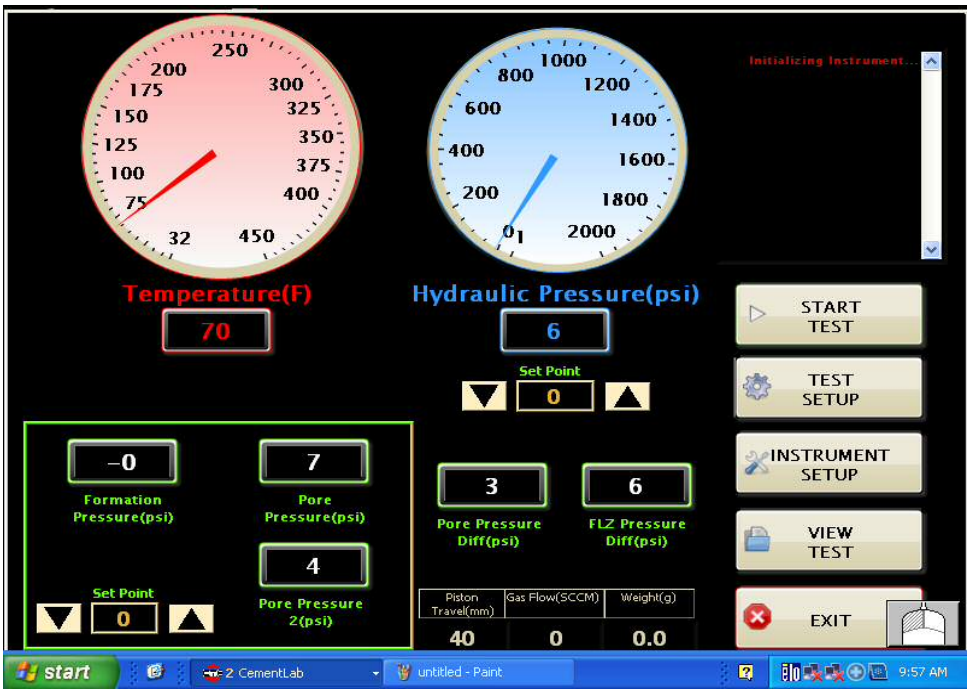
This chapter contains specific information on how to use the software.

Starting the Software

The Gas Migration Software runs on the Windows® 7 software platform. Locate the icon labeled “CTE” and double click to start the software if necessary.

Main Menu

The main menu is the starting point for the software. From here users may start new tests, calibrate the instrument, or view and plot previous tests. The main menu screen is shown in the following figure. Descriptions of each of the menu buttons are given following the figure. Features shown on the main menu will be discussed further in the sections following this one.



START/STOP TEST – START TEST will take the user to a new screen where every channel's value is displayed, along the chart and test ramps. The data is continuously written to the TDMS file until the STOP TEST button is selected. STOP TEST closes the file and stops the data writing process.

TEST SETUP – Allows the user to program a ramp and soak pressure profile for the hydraulic pressure, formation pressure, and temperature.

INSTRUMENT SETUP – Allows the user to calibrate the pressure transducers, temperature, and the piston travel linear potentiometer.

VIEW TEST – Allows the user to retrieve and view any previous test stored on the computer. The archive test may also be printed.

EXIT – Closes the program.

Calibrate

When the INSTRUMENT SETUP button is pressed, the following screen will appear.

This menu option allows the user to calibrate the pressure transducers, or other devices, if necessary. The procedure uses a dead weight tester or compressed gas and a certified pressure transducer to calibrate the transducer. Follow the steps below to calibrate the hydraulic pressure transducer. The steps are similar for the other devices.

1. Connect a pressurized gas source to the nitrogen inlet on the rear of the instrument. A dead weight gauge or certified pressure transducer/gauge may be connected to the high pressure nitrogen line. The nitrogen pressure must be equal to the desired calibration pressure. DO NOT USE OXYGEN AS A SOURCE OF PRESSURIZED GAS.

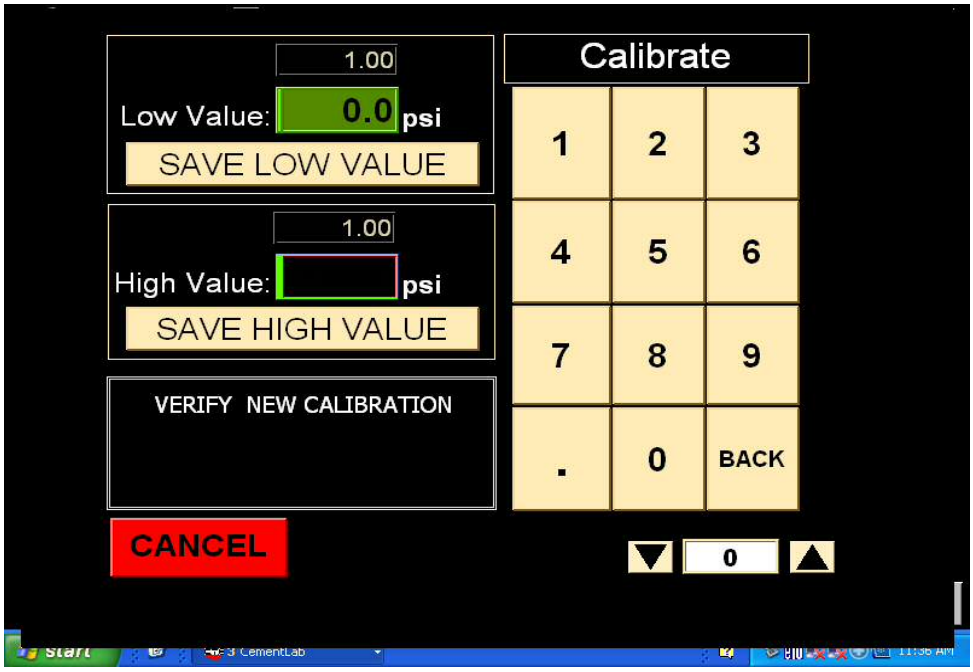
2. Fill the pressure vessel with water and install in the heating jacket. Connect all high pressure hoses including the filtrate receiver.

3. Click the INSTRUMENT SETUP button.

4. Select the desired process to calibrate from the INSTRUMENT SETUP menu.

5. Apply a pressure of zero to the transducer being calibrated. This may be done by turning the nitrogen supply off and reducing the pressure to zero. Make certain there is no pressure trapped inside the vessel.

6. When a value of zero pressure is obtained, enter a Low Value of 0 psi and press the SAVE LOW VALUE button.



7. Use the arrows in the lower right corner to increase pressure to the desired High Value. The value that is displayed is the Voltage from the transducer being calibrated.

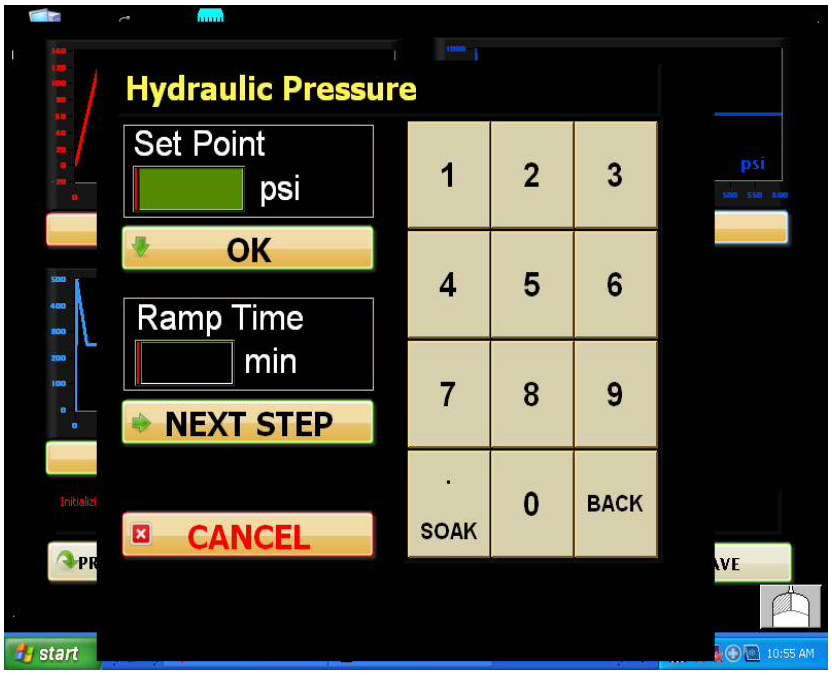
8. When the high pressure value is obtained, enter a High Value equal to the deadweight gauge/pressure transducer value and press the SAVE HIGH VALUE button.

9. As the pressure value is increased or decreased, the SCALED VALUE display should change. Make sure the SCALED VALUE equals the pressure applied to the instrument. When the user is confident the calibration has been successful, press the SAVE button to store the new calibration. If the calibration was not successful, press CANCEL and repeat the process.

When the calibration has been stored, the nitrogen pressure should be removed and the instrument returned to normal operational status.

Program Test Ramps

There are three processes that need to be programmed. The hydraulic and formation pressures and temperature may be controlled automatically using the software. It is possible to program them to ramp and soak to the desired values. To program a ramp, press the TEST SETUP button then press the desired process to program. You can click either the corresponding chart or button to choose the channel to program.

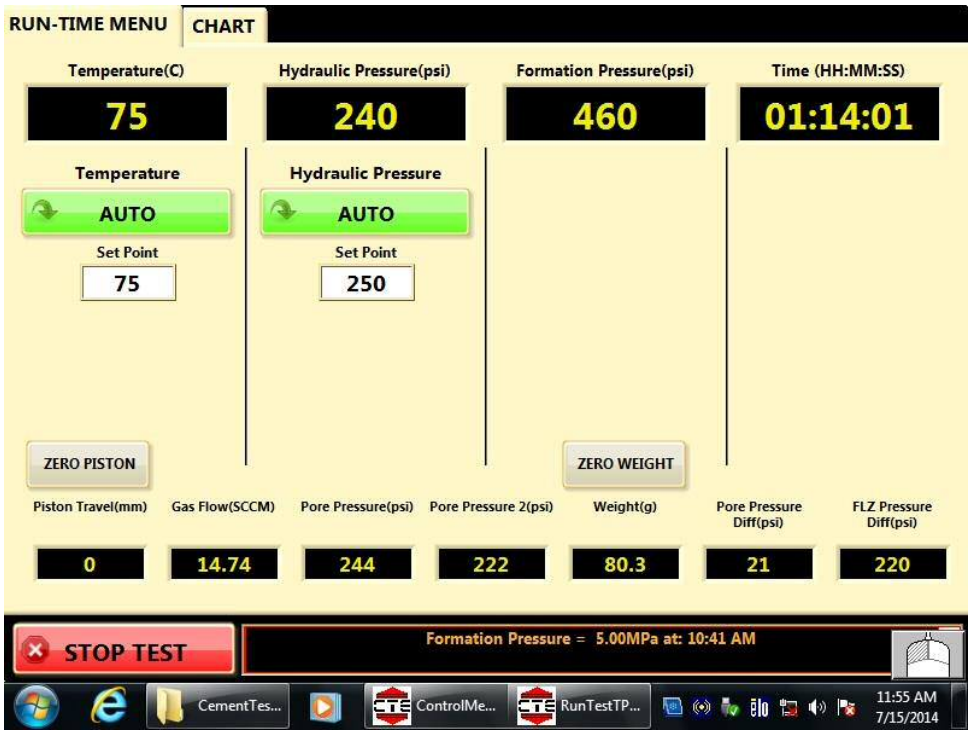


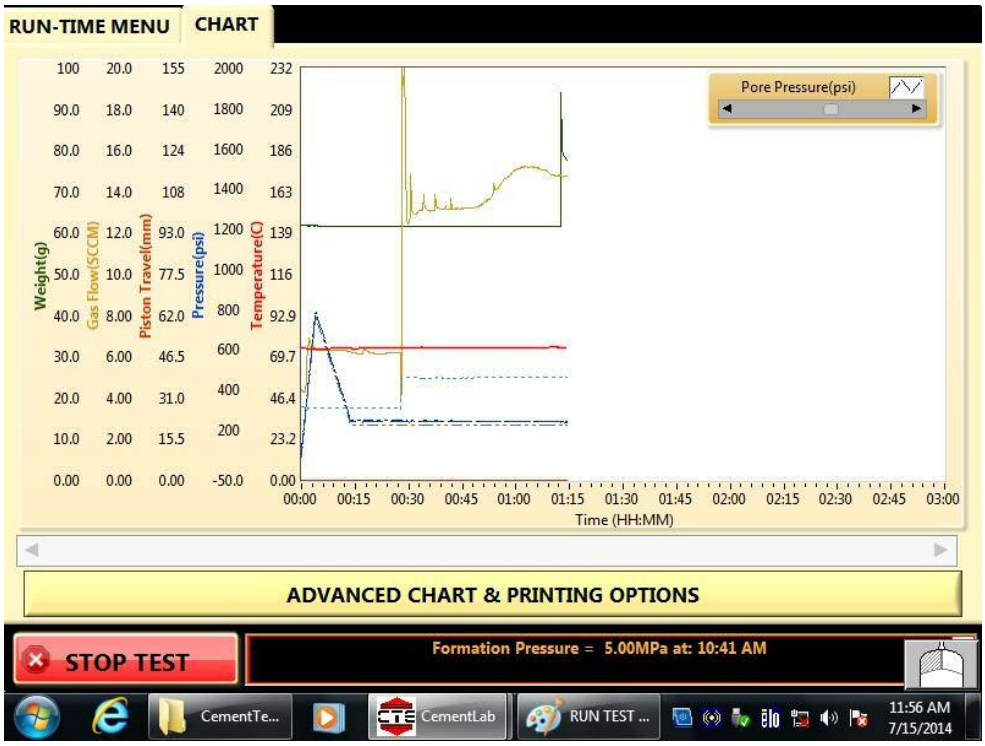
Next, enter the desired ramp start value, followed by the ramp time. Then select the NEXT STEP button. The same process is used to program the SOAK duration of the test. Press the DONE button when finished entering values. A pressure profile will be displayed on the accompanying plot. Make any corrections as necessary, and then press SAVE. Keep in mind that it is advised to keep the temperature test ramp at or below 2°C/min or 5°F/min.

After the user has confirmed that the Test Ramps are adequate, pressing SAVE will prompt the user to type in a test name for a TDMS file to store the data for later viewing.

Start Test

Pressing the **START TEST** button causes the following screen to appear. Pressure control will begin immediately when **START TEST** is pressed. The software will control hydraulic pressure as well as the temperature. Refer to chapter 4 for more information on testing procedures.





Running a Test

Once a test has begun, real-time current values will be displayed on the primary screen. This is done by selecting the **START TEST** button. All of the collected data is stored on the computer. The user may view the graph at any time by clicking the **CHART** button located at the top of the screen. The graph may be printed at any time using the **PRINT** button located in the bottom of the screen. Please note that a printer must be connected to the instrument before trying to print. Failure to do so will cause a printer malfunction. The software will print to the current default printer.

Stopping a Test

To stop the current test, the user must click the **STOP TEST** button. Once the test has been stopped, no further data will be logged to the file. The hydraulic and formation pressures will hold at the last value. Refer to chapter 4 for information on stopping a test. It is recommended that the hydraulic and formation pressure be maintained until the cylinder has cooled below 212°F (100°C) to prevent any water in the cylinder from turning to steam.

Chapter 3

A Description of the GMA Components

Chapter 3 will discuss in detail each component found on the GMA.

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 three categories: hydraulics, pressurized gas, and electrical/electronic.

Before discussion of the various software controls and peripheral devices, it may be helpful to define some terms that will be used in the remainder of this manual.

HYDRAULIC PRESSURE – A pressure that is applied to the piston in the cell that simulates the pressure caused by the fluid column above a cement slurry in a well bore.

FORMATION GAS – Gas pressure applied to the bottom of the cell to simulate the gas pressures that may be found in a producing formation.

PISTON TRAVEL – The movement of the piston inside the cell. Lack of piston movement indicates that the cement has become load bearing.

SLURRY PORE PRESSURE – A measurement of the pressure inside a cement slurry that has a simulated hydraulic pressure applied. This will typically be equal to the HYDRAULIC PRESSURE until the slurry becomes load bearing. As the slurry becomes load bearing, the SLURRY PORE PRESSURE will begin to decrease and may even fall to near zero. If the cement is gas permeable, the gas will slowly recharge the cement slurry and result in an increase in

slurry pore pressure until it is roughly equal to the FORMATION GAS pressure.

The Hydraulic Pressure Controls

This section consists of the following control: the **HYDRAULIC PRESSURE** controller. Components that make up this section are used set the pressure in the water on top of the piston to simulate the pressure of a fluid column above a cement slurry in a well bore.

To increase the **HYDRAULIC PRESSURE** manually, depress the UP arrow on the touch screen until desired pressure is reached. To decrease the **HYDRAULIC PRESSURE**, depress the DOWN arrow on the touch screen until desired pressure is reached.

However, the manual HYDRAULIC PRESSURE controller should never be used when running a test. The Run-Time screen will be displaying on the screen, and the manual controller is not accessible from that screen. The software adjusts the pressure automatically.

The Formation Gas Controls

This section consists of the **FORMATION GAS PRESSURE** gauge, **FORMATION PRESSURE REGULATOR** and **FORMATION GAS FLOW** meter. The components in this section are used to simulate the gas pressure and monitor the amount of gas flowing through the cement.

To increase the formation pressure, rotate the formation pressure regulator clockwise until desired pressure is reached. To decrease the formation pressure, rotate the formation pressure regulator counter-clockwise until desired pressure is reached.

The Electrical and Electronic Controls and Displays

The electrical/electronic controls and displays found on the apparatus are the **POWER** button and touch screen which displays all of the digital controls and gauges.

The only button located on the front of the instrument is the **POWER** button. The power button 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-1337.

The **THERMOCOUPLE** connector accepts the cable from the thermocouple installed in the test cell.

The **PORE PRESSURE TRANSDUCER(S)** connector accepts the cable from the pressure transducers installed in the test cell below and above the thermocouple. Plug the pore pressure transducer cables into the correctly labeled pore pressure transducers.

There are several **USB** connectors on the back of the computer to connect any peripheral devices such as a digital weight scale. Plug the scale into the USB port labeled “scale”. The weight scale power adapter accepts 110-220V input.

This completes our tour of the front panel controls. The actual operation of the device is discussed in greater detail in the following chapter.

Chapter 4

Operation

Chapter 4 will discuss in detail the steps required to run a gas migration test.

Preparing the Test Cell

The steps that should be used to set up the test cell are listed below. It is recommended that inexperienced users review SPE Papers 11207*, Gas Flow in Cements,* and 19522, *A Method for Selection of Cement Recipes To Control Fluid Invasion After Cementing* by Cheung and Beirute prior to the start of testing.

Failure to fill the inside of the pressure transducer adapter with grease can cause the transducer to be permanently cemented in place.

1. Remove the pressure transducer(s) (p/n C-0327) from the pressure transducer adapter (p/n 13-0017) installed into the test cell. Fill the inside of the adapter with grease and re-install the pressure transducer. This will keep cement from filling the transducer adapter and cementing the transducer in place. If the adapter is filled with cement, the pressure transducer will not be able to accurately sense the pressure. It is also a good idea to fill the thermocouple bore with grease.

2. Apply a light coating of grease to the o-rings on the top (p/n 13-0011) and bottom (p/n 13-0013) plugs as well as the piston o-ring (p/n C-0650). Coating the threads will grease or anti-seize lubricant is also recommended.

3. Inspect the screens (p/n C-0295 for the bottom plug and 13-0059 for the piston) for damage and snap/thread into place on the bottom plug and the piston (13-0041). Make certain the o-rings (C-0651) are in place under each screen and take care not to damage the screens.

4. Screw the bottom plug into the bottom of the test cell until the plug makes contact with the cell. Excessive tightening of the plug will not make it seal better—it will simply make it harder to remove. The thermocouple and pressure transducer(s) are located the middle of the test cell.

6. Add cement to the test cell allowing enough room at the top to install the piston and top plug. The longer the column of cement, the more difficult it will be to

press out. 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.

7. Open the valve (p/n C-0656) on top of the piston rod. This will allow air to escape as the piston is inserted into the cell.

8. Insert the piston into the cylinder and push down until piston is on top of the cement slurry. Close the valve on top of the piston rod.

9. Pour water on top of piston. Allow enough room for insertion of the plug.

10. Screw the top plug in place. It is not necessary to tighten with a wrench.

11. Wipe the test cell clean and gently place in heater assembly.

Over tightening plugs does not cause better sealing; it only causes plug removal difficulty.

12. Connect the quick disconnect fitting attached to the stainless steel hose on the bottom of the test cell. This is the **FORMATION PRESSURE.**

13. Close the ball valve (p/n C-0640) attached to the quick-connect fitting to prevent filtrate from leaking out prior to the start of the test.

14. Connect the 1/8 inch L shaped tubing to the fitting leading from the valve on the top of the piston rod. Filtrate from this tube may be drained into a beaker or other suitable container.

15. Connect the cable to the linear potentiometer that is fixed on the side of the heater box that contains the test cell.

16. Connect the linear potentiometer (p/n C-0601) located on the side of the heater assembly to the bar (p/n 13-0018) attached to the piston shaft.

17. Connect the cable from the thermocouple (p/n C-0629) to the receptacle on the top panel.

18. Connect the electronic balance if not already connected.

19. Turn on the power to the instrument and start Cementlab software if not already completed.

20. Program the desired pressure ramps and soaks into the software.

21. Program the desired ramp and soak temperature profile into the temperature controller. Save the test profile using descriptive words and/or test parameters to easily remember for future reference. Save a new test setup each time you start a new test. If a new test setup is not saved, the previous test file will be used and new test data will be truncated onto the end of the old test data. Effectively creating two tests in one file.

The instrument is now ready to begin a gas flow test.

Running a Test

It may sometimes be necessary to run water only in the test cell to tune the temperature controller, calibrate pressure, or troubleshoot other aspects of the instrument. When operating the unit with water only, fill the cylinder only about half full of water and make certain to allow room at the top for the piston to move upward due to water expansion during heating. Failure to leave room for water expansion may cause the piston to bottom against the top plug and cause a dangerous overpressure condition. Always be sure to monitor the **SLURRY PORE PRESSURE** transducer when testing with water. It is also a good idea to apply 100-200 psig nitrogen pressure to prevent the water from flashing to steam.

Be sure to close the **FORMATION GAS VALVE**. This is located on the quick connect fitting. A large change of pressure between FORMATION (bottom) and HYDRAULIC (top) pressures could be very harmful and dangerous. Again, this only applies to a water test.

Rapid upward or downward piston movement generally means a malfunction. The malfunction can usually be corrected by closing the appropriate valve or reducing the pressure.

This section describes the steps used to conduct a gas flow test on a cement slurry

1. Make certain the test cylinder is filled with slurry and installed properly as described in the previous section "Preparing the Test Cell". Double check all piping and electrical connections to insure they are correct.

2. Close the ball valve (p/n C-0640) attached to the bottom of the cylinder if it is not already closed.

3. Close the valve on the filtrate receiver.

4. Close the needle valve connected to the piston rod on the top of the test cell if not already closed.

5. Slowly turn the bottle of compressed nitrogen to the ON position. High pressure compressed gasses can be dangerous. Be careful.

6. Make certain the appropriate pressure and temperature profiles have been programmed prior to beginning the test.

7. Place a small beaker or other container under the upper filtrate outlet tube to collect the filtrate from the top of the pressure vessel, if desired.

8. Slowly open the needle valve connected to the piston rod on the top of the test cell if desired. Beirute and Cheung recommend this valve remain closed until the test is nearly completed to prevent filter cake buildup on the screen. This will allow filtrate to be removed from the top of the slurry and gas to flow through the slurry. Filtrate may spew out when the valve is opened. Be careful.

9. Slowly open the ball valve on the bottom of the cylinder. This will allow filtrate to be removed from the bottom of the slurry as well as allow formation gas pressure to be applied to the bottom of the slurry.

10. If the test is done at a temperature in excess of 212°F/100°C and the top filtrate valve is opened, wait for temperature to decrease to prevent the filtrate from flashing to steam as it exits.

11. The flow rate of the gas may be observed using the **FORMATION GAS FLOW** meter. As formation gas pressure is increased or decreased, the expansion or contraction of the gas may make the **FORMATION GAS FLOW** meter register as though a gas were flowing. For this reason, the gas flow rate should be allowed to stabilize for several minutes before a reading is considered valid.

This completes the steps required to run a test. No attempt will be made in the manual to provide an interpretation of the results. This will be left up to the user. However, the next section will discuss some general trends that should occur as the test progresses. The next section will also outline the procedure for stopping a test.

Test Results and Stopping a Test

When the test is underway and the valves on the top and bottom of the test cell are opened, filtrate should be expected to drain out. As the cement dehydrates, the piston will begin to move downward. When the piston stops downward movement, this is an indication that the cement has developed enough strength to support the hydrostatic load.

The pressure exerted on the slurry itself (called slurry pore pressure) is plotted by the data acquisition software. Before the slurry begins to develop compressive strength, the slurry pore pressure will be roughly equal to the hydrostatic pressure. As the slurry becomes load bearing, the slurry pore pressure will drop. As long as the slurry pore pressure is greater than the formation gas pressure, gas migration will not occur. However, once the slurry pore pressure drops below the formation gas pressure, gas may begin to migrate through the cement sample if the slurry has not been properly designed.

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

Use gloves or other appropriate safety gear when handling a hot test cell.

1. Select **STOP TEST** from the software menu. If automatic pressure control is in use, the hydraulic pressure will be maintained after the **STOP TEST** button has been pressed. This will prevent any water in the cell from flashing to steam. To reduce the hydraulic pressure, simply press the **DOWN ARROW** button and the pressure will immediately vent to any pressure you choose. Maintain enough pressure on the cell to prevent any water in it from flashing to steam.
2. It is recommended that the test cell temperature be well below 200°F (93°C) before attempting to dismantle the test cell.
3. Turn off the compressed nitrogen supply to the apparatus.
4. Remove the formation pressure by turning the formation pressure regulator knob counter clockwise and very slowly opening the needle valve on the filtrate receiver. Use caution when opening this valve as any collected filtrate will also want to exit the valve. Tilt the filtrate receiver valve exit upwards to vent more of the gas than any filtrate. This should be done before the hydraulic pressure is removed from the cement column.
5. Disconnect the electrical connector(s) connected to the pressure transducer(s) on the test cell.
6. Press the Hydraulic Pressure **DOWN ARROW** button until the pressure displays zero.
7. Unhook the potentiometer bar (p/n 13-0018) connected to the piston shaft from the sliding rod on the potentiometer (p/n C-0601) mounted to the side of the heating assembly.
8. Disconnect the 1/8 inch tubing leading from the valve on the top of the test cell.
9. Disconnect the quick connect fitting connecting the filtrate receiver to the test cell and remove.
10. Disconnect the thermocouple cable connected to the test cell.
11. If the test cell is sufficiently cooled, lift the test cell from the instrument.
12. Open the valve connected to the piston rod if not already open.
13. Place the test cell in a vice and remove the top plug. Inspect the o-ring (p/n C-0650) for damage. Replace if necessary.
14. Pour the water on top of the piston out.

15. Carefully remove the piston from the test cell. Inspect the o-ring (p/n C-0650) and screen (p/n 1). Replace if necessary.

16. Remove the bottom plug from the test cell. Inspect the o-ring (p/n C-0650) and screen (p/n C-0295). Replace if necessary.

The test cylinder is now ready to be cleaned.

About Formation Gas Flow Rate

Since the volume of a gas changes with temperature and pressure, it is meaningless to refer to a volumetric flow rate of a gas without specifying a temperature and pressure. The formation gas flow rate displayed by the meter is referenced to the standard conditions of 70°F (21.1°C) and 14.7 psia (1 absolute bar). This means that even though the formation gas may be at a temperature and pressure other than 70°F and 14.7 psia, the electronics in the apparatus will do the necessary conversions and display the flow rate at these standard conditions. The flow rate is displayed in units of standard cubic centimeters per minute (SCCM).

Allow a few minutes for the gas flow rate to stabilize. Any increase or decrease in temperature or pressure of the formation gas can cause an apparent flow of gas that is really just a movement of the gas caused by the change in temperature or pressure. The gas flow rate should be allowed to stabilize and should remain relatively stable if the flow rate is valid.

Cleaning the Test Cell

Cleanup should be done as soon after completion of a test as possible when the sample is easiest to remove. The cement sample will generally have to be pressed out of the test cell. Forces up to 80,000 pounds (36,300 kg) are sometimes required to remove the sample from the cell. Note that forces in excess of 94,000 pounds (42,600 kg) may cause permanent deformation of the test cell. Use caution when pressing the sample from the test cell. The extreme forces required can cause serious injury or death.

The pressure transducer is delicate and may break if handled roughly or dropped.

Be careful not to nick or scratch the inside of the test cell. Doing so may cause the fluid to leak past the internal piston, ruining the test cell. Remember to remove the pressure transducer from the test cell and clean any cement from around the transducer and out of the housing. Failure to do so may cement the transducer in place or may cause it to malfunction. Fill the pressure transducer adapter with grease to prevent cement contamination during the next test. Be certain to grease all o-ring prior to test cell re-assembly.

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

GMA'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 the GMA are very simple and should consume little time.

The first maintenance item is to thoroughly clean the test cylinder after every test. Fill the pressure transducer adapter with grease before every test and lubricate all o-rings. Be sure to inspect the o-rings for damage and replace if damaged or severely distorted.

Periodically apply compressed air to the test cell to insure that the filtrate lines are not blocked. Cement filtrate sometimes contains compounds that can cause a buildup, even on stainless steel. Clean the lines with solvent periodically or replace the clogged lines.

Periodically wipe the linear potentiometer rod with a clean cloth to remove any dirt or debris. It is important that the rod move freely.

Troubleshooting

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

Symptom	*Cause*	*Remedy*
Test cell leaks where piston rod enters top plug	Damaged o-ring	Replace C-0652 o-ring. See drawing 13-0010 for instructions
Filtrate will not come out of top or bottom.	Filtrate tubing is plugged. Top and/or bottom valve is not open. Damaged screen.	Clean with solvent or replace plugged components. Open valve(s). Replace screen.
Slurry pore pressure is incorrect or displays zero	Pressure transducer adapter on test cell is plugged with cement. Open circuit in pressure transducer cable. Faulty pressure transducer.	Remove adapter and clean cement out. Check with an ohmmeter. Repair or replace as necessary. Replace pressure transducer.
Instrument not receiving power	Instrument not plugged in. Current Sense Relay tripped open.	Connect instrument to the correct power source. Unplug the power cord and plug back in.
Heater will not get hot.	Blown fuse. **HEATER** switch not in the ON position. Faulty heater. Faulty solid state relay.	Check fuses inside cabinet. 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.
Temperature displays ---- instead of temperature	Open circuit in thermocouple. Open circuit in thermocouple circuitry	Replace thermocouple. Check thermocouple circuitry for open circuits or loose connections.
FORMATION GAS FLOW display is erratic or excessively high.	Leak in nitrogen line. Loose electrical connection.	Check for leaks and tighten fittings as needed. Check connections and correct if necessary.

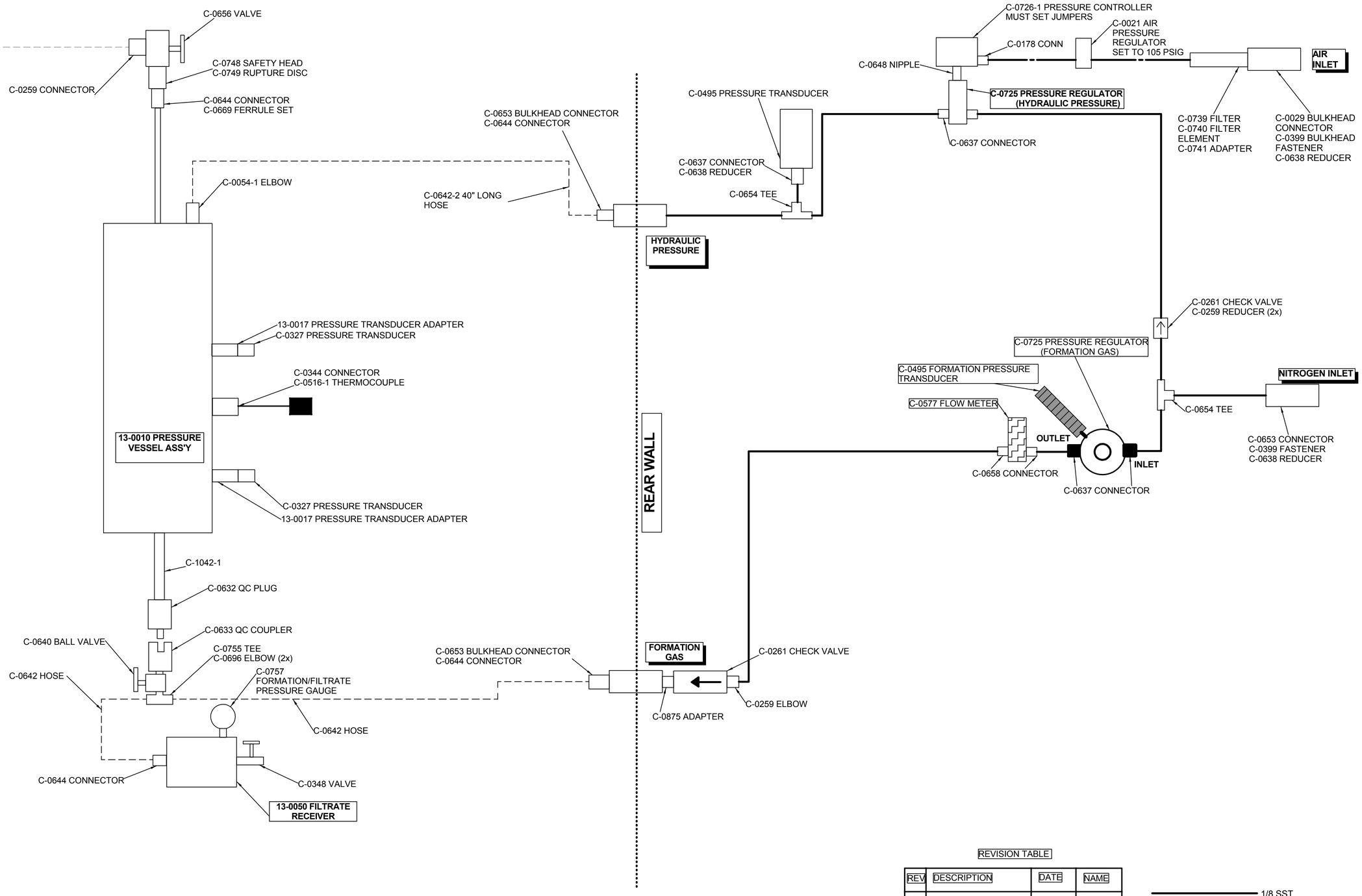
Symptom	*Cause*	*Remedy*
	Faulty gas flow meter.	Return for repair or replacement.
Apparatus will not build hydraulic or formation gas pressure.	Nitrogen bottle not turned on. Insufficient nitrogen pressure. Severe leak. Plugged nitrogen line.	Turn on nitrogen bottle. Check nitrogen pressure and replace or recharge bottle if necessary. Check for leaks and tighten fittings. Isolate plugged line and repair or replace.
Contamination occurs across the piston.	Damaged o-ring (p/n C-0650). Bore of test cell is damaged. Piston rod not screwed in tightly.	Replace o-ring. Replace test cell.
Cement leaks out bottom plug.	Damaged o-ring (p/n C-0650).	Replace o-ring.
Water leaks out top plug.	Damaged o-ring (p/n C-0650).	Replace o-ring.
Optional balance output is not displayed.	Balance not plugged in. Balance not turned on. USB not connected. Bad USB cable.	Plug in to appropriate wall supply Turn on using pushbutton on balance Connect serial cable Replace cable
Electronic pressure regulators will not operate.	Loose wire. Insufficient air pressure. Insufficient N_2 pressure. Air filter plugged.	Repair. Increase air pressure to 105 psig min. Must be higher than desired hydraulic pressure. Clean or replace filter.
FORMATION GAS FLOW display is always zero.	Plugged nitrogen line.	Locate the plugged line and repair or replace.

Parts List and Cross Reference

The following table contains a list of spare parts for the CTE Model 300 Gas Flow Test Apparatus.

Part Number	Description
04-0065-1	Handy Dandy Multi-Wrench
13-0035	Cement removal plug base
13-0036	Lower Cement Removal Plunger
13-0037	Upper Cement Removal Plunger
13-0059	Screen
C-0156	Power Cord
C-0179	Push-On Connector
C-0259	Elbow
C-0295	Filter Press Screen
C-0301	O-ring
C-0595	USB Cable
C-0596	Printer
C-0639	Stainless Steel Connector
C-0650	O-Ring
C-0651	O-Ring
C-0652	O-Ring
C-0669	Ferrule Set
C-0670	Grease-Red
C-0728-1	Balance
C-0798	Adaptor

Part Number	Description
C-1076	Rubber Hose
C-1078	Hose Clamp
C-1179	O-Ring
C-1205	Plastic Case
C-1311	Wrench-7/16”x9/16”
C-1312	Wrench-1/2”
C-1313	Wrench-5/8”
C-1314	Wrench-3/4”
M-0022	1/8” Stainless Steel Tubing
M-0046	1/4" Black Tubing



REVISION TABLE

REV	DESCRIPTION	DATE	NAME
B	REVISED PER BUILD	10-16-2013	GRH
C	REVISED PER BUILD	07-17-2014	GRH

1/8 SST

1/4 TEFLON

CAD GENERATED DRAWING, DO NOT MANUALLY UPDATE		CEMENT TEST EQUIPMENT, INC.
APPROVALS	DATE	PLUMBING SCHEMATIC GAS MIGRATION APPARATUS
DRAWN CCD	4-21-98	
CHECKED CCD	4-21-98	
RESPEND CCD	4-21-98	
MFG ENG CCD	4-21-98	SIZE B DWG. NO 13-0009-2 REV C
QUALENG CCD	4-21-98	SCALE CAD FILE SHEET 1 OF 1

RED T/C-
WHITE T/C +
C-0167
C-1027 THERMOCOUPLE EXTENSION
INLET POWER
240V 5A
50/60 HZ
C-0271
L
N
C-0516-1 THERMOCOUPLE
C-0601
LINEAR
POTENTIOMETER
2
1
3
RED
BLACK
GREEN
C-659 CURRENT MONITORING RELAY
RED
YELLOW
C-658 CONTACTOR
RED
C-0472
TERMINAL BLOCK
YELLOW
C-0472
TERMINAL BLOCK
A1 I1 21
B1 B2 B3
18 RED
Imax=4A
Hyst=3
Tv=15
Ts=5
DIP: OFF ON ON OFF
I max
Hyst
Tv
Ts
I4 I2 C
24 22 A2
C-0574-1 FUSE BLOCK
C-0221 6A FUSE X2
18 YELLOW
RED
YELLOW
Power Switch
C-1337
Load
Line
WHT/ORG
WHT/BLK
RED 18
YELLOW 18
GREEN 22
WHITE 22
RED 22
BLACK 22
CH 2
PORE PRESSURE TRANSDUCER (2)
C-0327
C-0327-1 CABLE
CH 1
PORE PRESSURE TRANSDUCER (1)
CONNECTOR
C-0763
3 +12 VDC
5 GND
TO CPU
+5VDC
WHT/ORA
WHT/BLK
WHT/RED
POWER
SUPPLY
C-0742
J1
1 5 3
1 +5 VDC
2 +5 VDC
3 +5 VDC
4 GND
5 GND
6 GND
7 GND
8 +24 VDC
9 +24 VDC
10 NC
11 -12 VDC
12 NC
13 +12 VDC J2
RED
WHT
GRY
VIO
C-0495
PRESSURE TRANSDUCER
HYDRAULIC PRESSURE
RED
GREEN
WHITE
+24 VDC
C-0495
PRESSURE TRANSDUCER
FORMATION GAS
RED
GREEN
WHITE
+24 VDC
C-0080
WHT/BLK 22
WHT/RED 22
4
1
3
2
DC
C-0080
2
3
1
4
DC
WHITE/RED 22
WHITE/BLACK 22
RED 18
YELLOW 18
65 OHMS
C-1202 HEATERS (Qty 4)
800 W
WHITE
RED
WHITE
GREEN
WHITE
GREEN
WHITE
GREEN
W/PUR
W/BLUE
TC0H TC0L AI1H AI1L AI2H AI2L AI3 AI4H AI4L
1 2 4 5 7 8 10 34 33
C-1181-1
AI5 AGD AI6 AGD DIO0 AO0 AGD AO1 AGD
31 29 28 26 14 38 37 36 35
WHT
WHT/BLK
GREEN
GREEN
WHITE
C-0277
2 4 8 7
9
WHITE/
BLK
+12 VDC
C-0577
FLOW METER
GREEN
TAN
YEL
ORG
RED
BROWN
+24 VDC
BLUE
GREEN
GRAY
VIOLET
COM
C-0726-1 PRESSURE CONTROLLER
HYDRAULIC PRESSURE
NOTE: REMOVE ALL JUMPERS FROM J5
BALANCE
C-0728-1
USB CABLE TO
SPECIFIC USB PORT
LABELED ON COMPUTER
POWER SUPPLY
110/220V

All AC wiring 18 Ga
Effective s/n 109

NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
± 1/32 .XX ± .01 ± 1°
.XXX ± .005
MATERIAL
FINISH
DO NOT SCALE DRAWING

CAD GENERATED DRAWING. DO NOT MANUALLY UPDATE

APPROVALS	DATE
DRAWN CAW	07-15-14
CHECKED	
RESP ENG	
MFG ENG	
QUAL ENG	

CEMENT TEST EQUIPMENT, INC.

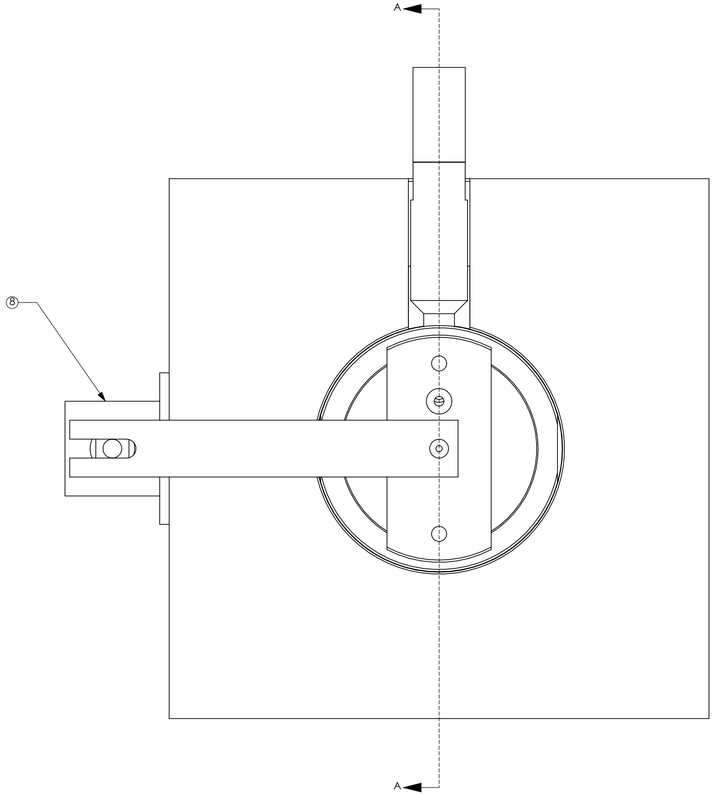
WIRING SCHEMATIC GAS MIGRATION APPARATUS

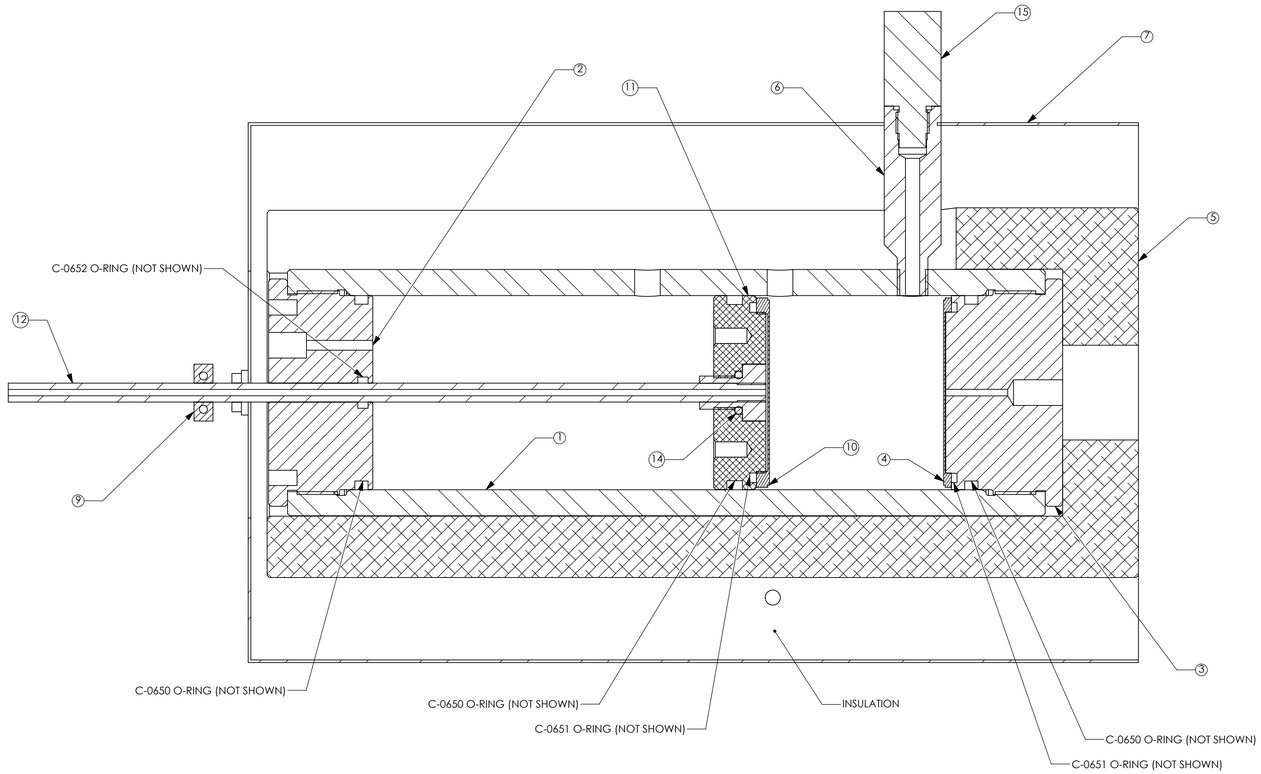
SIZE	DWG. NO.	REV
D	13-0008-2	D

SCALE | CAD FILE | SHEET 1 OF 1

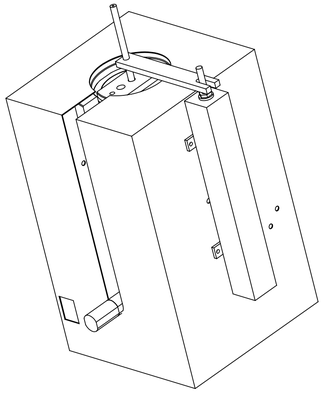
REVISIONS

REV.	DESCRIPTION	DATE	APPROVED





SECTION A-A
SCALE 1 : 1



NOTE: TO REPLACE THE C-0652 O-RING (ITEM 14) IT IS NECESSARY TO CAREFULLY GRIND OR FILE THE FERRULES SEALING THE C-0644 CONNECTOR OFF THE PISTON ROD SO THAT THE PISTON ROD MAY BE REMOVED FROM THE TOP PLUG. DO NOT DAMAGE THE PISTON ROD DURING FERRULE REMOVAL OR REPLACEMENT OF PISTON MAY BE REQUIRED. THE REPLACEMENT FERRULE PART NUMBER IS C-0669. SEE DRAWING 13-0009 FOR MORE INFORMATION.

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	13-0061	Cylinder	1
2	13-0011	Top Plug	1
3	13-0013	Bottom Plug	1
4	C-0295	SCREEN 325 MESH	1
5	13-0014	Heating Jacket	1
6	13-0017	Pressure Transducer Adapter	1
7	13-0015	Cabinet Assy	1
8	C-0601	Linear potentiometer	1
9	13-0018	Potentiometer Bar	1
10	13-0059	Screen, 325 mesh, threaded	1
11	13-0041	Piston	1
12	13-0042-1	Rod Shaft (use 13-0042)	1
13	13-0042-2	Rod Base (use 13-0042)	1
14	C-1179	O-ring, piston	1
15	C-0327	Pressure Transducer	1

NEXT ASSY | USED ON
APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:
FRACTIONS ±1/32 DECIMALS .XX ±.01 .XXX ±.005 ANGLES ±1°
MATERIAL
FINISH
DO NOT SCALE DRAWING

CAD GENERATED DRAWING. DO NOT MANUALLY UPDATE

APPROVALS	DATE
DRAWN CCD	5-6-98
CHECKED CCD	5-6-98
RESP ENG CCD	5-6-98
MFG ENG CCD	5-6-98
QUAL ENG CCD	5-6-98

CEMENT TEST EQUIPMENT, INC.

CYLINDER ASSEMBLY

SIZE D | DWG. NO. 13-0010 | REV. B
SCALE 1:1 | CAD FILE: | SHEET 1 OF 1