INSTRUCTION MANUAL
MODEL 7200
CEMENT HYDRATION ANALYZER

Revision P – May 2025
Part Number: 7200-1050

S/N: _____

CHANDLER ENGINEERING®

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General Information

Introduction

This instruction manual provides operation and maintenance instructions for a Model 7200 Cement Hydration Analyzer (CHA).

Purpose and Use

The Model 7200 Cement Hydration Analyzer is an apparatus used to determine susceptibility of different oil-well cement formulations to gas migration and to estimate the degree of hydration of the cement.

Description

The CHA is a closed system in which N_2 gas is injected into the bottom of a cement slurry during as it transitions from a slurry to a solid. Using this well model, the cement slurry performance designed to prevent gas migration is evaluated.

If N_2 gas is transmitted through the column of cement, gas migration is indicated.

Gas migration will result if the pressure above the sample (pore pressure) increases and possibly becomes equal to the injection pressure.

If no gas migration occurs, the pressure above the sample (pore pressure) decreases due to cement shrinkage and loss of fluid communication through the sample during hydration.

Gas mass flow meters are used to measure the flow rate of the gas entering the cement slurry and the flow rate of the gas used to pressurize cement above a diaphragm. These volumes provide an estimate of shrinkage and/or expansion, and the degree of hydration.

Likewise, cement hydration is indicated using the internal sample cement temperature. This temperature rise indicates the exothermic reaction of hydration.

Features and Benefits

- Simultaneously measures several aspects of gas migration and cement hydration.
- Uses inexpensive disposable cylinder (body) for cement sample.
- Can test multiple scenarios of gas migration (severe and less severe cases).
- Little likelihood of plugging tubing with cement.
- Graphical user interface software for control of experiment, data acquisition and logging of results.
- Unattended operation of test, after initial setup.
- On-screen plots, with printing capabilities, for recording and presentation of results.
- Designed for operator safety.
- Backed by Chandler Engineering service and support.
- CE certified.

Specifications

Operating Conditions

Input Voltage:	208 – 230 VAC
Input Current:	11A
Frequency:	50 / 60 Hz, 1 PHASE
Max. Working Temperature:	325°F (163°C)
Min. Working Temperature:	34°F (1°C)

Operating Pressures

Cement Sample:	Max. 1000 psig (6.895 MPa, 68.95 bar, 68.05 atm.) (Gas Injection Pressure, H_2O Confining Pressure, and Pore Pressure)
Gas (N_2) Inlet:	Max. 3000 psig (20.685 MPa, 206.85 bar, 204.14 atm.) Min. = whatever max. pressure is required by your test
H_2O Inlet:	Max. 160 psig (1.103 MPa, 11.03 bar, 10.89 atm.) Min. 20 psig (0.138 MPa, 138 kPa, 1.38 bar, 1.36 atm.)
Air Supply Inlet:	Max. 160 psig (1.103 MPa, 11.03 bar, 10.89 atm.) Min. 20 psig (0.138 MPa, 138 kPa, 1.38 bar, 1.36 atm.)
Measurement Accuracy:	0.2 % of Full Scale **(**± 2 psi)
Measurement Resolution:	0.25 psi (0.1 psi resolution displayed & logged)
Control Accuracy:	±10 – 20 psi (70 – 140 kPa) approximately

Cell Volumes (approximate:)

CHA (cement sample):	417 cc
H_2O Accumulator:	100 cc

Cement Temperature & Cabinet Temperature:

Measurement Accuracy:	± 0.5°C
Measurement Resolution:	0.1°C

Oven Temperature:

Measurement Accuracy:	± 1°C
Measurement Resolution:	0.1°C
Temperature Uniformity (between different locations within oven):	± 3°C at 150°C
Temperature Control Stability:	± 0.5°C

Gas Injection Flow Rate and H_2O Confining Flow Rate (as measured by N_2 gas flow Through thermal gas Mass Flow Meter):	0 – 5 sccm (std. cc/min.) of N_2 (nitrogen), referenced to std. conditions of 70°F (21°C), 760 mm Hg (1.00 atm., 14.696 psia, 101.3 kPa, 1.013 bar)
Flow Rate Measurement Accuracy:	± 1.2 % of Full Scale **(**+/- 0.06 sccm) at manufacturer-calibrated inlet conditions of Inlet Pressure = 1000 psig (6.895 MPa, 68.95 bar, 68.05 atm.), Temperature = 70°F (21°C)
Flow Rate Measurement Resolution:	0.01 sccm

Environmental Conditions

Environment:	Indoor Use
Altitude:	6561.6 ft (2000m)
Temperature:	41°F - 104°F (5°C - 40°C)
Relative Humidity:	0% to 95% non-condensing

Weights and Dimensions

Dimensions:	37” (94cm) H x 44” (112cm) W x 29” (74cm) D
Net Weight:	1000 lbs. (454 kg)

Safety Requirements

READ BEFORE ATTEMPTING OPERATION OF INSTRUMENT!

Any instrument that is capable of extremely high temperatures and pressures, such as this CHA system, should always be operated with **CAUTION!** The instrument is designed for operator safety.

To ensure safety:

- Provide adequate training of all personnel that will operate the instrument.
- Locate the instrument in a low traffic, well ventilated area.
- Always position the instrument in such a manner that allows easy access to the power cord.
- Post signs where the instrument is being operated, to warn non-operating personnel.
- Read and understand instructions before attempting operation.
- Observe warning and caution notes throughout this manual.
- Observe and follow the Warning Labels on the instrument.
- Never exceed the instrument maximum pressure and temperature ratings.
- Always disconnect main power to the instrument before attempting any repair, or when opening the instrument cabinet.
- Keep access doors closed when operating instrument.
- A suitably rated fire extinguisher should be located within 15 m (50 feet) of the instrument.
- Before attempting to operate the instrument, the operator must read and understand this manual.

Symbols Used on Equipment

Symbol	Meaning
	Protective Conductor Terminal
	Hazardous Voltage Inside Disconnect power before opening
	Hot Surface Do Not Touch Allow to cool before servicing
	Documentation must be consulted in all cases where this caution symbol is marked.

Where to Find Help

Training classes are available in your laboratory and at Chandler Engineering. For more information, contact our sales department at Chandler Engineering. In the event of problems, your local sales representative will be able to help, or you can contact the personnel at Chandler Engineering using the following:

- Telephone: 1-918-250-7200
- FAX: 1-918-459-0165
- E-mail: chandler.sales@ametek.com
- Website: www.chandlereng.com

Section 1 - Installation

Unpacking the Instrument

After the instrument is removed from the shipping crate, the operating equipment and spare parts on the packing list must be checked to affirm that all have been received and none are damaged.

Note: File an insurance claim with your freight carrier if damage has occurred during shipment. Verify all parts shown on the enclosed packing list have been received. If items are missing, please notify Chandler Engineering immediately.

Lifting Instructions

To position the instrument for installation, a forklift or equivalent power lift is recommended. Also, keep the CHA on a pallet while transporting to its final destination.

The control box is attached to the oven and should not be used to lift the CHA. Ensure the forks are long enough to fully engage the oven from front to back. Elevate the forks in such a manner as to be able to safely slide the CHA onto the forks. Lift the instrument in such a manner as to keep it level.

Do not attempt to manually lift or carry the instrument.

Utilities Required

- Electrical: 208-230 VAC, 50/60 Hz, 11 Amps (2400 W) max., 1-phase.
- N_2 (nitrogen) gas supply: Max. 3000 psig (20.685 MPa, 206.85 bar, 204.14 atm.) Min. = whatever max. pressure is required by your test Adapters supplied for 1/8”-OD tubing, ¼”-OD tubing, 3-mm-OD tubing, 6-mm-OD tubing, and ¼” NPT female (U.S. std. tapered National Pipe Thread).
- H_2O supply: Max. 160 psig (1.103 MPa, 11.03 bar, 10.89 atm.) Min. 20 psig (0.138 MPa, 138 kPa, 1.38 bar, 1.36 atm.) Adapters supplied for 1/8”-OD tubing, ¼”-OD tubing, 3-mm-OD tubing, 6-mm-OD tubing, ¼”-ID hose, ½”-ID hose, and ¼” NPT female (U.S. std. tapered National Pipe Thread).
- Air (or N_2) supply: Max. 160 psig (1.103 MPa, 11.03 bar, 10.89 atm.) Min. 20 psig (0.138 MPa, 138 kPa, 1.38 bar, 1.36 atm.) Adapters supplied for 1/8”-OD tubing, ¼”-OD tubing, 3-mm-OD tubing, 6-mm-OD tubing, ¼”-ID hose, ½”-ID hose, and ¼” NPT female (U.S. std. tapered National Pipe Thread).

Tools/Equipment Required

- High-temperature lubricant for O-rings (such as silicone “vacuum grease”).
- Anti-seize lubricant for threads (copper-based, or nickel-based).
- Leak-detector liquid (or soap in water).
- Screwdriver, T15 Torx, for screws on oven.
- Screwdriver, #1 Phillips.
- Screwdriver, #2 Phillips.
- Screwdriver, flat-blade, small, for small electrical terminal screws.
- O-ring pick (brass O-ring extractor tool, which will not scratch polished sealing surfaces).
- Wrench, 7/8” open-end, thin-head, or similarly-sized adjustable wrench), for Jam Nut for Diaphragm of CHA vessel.
- Wrench, 5/8” open-end, as backup wrench on flats of Diaphragm Stem of CHA vessel.
- Wrench, 1/2” open-end, as backup wrench on body of fittings for 1/4”-OD tubing.
- Wrench, 9/16” open-end, for nut of fittings for 1/4”-OD tubing.
- Wrench, 7/16” open-end, for fittings for 1/8”-OD tubing, and as backup wrench on flats on bottom of Diaphragm Stem of CHA vessel.
- Wrench, 10”-long adjustable, for various parts.
- Wrench, 6”-long adjustable, for various parts.
- Hex (Allen-head) wrench set, SAE (inch). 3/16” wrench required for screws on retainer ring of CHA vessel.
- Hex (Allen-head) wrench set, metric.
- Long (3.5”-long) drive pin (straight) punch, 1/8”-diameter, for removing filter cup from diaphragm stem of CHA vessel.

See the #7200-TOOLS tool kit for which tools are included with the instrument. Other standard hand tools may be required for certain disassembly or repair operations.

Setting up the Computer Control System

1. Unpack and connect the computer system. Unless otherwise specified by the purchase order, the computer has been completely assembled, configured, set up and tested at the factory with all communication hardware and CHA-Control software installed.
2. Connect the RJ-45 Ethernet port on the back of the Model 7200 CHA system to the RJ-45 Ethernet port of the computer: use the supplied "cross-over" Ethernet cable.
3. If equipped with a serial interface to the oven (a DB9 serial port connection is on the rear panel of the control box), connect the RS-232 SERIAL (Temp Controller) port on the back of the Model 7200 CHA system to a serial port on the computer using the supplied DB9-Male–to-DB9-Female serial cable. If no serial connection exists, the Temperature Controller will use the existing ethernet interface.
4. If the software is being installed onto your own computer (not supplied by Chandler Engineering), or if the CHA-Control software must be reinstalled or upgraded to a new version, then see procedure #7200-1042, located in Section 7 (with software reinstallation image) of this manual.

Installing the CHA Vessel and Stand

Note: The Stand of the CHA Vessel and Stand is an integral part of this pressure vessel and is necessary to contain the pressure in the vessel. If the vessel is pressurized without being tightly clamped in the Stand, the end caps will be blown off the ends of the vessel's body, possibly causing damage to the instrument and injury to personnel, even at low pressures.

1. If the CHA Vessel and Stand has been shipped assembled, then just open the oven door, place it in the middle of the oven floor. If it is shipped unassembled, assemble it according to instructions in *Section 2 – Operating Instructions*, while studying the assembly drawing for the vessel in *Section 7 – Drawings and Schematics*.
2. Tilt the vessel so that you can insert the Cement Temperature RTD (Resistive Temperature Device, temperature sensor) into the tee fitting on top of the cell and tighten the tube fitting to seal the RTD when later pressurized.
3. Connect the RTD female connector, inside the oven, to the male connector on the RTD itself.
4. Connect the tubing, inside the oven, to the tube fittings on the CHA Vessel. Tighten ¼-turn past hand snug, to seal when later pressurized. If necessary, open the door of the instrumentation cabinet (on the right side of the oven) to see the labels where the tubing passes through the enclosure and oven walls, to determine which tube is which. Match these using the assembly drawing of the CHA Vessel, to connect the correct tubes to the correct fittings on the vessel).

Installing the Pressure Transducers

1. If the pressure transducers have been shipped installed in the instrumentation cabinet, then no action is required.
2. If the pressure transducers have been shipped separately (to prevent damage from the heavy transducers to the other parts in the instrumentation cabinet, during shipping), then just open the cabinet door, and connect the transducers by matching up the transducer to its labeled unused tube fitting.
3. If the fittings are not labeled, then use the Flow Diagram/Schematic in Section 7 of this manual to find which tube is which. If the pressure transducers are not labeled, match the serial number of the transducers to the note on the manufacturer Certificate of Calibration.
4. Alternately, you can just make a note of which serial number transducer you install to measure each pressure, and then perform your own Automatic Calibration for each transducer, as discussed in *Section 4 – Calibration.*

Connecting Utilities

1. Connect an air pressure supply to the AIR SUPPLY INLET connection on the back of the CHA instrumentation cabinet. See the **Utilities and Environmental Requirements** earlier in this section for minimum and maximum pressures required, and the types of connectors and tubing required.
2. Connect a vent line (tube) to the GAS VENT connection on the back of the CHA instrumentation cabinet and run this tube to a vent hood (or outside the building), if desired. See the **Utilities and Environmental Requirements** earlier in this section for the types of connectors and tubing required. This is an atmospheric-pressure line, and is not absolutely required, since the gas vented should only be nitrogen (N_2).
3. Connect a high-pressure nitrogen (N_2) gas supply (such as from a gas bottle) to the GAS (N_2) INLET connection on the back of the CHA instrumentation cabinet. See the **Utilities and Environmental Requirements** earlier in this section for minimum and maximum pressures required, and the types of connectors and tubing required.
4. Connect a pressurized water (H_2O) supply to the H_2O INLET connection on the back of the CHA instrumentation cabinet. See the **Utilities and Environmental Requirements** earlier in this section for minimum and maximum pressures required, and the types of connectors and tubing required.
5. Connect a drain line (tube) to the H_2O PURGE connection on the back of the CHA instrumentation cabinet. We suggest you use the 1/8”-OD PFA tubing, which is included in the #7200-ACCESS accessory kit and run this tube to a small beaker next to the CHA instrument. See the **Utilities and Environmental Requirements** earlier in this section for the types of connectors and tubing required. If you use the tubing mentioned above, you can use the connector which is included in the #7200-ACCESS accessory kit that comes with the CHA.

Section 2 - Operating Instructions

Front-Panel Valves, Indicators, and Controls

The Flow Diagram / Plumbing Schematic drawing #7200-1020 (found in the Drawings and Schematics section of this manual) provides an illustration of the valves and flow paths for the Model 7200 CHA. The function of each valve is detailed below:

Gas Supply valve

This 2-way (on/off, open/closed) manual ball valve is used to block or allow N_2 (nitrogen) gas supply pressure into the instrument. This valve must be open, to provide N_2 gas supply pressure to the inlets of the pressure regulators when conducting any test with the instrument, and during later parts of the setup of the test. After the test is finished (and during any assembly/disassembly or removal of the CHA vessel and stand), this valve must be closed to prevent continued pressurization of the system.

Gas Supply Pressure gauge

This 0 – 3000-psig (0 – 20700-kPa) dial pressure gauge indicates the N_2 GAS SUPPLY PRESSURE downstream of the GAS SUPPLY valve.

H_2O Confining Pressure regulator

This hand-adjusted, spring-loaded, outlet-pressure regulator is used to set the H_2O CONFINING PRESSURE required for each test. It is adjustable up to approximately 1500 psig (10,342 kPa, 10.34 MPa), but you must take care to not exceed the 1000-psig (6895-kPa, 6.895-MPa) maximum working pressure of the CHA. It is a self-relieving regulator and should be turned fully counterclockwise (CCW) to reduce the pressure to atmospheric pressure before assembling/disassembling or removing any part of the CHA downstream from this regulator.

H_2O Confining Pressure gauge

This 0 – 3000-psig (0 – 20700-kPa) dial pressure gauge indicates the H_2O CONFINING PRESSURE downstream of, and controlled by, the H_2O CONFINING PRESSURE regulator.

H_2o Confining Valve indicator light (LED, Light-Emitting Diode)

This green indicator light turns on to indicate when the H_2O CONFINING valve is opened by the CHA-Control software/hardware.

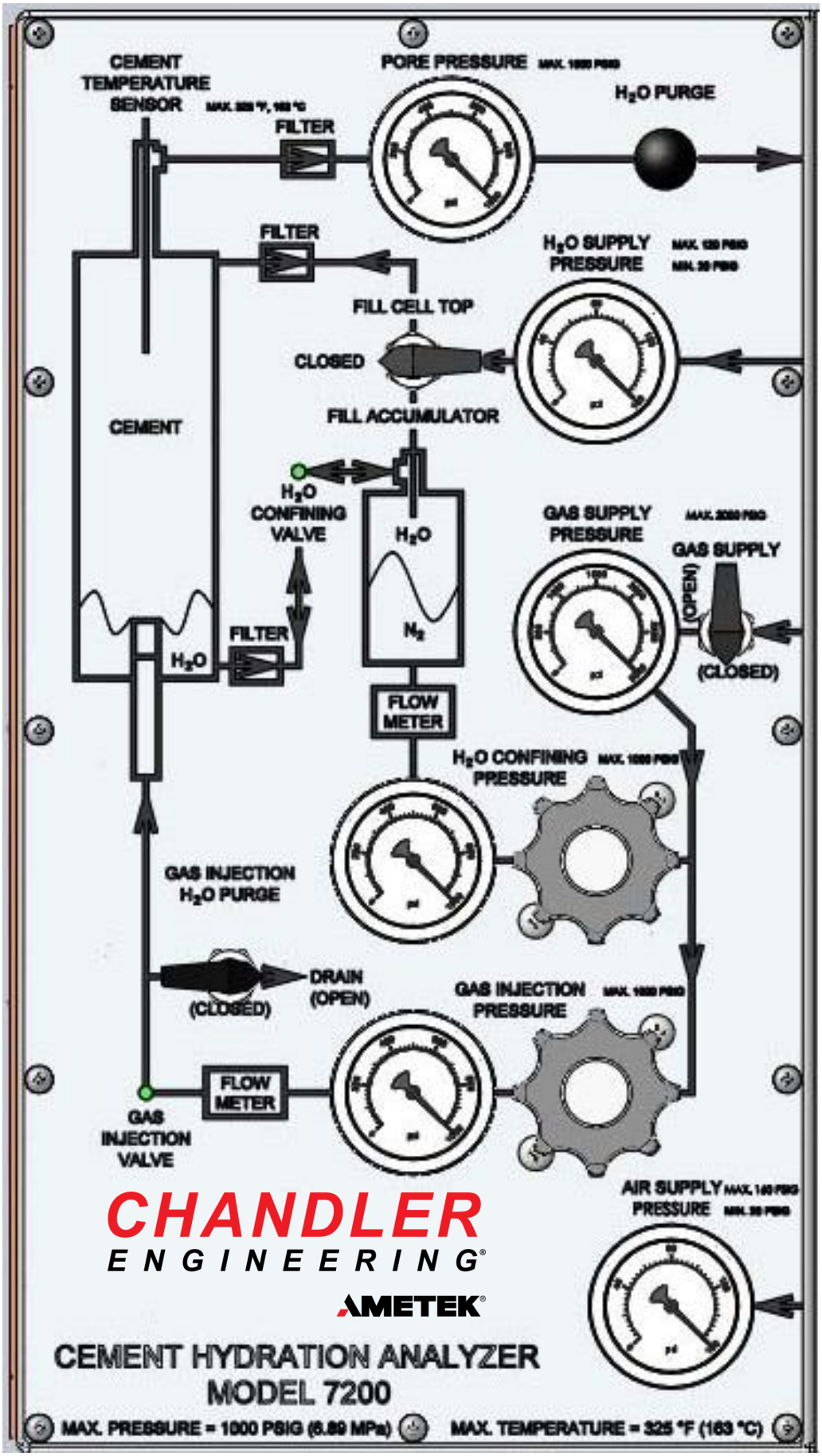

Figure 1 - Front Panel

Gas Injection Pressure regulator

This hand-adjusted, spring-loaded, outlet-pressure regulator is used to set the GAS INJECTION PRESSURE required for each test. It is adjustable up to approximately 1500 psig (10,342 kPa, 10.34 MPa), but you must take care to not exceed the 1000-psig (6895-kPa, 6.895-MPa) maximum working pressure of the CHA. It is a self-relieving regulator and should be turned fully counterclockwise (CCW) to reduce the pressure to atmospheric pressure before assembling/disassembling or removing any part of the CHA downstream from this regulator.

Gas Injection Pressure gauge

This 0 – 3000-psig (0 – 20700-kPa) dial pressure gauge indicates the GAS INJECTION PRESSURE downstream of, and controlled by, the GAS INJECTION PRESSURE regulator.

Gas Injection Valve indicator light (LED, Light-Emitting Diode)

This green indicator light turns on to indicate when the GAS INJECTION valve is opened by the CHA-Control software/hardware.

Gas Injection H_2O Purge valve

This 2-way (on/off, open/closed) manual ball valve is opened to the DRAIN position (horizontal, pointing to the DRAIN label), during test setup only, to back-fill the stem of the CHA vessel and tubing up to this valve with water, purging any air from that portion of the instrument. It is then closed (vertical position), and must remain closed, during any CHA test.

Air Supply Pressure Gauge

This 0 – 160-psig (0 – 1103-kPa) dial pressure gauge indicates the AIR SUPPLY PRESSURE being supplied to the CHA. This low-pressure air is necessary to open and close the air-actuated, remote-controlled ball valves (H_2O CONFINING valve and GAS INJECTION valve).

Air Supply Pressure Regulator

This hand-adjusted, spring-loaded, outlet-pressure regulator is used to set the air pressure supplied to the electric solenoid valves, which control the air-actuated H_2O CONFINING valve and GAS INJECTION valve. It is not on the front panel but is inside the instrumentation cabinet (on the right side of the oven). With air pressure supplied to the AIR SUPPLY INLET bulkhead fitting (and measured by the AIR SUPPLY PRESSURE gauge on the front panel), pull the regulator knob upward to unlock it, and then adjust the regulator outlet pressure to between 20 psig minimum and 100 psig maximum, as measured by the small gauge mounted on the regulator. Then, push the regulator knob downward to lock in the setting.

H_2O Supply Pressure gauge

This 0 – 160-psig (0 – 1103-kPa) dial pressure gauge indicates the H_2O SUPPLY PRESSURE being supplied to the CHA. This low-pressure water is necessary to fill the bladder ACCUMULATOR, so that the water can be injected into the CHA Vessel, on the underside (bottom side) of the diaphragm.

Fill Cell Top / Closed / Fill Accumulator valve

This 3-way (open, closed, open) manual ball valve is used to block or allow low-pressure H_2O (water) into the instrument.

After first lowering the H_2O CONFINING PRESSURE to a pressure lower than the lower-pressure H_2O SUPPLY PRESSURE (by turning the H_2O CONFINING PRESSURE regulator knob fully counterclockwise (CCW) to reduce the pressure), to prevent damage to the lower-pressure gauge, the valve is manually turned to the FILL ACCUMULATOR position to fill the bladder accumulator with water. A check valve is between this valve and the lower-pressure H_2O SUPPLY PRESSURE gauge, to prevent backflow and protect the gauge from over-pressure.

During test setup (first lower the PORE PRESSURE to a pressure lower than the H_2O SUPPLY PRESSURE, by opening the H_2O PURGE valve), the valve is manually turned to the FILL CELL TOP position to fill the top portion of the CHA vessel, above the cement and rubber "wafer" (baffle), and fill the PORE PRESSURE gauge and tubing up through the H_2O PURGE valve with water, purging any air from that portion of the instrument.

During the test, and during any assembly/disassembly or removal of the CHA Vessel and Stand, this valve must be manually CLOSED to prevent continued pressurization of the system downstream of the valve, and to prevent over-pressurization of the low-pressure H_2O SUPPLY PRESSURE gauge by the high-pressure of the water in the accumulator (which is pressurized by the N2 gas flowing from the H_2O CONFINING PRESSURE regulator and FLOW METER).

Pore Pressure gauge

This 0 – 3000-psig (0 – 20700-kPa) dial pressure gauge indicates the PORE PRESSURE at the top of the cement sample column in the CHA Vessel.

H_2O Purge valve

This 2-way (open/closed) manual needle valve is used to hold pressure and contain fluids in the CHA Vessel or allow release of the PORE PRESSURE from the top of the cement sample in the CHA Vessel. This valve is opened during test setup, to fill the PORE PRESSURE gauge and tubing up through this valve with water, purging any air from that portion of the instrument. It is also opened to relieve pressure from the CHA Vessel and instrument at the end of a test, before disassembly or removal of the CHA Vessel and Stand. During the test, this valve must be closed to contain the PORE PRESSURE at the top of the cement sample in the CHA Vessel.

Software Operation

Main Display

The Main screen is displayed, as shown in Figure 2 below, when the program starts, and when you click on the Main tab (Notice the Main and Plot tabs near the upper left corner of the screen).

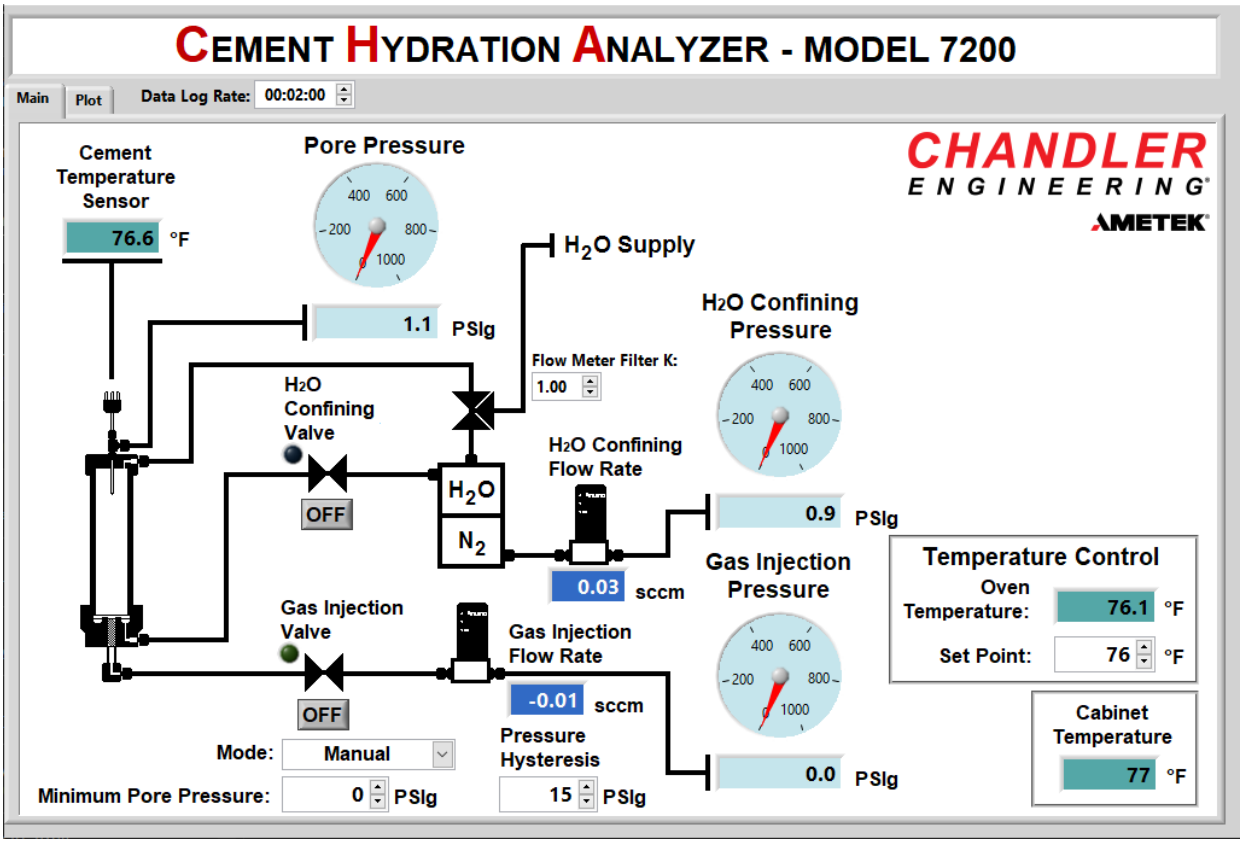

Figure 2 - Main Display

Menu Bar

File menu

Log Data

There are two modes for logging data to a file. When Log Data is selected, the **Manual** or **Automatic** mode must be selected.

When **Automatic** data logging is selected, a dialog will appear to specify where to save the file. The data is saved in Comma-Separated Values (.csv) format.

Once the file is selected, the system will begin logging every measured and calculated data value at the time intervals specified in the **Data Log Rate** window. The **Elapsed Log Time** appears on the main window when data logging is active.

When **Manual** mode is selected, the **User Comment** control appears (See Figure 3), and data is logged only when the blue **Log Data** button is clicked. This window allows the user to add comments about the test to the data file. The **User Comment** is saved to the log file along with the corresponding data points.

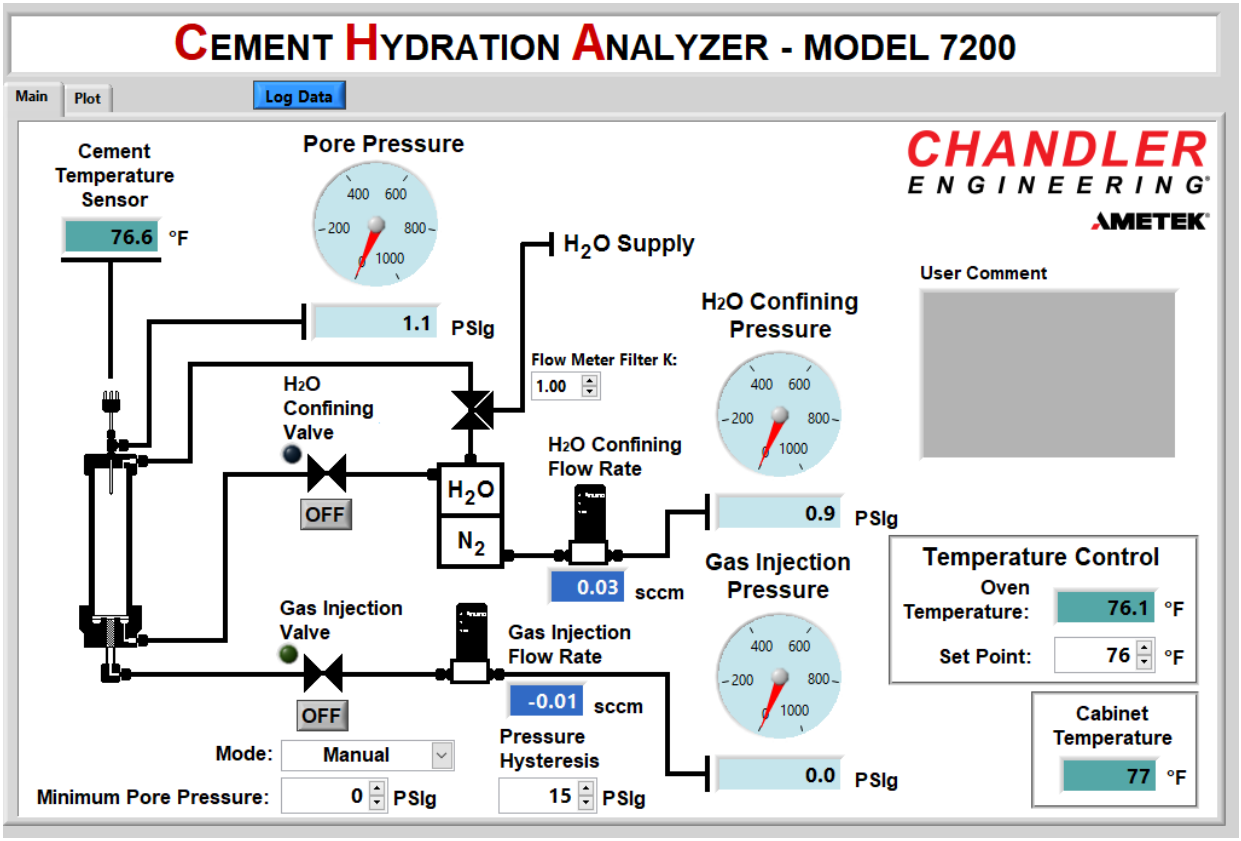

Figure 3 - Main Screen while Manual Data Logging, with User Comment window

Exit

This menu item closes the CHA-Control software.

Operation menu

Online mode

Choose this menu item to communicate with and operate the CHA, and run a Cement Hydration Test.

Simulation mode

Choose this menu item to operate the software, for training and familiarization purposes, without being in communication with the CHA (or even having the CHA present).

Setup Menu

Temperature Units

This menu selection allows you to choose between °C and °F for all temperature data displayed and logged. **WARNING: CHANGING THIS ALSO REQUIRES CHANGING THE TEMPERATURE UNITS OF THE OVEN TEMPERATURE CONTROLLER!**

The CHA-Control software and the Oven Temperature controller must be set to use the same temperature units. See the temperature controller user manual for how to change its units.

Alarm Limits

This menu selection, as shown in Figure 4 below, allows the user to set software alarm limits for the Maximum Pressure (H_2O Confining Pressure and Gas Injection Pressure) and for the Maximum Temperature (Oven Temperature and Cement Temperature). When a limit is changed, the OK button must be pressed for the software to accept the new value. These limits are the triggers for the pop-up over-temperature and over-pressure on-screen alarms and should be changed with caution. When the Maximum Pressure alarm limit is reached, no action is performed by the software other than the pop-up alarm message. When the Maximum Temperature alarm limit is reached, the software automatically turns off the oven heating by setting the Oven Temperature Set Point to 0.0°C.

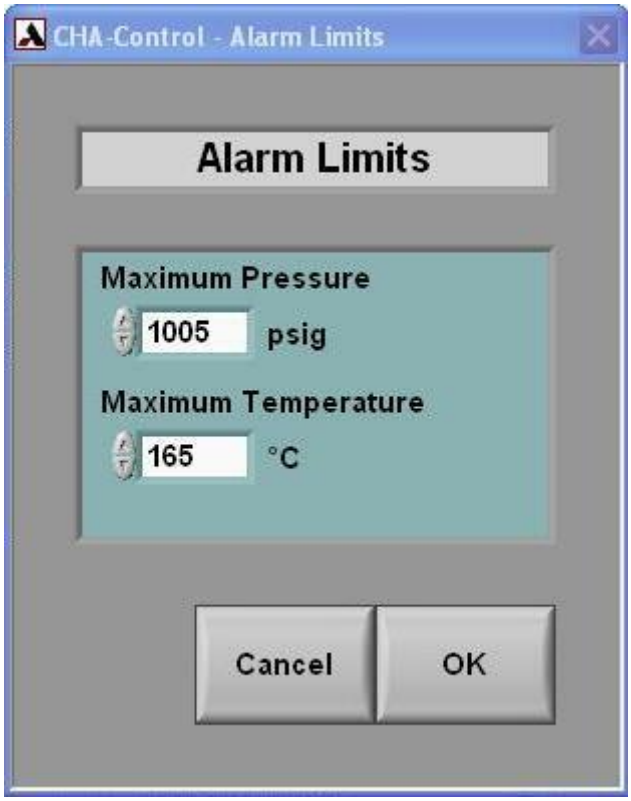

Figure 4 - Alarm Limits

Com Port

This menu selection allows you to choose which COM port to be used for communication with the instrument (specifically, the Oven Temperature controller). If using an ethernet connected Oven Temperature controller, select the “IP Address” menu item.

Calibration menu

These menu items will open the Calibration window for the selected sensor. For more details, see *Section 4 - Calibration* of this manual.

Help menu

Index

This menu item opens the Help file.

About

This menu item opens the About screen, showing the CHA-Control software copyright message, date, and version number.

Main screen controls and indicators

Oven Temperature

The **Oven Temperature** is displayed on the main screen, as measured by the oven temperature controller's thermocouple. Below that is a **Set Point** control which you can use to remotely change the oven temperature set point of the controller. Either use the arrows to increase or decrease the set point, or type in a value in the box. The software will not accept and make use of the new value until you either click somewhere else on the screen or use the ENTER key on the computer's keyboard. *To turn off the oven heating, enter a **Set Point** of 0.0°C.*

Cabinet Temperature

The **Cabinet Temperature** displayed on the main screen is the temperature inside the instrumentation cabinet, as measured by an RTD. Since the CHA uses very-low-flow-rate flow meters to measure gas injected (**N_2 Flow Rate**) and to indicate the relative expansion/contraction of the cement (**H_2O Flow Rate**), room temperature changes could affect the measurements by causing drift in the flow meters' output signals. This is prevented by keeping the doors of the instrumentation cabinet closed, allowing time for the **Cabinet Temperature** to reach equilibrium as the nearby oven heats up to test temperature, and if necessary, then rezeroing the **N_2 Flow Rate** and **H_2O Flow Rate**, using the drop-down menu items **Calibration**… **Gas Injection Flow Rate** and **H_2O Confining Flow Rate**.

Cement Temperature

The **Cement Temperature** displayed on the main screen is the temperature inside the cement sample being tested in the CHA vessel, as measured by an RTD. This temperature provides an indication of the hydration/curing process of the cement during the test, and is used to measure when the cement sample has reached the desired test temperature and begin pressurization of the sample.

Pore Pressure

The **Pore Pressure** indicator monitors the pressure at the top of the cement sample column in the CHA vessel, giving an indication of the stage of hydration/curing of the sample, and whether or not any injected gas has migrated from the bottom of the sample, through the sample and up to the top.

H_2O Confining Pressure

The **H_2O Confining Pressure** indicator monitors the pressure being applied to the bottom of the cement sample column in the CHA vessel (by water on the bottom side of the rubber diaphragm). Use the H_2O CONFINING PRESSURE regulator on the front panel of the instrument to manually set the desired pressure for the test.

Gas Injection Pressure

The **Gas Injection Pressure** indicator monitors the pressure of the N_2 gas injected into the bottom of the cement sample column in the CHA vessel. Use the GAS INJECTION PRESSURE regulator on the front panel of the instrument to manually set the desired pressure for the test.

H_2O Flow Rate

The **H_2O Flow Rate** indicator monitors the flow rate of the water being applied to the bottom of the cement sample column in the CHA vessel (by water on the bottom side of the rubber diaphragm). It actually measures the flow rate of the N_2 gas used to pressurize the bottom side of the bladder in the accumulator containing the water. This can be used as a relative indication of the expansion/contraction of the cement as it heats up and during the hydration, before injecting gas. If the **H_2O Confining Valve** is closed (as in after **Automatic** opening of the **Gas Injection Valve**), then any nominal flow rate measured will be meaningless.

N_2 Flow Rate

The **N_2 Flow Rate** indicator monitors the flow rate of the gas being injected to the bottom of the cement sample column in the CHA vessel. This can be used as an approximate indication of the volume of gas which migrates into the cement after opening the **Gas Injection Valve**.

H_2O Confining Valve

The **H_2O Confining Valve** control is used to remotely open and close the air-actuated **H_2O Confining Valve**. If the **Mode** control button is set to **Manual** mode, then you can click on the **ON/OFF** button (next to the valve picture on this main screen) to open the valve and click to manually close the valve. If the **Mode** control button is set to **Automatic** mode, then the **ON/OFF** button is not usable, and the software automatically closes this valve immediately before it automatically opens the **Gas Injection Valve** at the user-entered **Minimum Pore Pressure** value. When this valve is open, the related flow lines on the screen, and the **Gas Injection Valve** indicator light (on the screen) light up blue, and the green **H_2O Confining Valve** indicator light on the CHA's front panel turns on.

Gas Injection Valve

The **Gas Injection Valve** control is used to remotely open and close the air-actuated **Gas Injection Valve**. If the **Mode** control button is set to **Manual** mode, then you can click on the **ON/OFF** button (next to the valve picture on this main screen) to open the valve and click to manually close the valve. If the **Mode** control button is set to **Automatic** mode, then the **ON/OFF** button is not usable, and the software automatically opens this valve immediately after it automatically closes the **H_2O Confining Valve** at the user-entered **Minimum Pore Pressure** value. When this valve is open, the related flow lines on the screen, and the **Gas Injection Valve** indicator light (on the screen and on the CHA's front panel) light up green.

Mode button

Set the **Mode** control button to **Manual** mode so that you can click on the **ON/OFF** button (next to the two valve pictures on this main screen) to open the valve and click to manually close the valve (**H_2O Confining Valve** and **Gas Injection Valve**). See Figure 1.

Setting the **Mode** control button to **Auto (Press.)** mode makes the manual valve **ON/OFF** buttons unusable, and the software automatically closes the **H_2O Confining Valve** and opens the **Gas Injection Valve** when the **Pore Pressure** decreases to become equal to the user-entered **Minimum Pore Pressure** value. This mode is for use when conducting a test according to the Procedure 2 of Type 3 experiment (see the discussion of "Basic Tests Performed with the model 7200 CHA," later in this section). See Figure 5 below.

Setting the **Mode** control button to **Auto (Temp.)** mode makes the manual valve **ON/OFF** buttons unusable, and the software automatically closes the **H_2O Confining Valve** and opens the **Gas Injection Valve** when the **Cement Temperature** increases to become equal to the user-entered **Oven Temperature Set Point** value. This mode is for use when conducting a test according to the Procedure 1 of Type 3 experiment (See the discussion of "Basic Tests Performed with the Model 7200 CHA," later in this section.). See Figure 6 below.

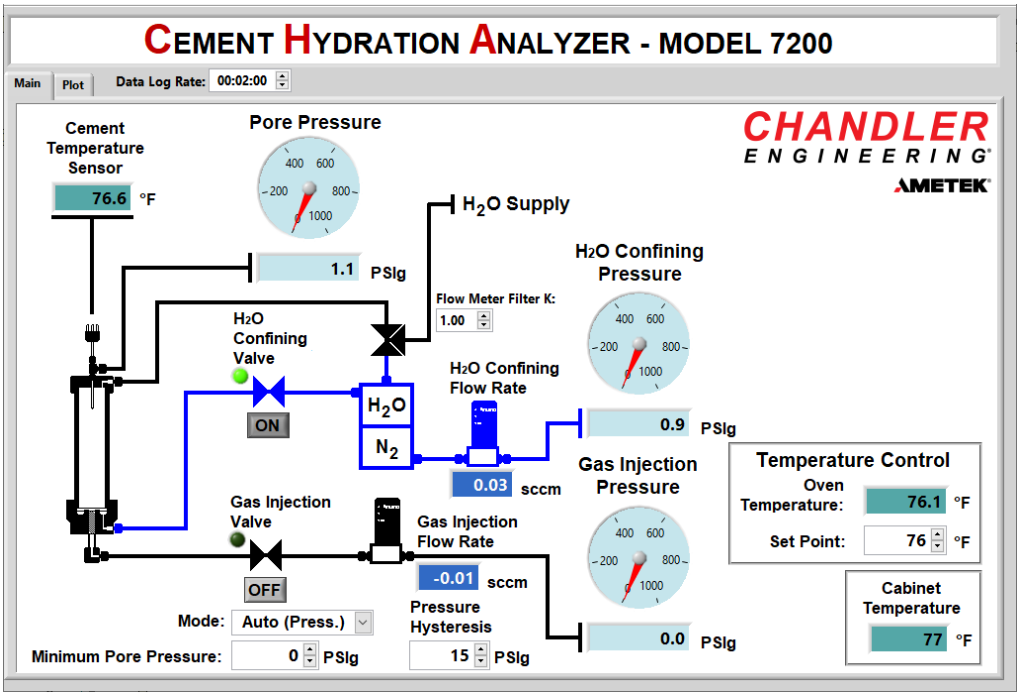

Figure 5 - Main screen with Auto (Press.) mode chosen

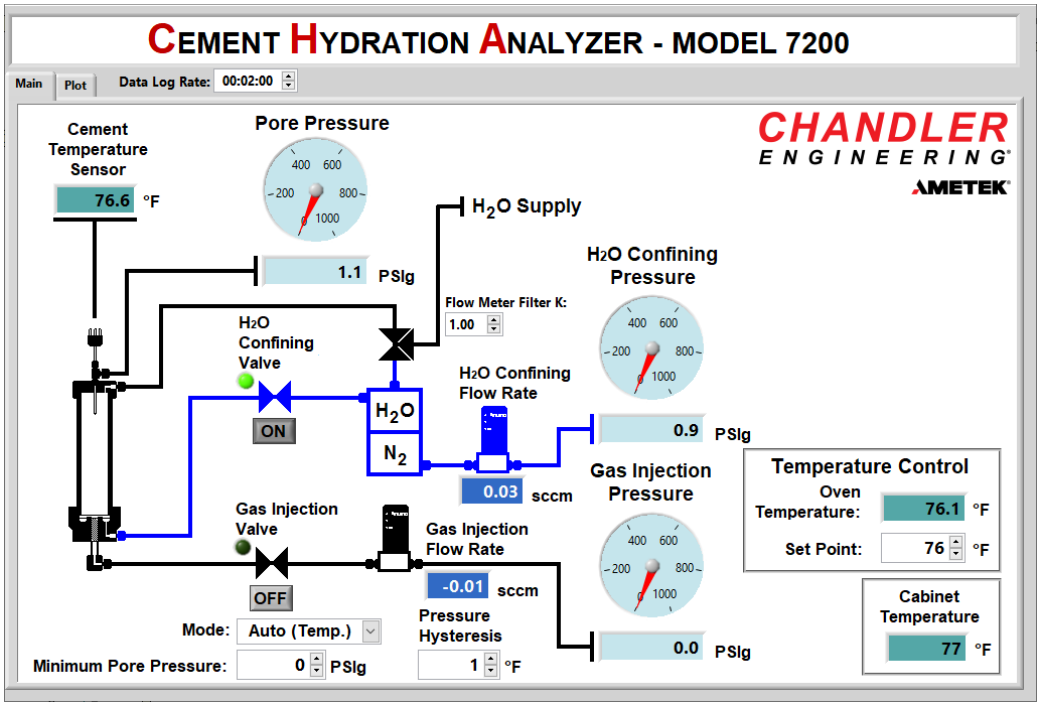

Figure 6 - Main screen with Auto (Temp.) mode chosen

Minimum Pore Pressure

Use the **Minimum Pore Pressure** control to set the minimum **Pore Pressure** at which the software will automatically close the **H2O Confining Valve** and open the **Gas Injection Valve**, if you have set the **Mode** button to **Auto (Press.)**.

Pressure Hysteresis

Use the **Pressure Hysteresis** control to set the hysteresis in the **Pore Pressure** at which the software will automatically reopen the **H2O Confining Valve** and reclose the **Gas Injection Valve** (after it automatically closed the **H2O Confining Valve** and opened the **Gas Injection Valve** upon the **Pore Pressure** dropping to equal the **Minimum Pore Pressure** setting), if you have set the **Mode** button to **Auto (Press.)**. For example, if you have set the **Minimum Pore Pressure** to 400 psig and the **Pressure Hysteresis** to set to 15 psig, and the valves switch automatically upon the **Pore Pressure** reaching 400 psig, the **Pore Pressure** must increase back up to 415 psig for the valves to switch back to their original positions. This control allows you to prevent any up-and-down noise or swings in the pressure from switching the valves back, which may render the test unusable.

Temperature Hysteresis

Use the **Temperature Hysteresis** control to set the hysteresis in the **Cement Temperature** at which the software will automatically reopen the **H2O Confining Valve** and reclose the **Gas Injection Valve** (after it automatically closed the **H2O Confining Valve** and opened the **Gas Injection Valve** upon the **Cement Temperature** increasing to equal the **Oven Temperature Set Point**), if you have set the **Mode** button to **Auto (Temp.)**. For example, if you have set the **Oven Temperature Set Point** to 100°C and the **Temperature Hysteresis** set to 3°C, and the valves switch automatically upon the **Cement Temperature** increasing to reach 100°C, the **Cement Temperature** must decrease back down to 97°C for the valves to switch back to their original positions. This control allows you to prevent any up-and-down noise or swings in the temperature from switching the valves back, which may render the test unusable.

Data Plotting

The Plot screen is displayed as shown in Figure 7 below, when you click on the Plot tab. (Notice the Main and Plot tabs near the upper left corner of the screen.)

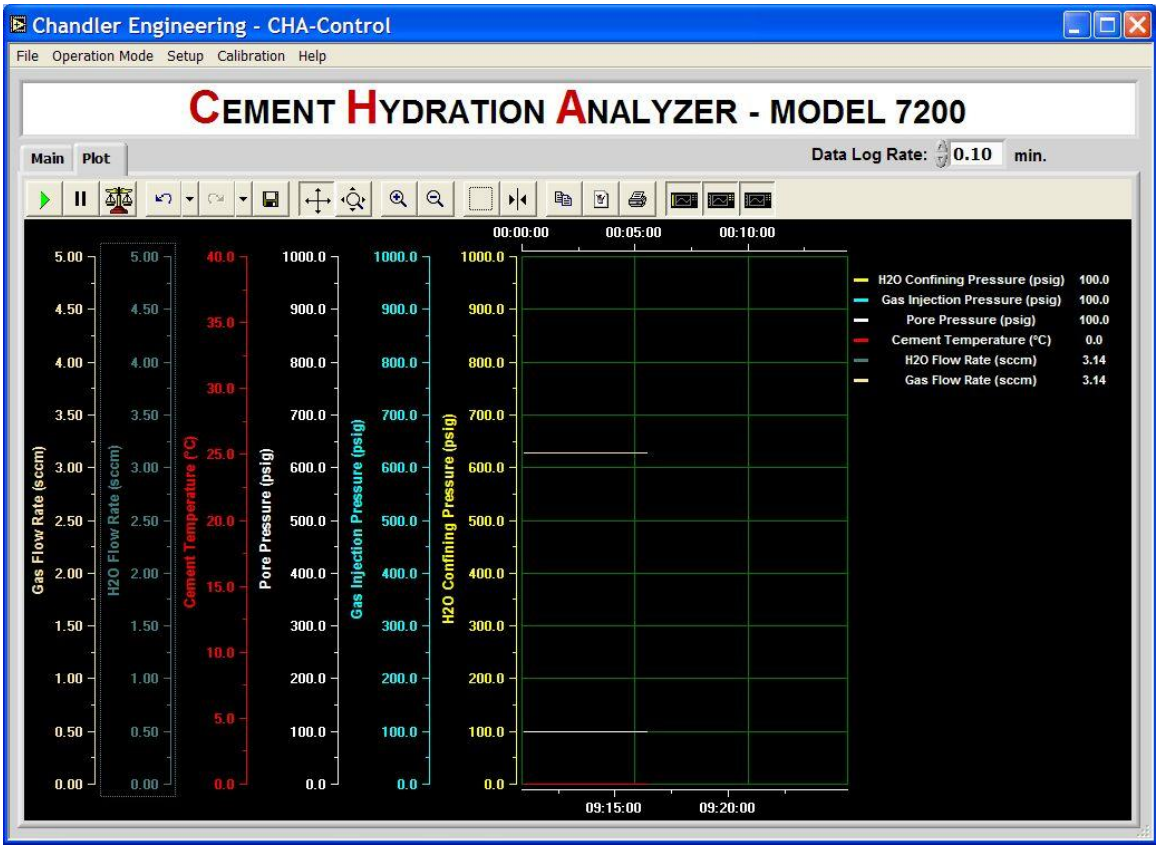

Figure 7 - Plot Screen

Up to 8 different parameters can be shown on this real-time plot. To choose which parameters are plotted, right-click on the plot, and choose the parameter desired, one at a time. The many different controls at the top of the plot, are, from left to right:

Enable X-axis tracking (Green arrow)

Disable X-axis tracking (2 black vertical bars)

Manual Axis Scaling (picture of scale)

Undo Manual Axis Scaling (counterclockwise arrow)

Redo (Manual Axis Scaling) (clockwise arrow)

Save as Default Setting

Save as Default Setting (diskette picture)

Scroll (Axes) (crossed arrows)

Zoom (Axes) (circle with arrows pointing outward)

Zoom In (magnifying glass with + symbol)

Zoom Out (magnifying glass with – symbol)

Zoom Box (box of dashed lines)

Cursor (vertical line with arrows pointing inward)

Copy to Clipboard (picture of 2 pages)

Save as Image (picture of image on page)

Print (picture of printer)

Show/Hide Y-axis titles (picture of plot screen with vertical bar highlighted on left)

Show/Hide Legend (picture of plot screen with legend highlighted on upper right)

Show/Hide Y Values in Legend (picture of plot screen with vertical bar highlighted on left)

These controls are mostly self-explanatory, allowing you to zoom in and out and rescale the plot manually, turn x-axis tracking on and off, print and save the plot, and hide or show various details. The Manual Axis Scaling pop-up screen is shown below in Figure 8.

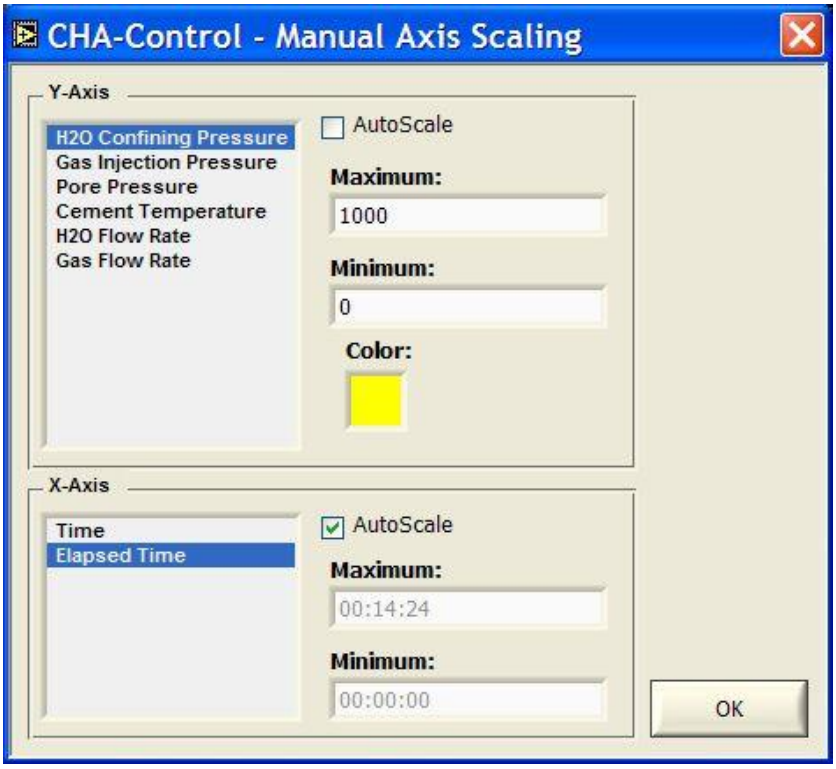

Figure 8 - Manual Axis Scaling

You can also right-click on the plot and choose to use either Linear (default) or Logarithmic scaling, and to choose to make the X-Axis Scaling. Either Scroll (like a strip-chart recorder, showing only the latest data) or Scale Min and Max (automatically, continually adjusting X-axis to make all data (since starting the software) fit on the plot).

5270 Monitoring

This section will outline how to configure the Chandler Engineering 5250 Data Acquisition and Control Software (DACS) to monitor the Model 7200 CHA. The CHA is included as a default instrument in 5270 version 2.7.4 and later.

Configure I/O Connection

The IP Addresses used by the CHA are hard-coded into the software. The Data Acquisition uses an IP Address of 10.1.10.100. If the Oven Temperature Controller uses ethernet, its IP Address must be 10.1.10.101.

- Select Tools > Configure > I/O Connections
- In the dialog that appears, click the New button and then select Modbus TCP.
- In the dialog that appears, set the IP Address to 10.1.10.100. Leave the remaining fields at their default values. The Settings indicator will show “This IP address is invalid” until you click the Test button. Click OK to close the dialog.
- Back in the Configure I/O Connections dialog, a new entry will appear. You can name this connection anything, but the remainder of this discussion assumes it is named “CHA DAQ”. If the Oven Temperature Controller uses ethernet, repeat this process to create another Modbus TCP I/O Connection that uses the 10.1.10.101 IP Address named “CHA Oven”.

Configure the Instrument

Configure a Model 7200 Cement Hydration Analyzer instrument as shown below in Figure 9. There are no Controllers, Digital Outputs, Analog Outputs or Advanced options to be configured.

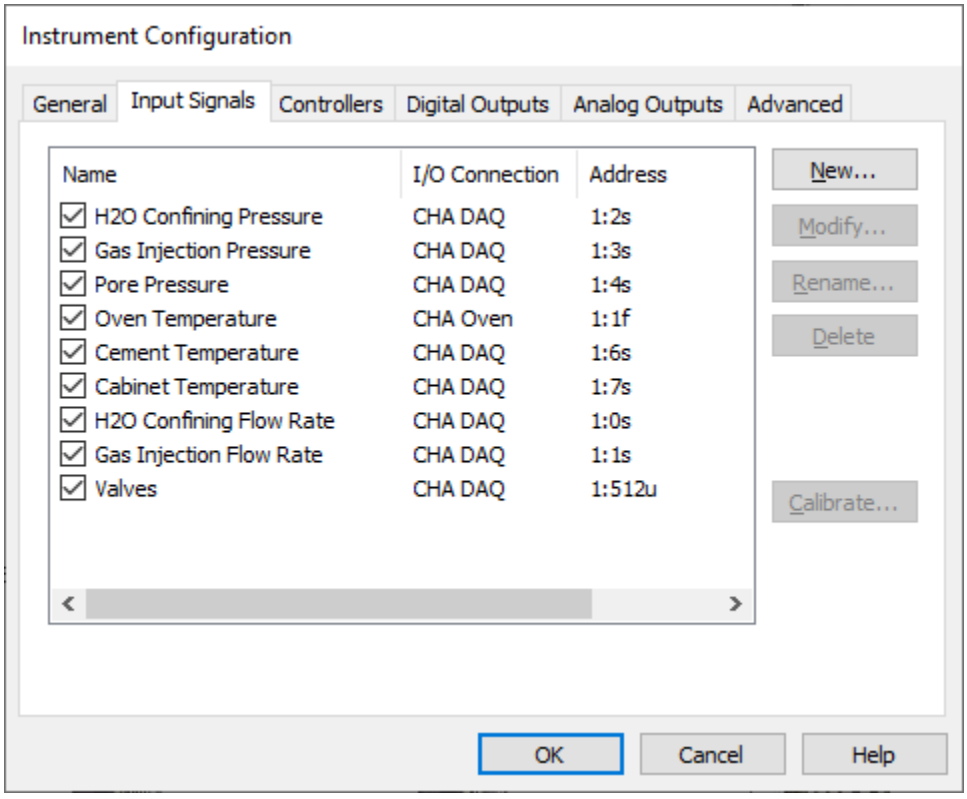

Figure 9 - 5270 CHA Input Signals

The Valves signal in 5270 is a number representing the state of all digital outputs in the system. This includes the valves but also includes the shunt relays used during Calibration. When the H2O Confining Pressure Valve is open and the Gas Injection Valve is closed, the value is 144. When the H2O Confining Pressure Valve is closed and the Gas Injection Valve is open, the value is 96. When both valves are closed, the value is 160. An example 5270 test is shown below in Figure 10. The Valves trace is red and has been thickened.

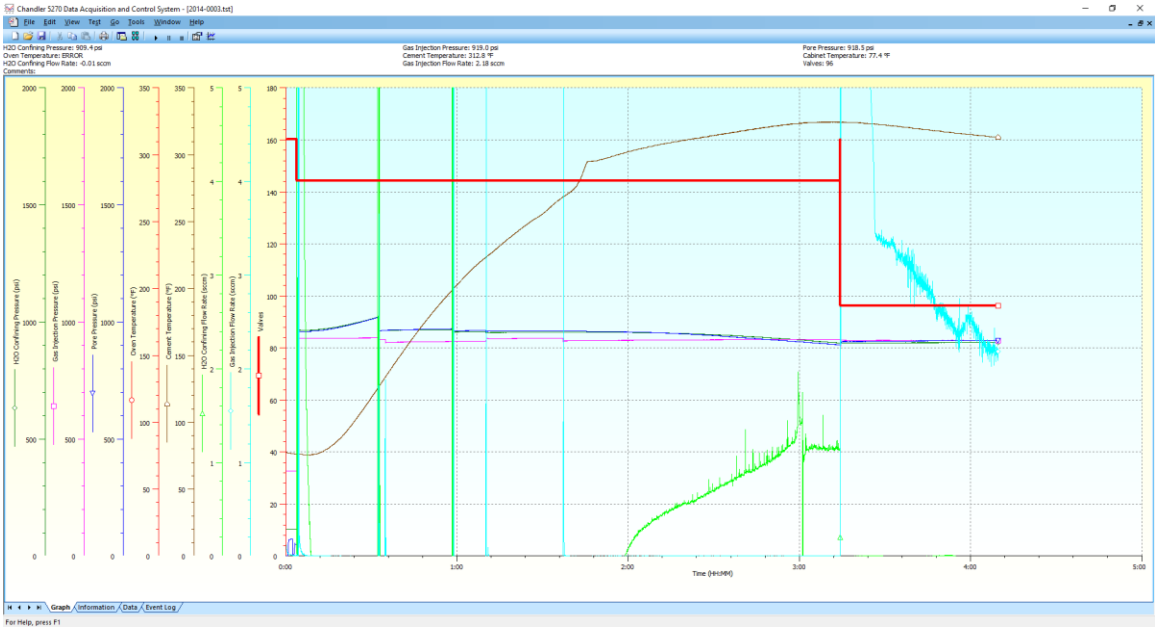

Figure 10 - Example 5270 CHA Test

Tests Performed with the Model 7200 CHA

This section will outline the basic tests that can be performed using the CHA instrument. It is intended to serve as a guide for operating the instrument and not as an exhaustive procedure for each type of test.

Note that the pressures used during a CHA experiment are based on actual well pressures and well geometry. Using this information, "scaled-down" pressures are determined to create comparable shear stress on the inside of the test section. The shear area within the well is determined as follows:

The dimensions and shear area of the CHA test section are listed as follows:

Internal diameter: 1.939-in / 4.925 mm (*2.00-inch Schedule 80 carbon steel pipe*)

Length: 8.50-in / 21.59 mm

CHA shear area: 51.78 in^2 / 334.05 cm^2

Well shear area: based on well geometry and cement column length

Scale-down factor: Well Shear Area / CHA shear area

Closed Cell, No Gas Injection

Cement shrinks when it hydrates: in a closed vessel, this results in a pressure decrease which depends upon the compressibility of the slurry.

During this experiment, the pore pressure at the top of the cement sample in the CHA vessel is measured. This pressure decreases slowly until the cement temperature begins to increase.

Then, pore pressure decreases sharply to a lower limit. At room temperature, the lowest value that the pore pressure can reach is approximately 7 psi (0.05 MPa, 50 kPa, 0.5 bar, 0.5 atm.), while at a test temperature of 150°C, this final pressure would be approximately 73 psi (0.5 MPa, 500 kPa, 5 bar, 4.9 atm.).

1. The CHA vessel is filled with the cement slurry sample and placed in the oven.

2. H_2O confining pressure is applied to the slurry until thermal equilibrium is reached between the slurry and the oven.
3. The CHA vessel is closed by closing the **H_2O Confining Valve** with the **Gas Injection Valve** closed.
4. The cement temperature reaches a constant temperature before increasing, reaches a maximum, and finally decreases to approach the oven temperature.

Cell Open (Constant H_2O Confining Pressure) Until Gas Injection

This procedure involves setting the gas injection pressure lower than the H_2O Confining Pressure (at 250 psi and 300 psi, respectively).

1. Fill the vessel with the cement slurry and pressurize with the H_2O Confining Pressure (300 psi) and preset the Gas Injection Pressure (250 psi). The Gas Injection valve is not opened now.
2. Allow the cement slurry temperature to reach the oven temperature.
3. Once the pore pressure above the sample reaches the preset Gas Injection Pressure (250 psi), close the H_2O Confining valve and open the Gas Injection valve to allow the gas to enter the cell throughout the remainder of the test. The open Gas Injection valve allows gas to enter at the preset gas injection pressure.
4. The amount of gas which enters the cell (as measured by the N_2 Flow Rate meter) is used to estimate the total shrinkage and will assist with determining if gas migration is occurring.

The CHA-Control software can be set to automatically open and close these valves as described, at whatever value of Minimum Pore Pressure you enter.

Stop the test after the cement completes its hydration, as monitored by the Cement Temperature decreasing and approaching the Oven Temperature.

Interpretation of Results

After gas injection starts, if the pore pressure increases (especially if it becomes equal to the gas injection pressure), then gas migration has occurred.

If the pore pressure continues to decrease (especially if it approaches 0 psig), then no gas migration has occurred.

The flow rates can be used as raw data used to make an approximate calculation of the shrinkage or expansion of the cement, and of the volume of gas which entered the sample. See Figure 11 and Figure 12 below for examples.

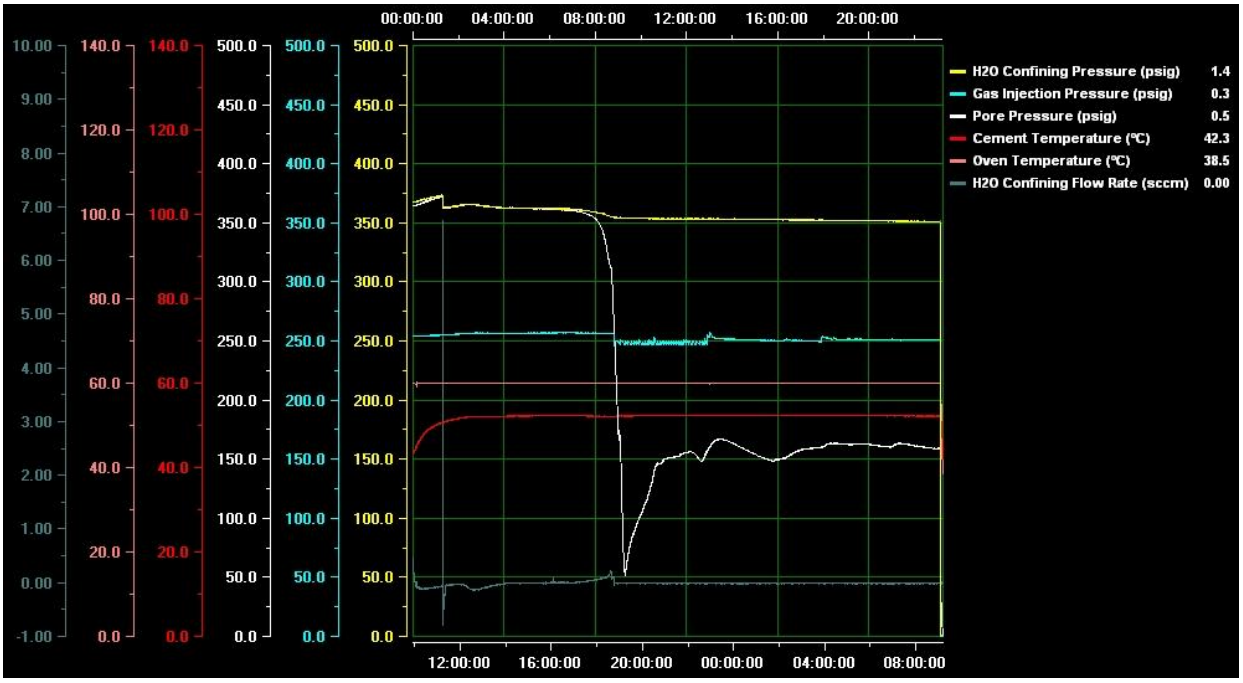

Figure 11 -Test Data Plot with Gas Migration

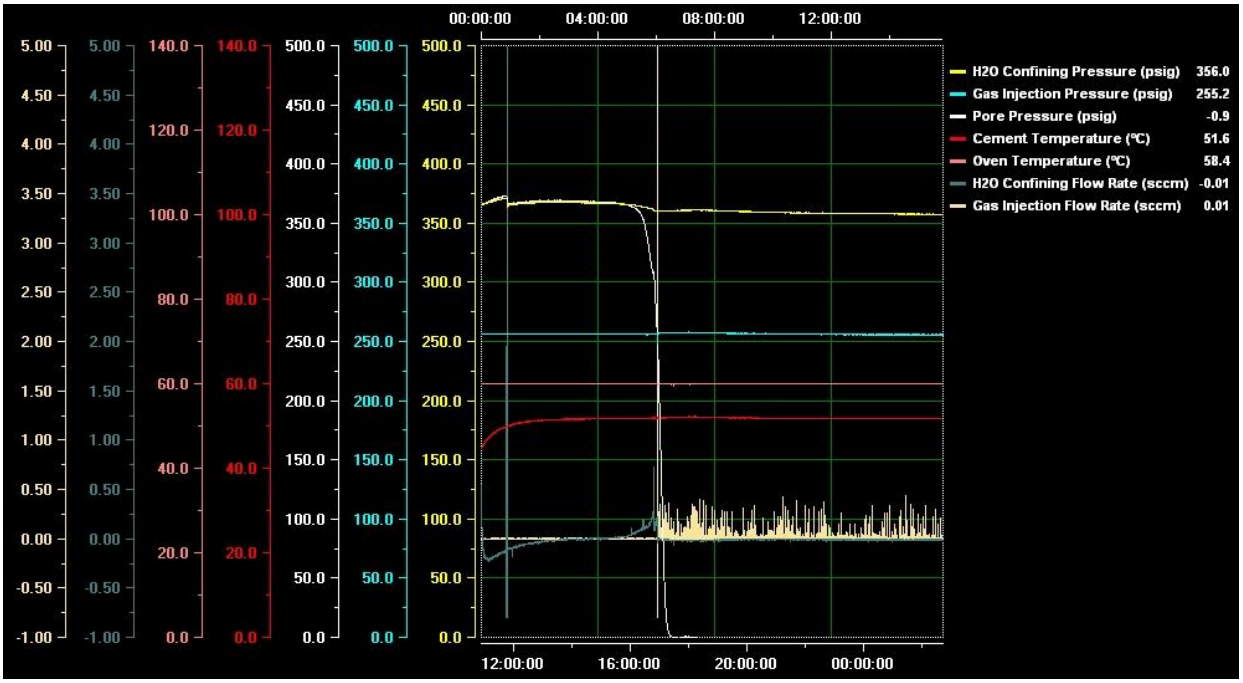

Figure 12 - Test Data Plot with No Gas Migration

Pre-start up Checks

Prior to start-up the following checks should be made to ensure that:

1. Lines (pressure tubing) are in place and secure.
2. Pressurized fluid sources are connected to the CHA.
3. Vent lines are connected to the H_2O PURGE and GAS VENT bulkhead fittings on the rear of the CHA.
4. Cables are connected between the computer and the Model 7200 CHA instrument.

Powering On

Power to the Model 7200 CHA instrument may be applied by the oven's power on/off switch located on the upper left panel at the top of the oven. All major system components are powered through this switch except the computer. Ensure that the computer is turned on.

Note: It is important that the instrument is powered up BEFORE the software is started.

Filling the System with Test Fluids, and Initiating a Test

1. Disassemble the CHA Vessel and Stand enough to remove the bottom cap. To remove vessel from stand:
   a. Release all pressure from all parts of vessel.
   b. Rotate hand knob (Item 24 on #7200-1010 CHA Vessel w/Stand assembly drawing) CCW (counterclockwise) to raise upper arm (Item 18).
   c. Pull plunger knob (Item 19) out and rotate 90° to hold it out.
   d. Raise vessel slightly from lower arm (Item 17), and tilt it and lift it to remove it from stand.
2. Pull the lower end cap (Item 3) from the body (Sample Tube, Item 1).
3. Remove the screws (Item 5) which clamp the retainer (Item 4) to the lower cap and clamp the diaphragm (Item 6) in place.
4. Pull the stem (with diaphragm (Item 6), washer (Item 8), and lock nut (Item 9)) upward, partly out of the lower end cap.
5. Clean, as necessary, and reassemble the stem/diaphragm assembly (Items 6, 7, 8, 9, 14, and 25). **DO NOT USE ANY SILICONE GREASE OR ANY OTHER LUBRICANT ON THE DIAPHRAGM!** Clamp the diaphragm (Item 6) tightly between the washer (Item 8) and the flange on the stem (Item 7), with the rougher, sandblasted face of the washer against the rubber diaphragm, by tightening the threaded nut (Item 9). This is more easily done by first folding the diaphragm upward and out of the way, and using the 7/8" flat wrench (included in the #7200-TOOLS tool kit) on the nut and a 5/8" open-end wrench (included in the tool kit) or 7/16" open-end wrench (included in the tool kit) on the appropriate flats of the stem (Item 7).
6. Submerge the lower end cap and stem/diaphragm assembly into a container of water, and reassemble underwater. This ensures that the chamber underneath the diaphragm, and the volume inside the stem are filled with water. Make sure that an O-ring (Item 11, lightly lubricated with silicone grease, included in the #7200-ACCESS accessory kit) is installed around the stem, to seal it inside the lower end cap. Push the stem back down until it stops, and place the retainer (Item 4) on top of the diaphragm, and clamp it in place, to seal the diaphragm, with the screws (Item 6). **DO NOT USE ANY SILICONE GREASE OR ANY OTHER LUBRICANT ON THE DIAPHRAGM!** After removing the assembly from the water, use a syringe, as necessary, to fill the passages out through the H_2O Confining Pressure port and Gas Injection Port with water. Plug the ports with the provided plugs.
7. Lubricate the O-ring (Item 10) with silicone grease (included in the #7200-ACCESS accessory kit) and install it in the groove of the retainer (Item 4). Pack more silicone grease around the O-ring and groove, to prevent cement from setting and sticking in this area.
8. Place this lower end cap, retainer, and diaphragm/stem assembly back into the stand, inside the oven. Place the body (Sample Tube, Item 1) back into the lower end cap and retainer.

9. Lubricate another O-ring (Item 10) with silicone grease and install it in the groove of the upper end cap (Item 2). Pack more silicone grease around the O-ring and groove, to prevent cement from setting and sticking in this area.
10. Insert the Cement Temperature RTD (Item 30) into and through the tee (Item 26) on the top of the upper end cap, and tighten the tube fitting to seal it.
11. Cut a piece of the TFE tubing (Item 12) to the proper length, and slide it over the RTD, to prevent cement from sticking to it.
12. Place the metal wafer (stainless-steel baffle, Item 13) over the RTD, up against the bottom of the upper end cap.
13. Place this upper end cap, RTD, and wafer assembly in the oven, but do not install it yet on the body (Sample Tube, Item 1).
14. Temporarily connect part #7200-1108 "TUBE, PURGE, CHA, LONG" (or make your own with two 1/8" Swagelok unions and a piece of 1/8"-OD tubing) between the unconnected H_2O Fill/Purge tubing ("Fill Cell Top") and the Gas Injection tubing inside the oven (with the filters still connected to these tubes exiting from the oven wall). Close the H_2O CONFINING VALVE and the GAS INJECTION VALVE. Turn the 3-way valve on the CHA front panel to the TO CELL TOP position to pressurize this temporary tubing circuit with water. Then, open the GAS INJECTION H_2O PURGE valve to the DRAIN position (horizontal, pointing to the DRAIN label) to allow the pressurized water to back-flow and purge all the air from the CHA vessel stem and Gas Injection tubing. When water exits from the H_2O PURGE tubing (length of 1/8"-OD translucent PFA tubing connected to the H_2O PURGE connection on the back of the CHA cabinet, with the open end routed to a beaker), and no more air exits, close the GAS INJECTION H_2O PURGE valve (to the vertical position). Turn the 3-way valve to the CLOSED position and disconnect the temporary #7200-1108 tube. Then, quickly remove the plug from the GAS INJECTION fitting on the bottom of the vessel's stem (inside the oven), and quickly connect the Gas Injection tubing coming out of the oven wall to this GAS INJECTION fitting. Tighten the tube fitting to seal it, *using a 7/16" wrench on the stem or body of fitting to prevent it from turning, which would damage the diaphragm*. The goal is to fill the underside of the diaphragm, the stem, and the tubing all the way back to the Gas Injection check valve, with water, so that the cement sample, when later pressurized, will have something to push against, preventing the cement from trying to enter the stem and building up a filter cake on the porous metal element (Item 14) in the stem.
15. Likewise, to fill the accumulator and H_2O Confining Pressure tubing completely with water and remove air, first turn the H_2O Confining Pressure regulator knob counter-clockwise (CCW) to lower the H_2O Confining Pressure to a pressure much less than the H_2O Supply Pressure, preferably to atmospheric pressure (0 psig). Then, with the H_2O Confining Valve closed, turn the 3-way valve on the front panel to the FILL ACCUMULATOR position. The H_2O SUPPLY PRESSURE gauge will usually drop immediately when that 3-way valve is opened to the FILL ACCUMULATOR position. Allow 2 – 10 minutes (depending upon the water pressure available) for the water (H_2O Supply Pressure) to push the diaphragm downward and completely fill the top chamber of the accumulator (above the bladder) with water.
16. Then, turn the 3-way valve on the front panel to the CLOSED position and open the H_2O Confining Valve. Adjust the H_2O Confining Pressure regulator knob to a low pressure, as necessary, to push water out of the accumulator, filling the H_2O Confining Pressure tubing up to the unconnected end of the tubing, purging all the air from it. Measure all of the water pushed out of this tubing until approximately 50 – 75 cc of water is collected, then close the H_2O Confining Valve. This will start the accumulator approximately one-half full, with its bladder in the middle, allowing approximately 50 - 75 cc water to move

back into the accumulator as the cement expands during the test, and allowing approximately 50 - 75 cc water to be pushed out of the accumulator and into the underside of the diaphragm, to compensate for cement shrinkage during the test. Quickly remove the plug from the H_2O Confining Pressure port on the lower end cap of the CHA vessel, and connect the water-filled H_2O Confining tubing to this fitting, and tighten the fitting to seal it.

17. Close the oven door and preheat the oven, to the desired test temperature, but only up to a maximum temperature of 90°C (a safe limit for pre-heating, since the cell will be opened later).
18. Mix the cement slurry to be tested according to API Spec. 10, and condition it as desired in an atmospheric consistometer at the test temperature. For tests at 90°C or above, condition the cement at 90°C, to prevent vaporization of the water.
19. Open the oven door, pour the cement sample into the sample tube of the vessel, nearly to the top (to within approximately 6 mm (1/4") of the top).
20. With a lubricated O-ring installed in the upper end cap, place the upper end cap, RTD, and wafer assembly in place on top of the sample tube, with the RTD (covered with the heat-shrink TFE tubing) going down into the cement slurry.
21. Then, before purging air and applying pressure, you must:
    a. Make sure that the lower end cap is centered in place in the lower arm (Item 17 on the #7200-1010 CHA Vessel assembly drawing).
    b. Pull plunger knob (Item 19) out and rotate 90° to let it press against the vertical bar of Item 17.
    c. Rotate the upper arm (Item 18) into place above the upper end cap. The plunger should fall into place in the slot of the vertical bar of Item 17.
    d. Rotate the hand knob (Item 24) CW (clockwise) and tighten until it is tight (by hand only), tightly clamping the CHA Vessel in place, in the stand, ready to contain pressure. **This is important to prevent injury, since the arm and stand are part of the CHA vessel, and necessary to contain pressure!**
22. Connect the tubes to the H_2O Fill/Purge port and Pore Pressure port of the CHA Vessel, and tighten to seal them.
23. Close the oven door, and change the **Oven Temperature Set point** to the desired test temperature.
24. Slowly open the 3-way valve on the CHA front panel to the FILL CELL TOP position, and allow the low-pressure water to slowly fill the top of the vessel above the cement and metal wafer (baffle).
25. Then, slowly open the H_2O PURGE valve to slowly let water fill all of the top chamber above the cement, out through the H_2O PURGE valve, until it exits the H_2O PURGE tubing coming out of the back CHA instrumentation cabinet and purges all air from that volume (length of 1/8"-OD translucent PFA tubing connected to the H_2O PURGE connection on the back of the CHA cabinet, with the open end routed to a beaker, so that you can see any air bubbles being purged). Then, close the H_2O PURGE valve.
26. Turn the 3-way valve to the CLOSED position.
27. Open the H_2O Confining Valve, and adjust the H_2O Confining Pressure to either the desired test pressure, or some initially lower pressure (using the H_2O Confining Pressure regulator).
28. See the previously discussed Type 1, Type 2, or Type 3 Experiments for how to conduct the desired experiment. If you are conducting a Type 3 Experiment, see its discussion for running either a Procedure 1 or a Procedure 2. Set the H_2O Confining Pressure and Gas Injection Pressure to the desired test pressures, according to the type of test you wish to conduct.

29. The CHA Vessel and Stand, and the Cement Temperature inside, are allowed to heat and reach the desired test temperature (Oven Temperature) during the test.
30. The test should be run long enough for it to be obvious (based upon the Pore Pressure response) that gas migration either did or did not occur.

System Shutdown and Post-Test Cleanup

The Model 7200 CHA has a recommended shutdown procedure to ensure all sub-components are properly turned off and all necessary parameters are stored in the system files. If the system is shut down other than by the recommended procedure, some parameters may not be saved.

1. Turn off the Automatic or Manual data logging, if still running.
2. Turn off the oven heating by entering an Oven Temperature Set point of 0.0°C. You can also turn off the HEATER switch on the oven.
3. Lower the Gas Injection Pressure and H_2O Confining Pressure to atmospheric by turning their regulator knobs fully CCW (counterclockwise), and open the H_2O PURGE valve to release all pressure from the CHA Vessel and Stand.
4. After the oven is cooled enough to allow safely working with the CHA Vessel, open the oven door and carefully disconnect all the tubing from the vessel (in case any pressure is still trapped).
5. Remove CHA Vessel from the stand:
    a. Check again that all pressure has been released from all parts of the vessel.
    b. Rotate hand knob (Item 24 on #7200-1010 CHA Vessel w/Stand assembly drawing) CCW (counterclockwise) to raise upper arm (Item 18).
    c. Pull plunger knob (Item 19) out and rotate 90° to hold it out.
    d. Rotate upper arm 90°, out of the way of the vessel.
    e. Loosen tube fitting nut on Cement Temperature RTD, and remove RTD from vessel. The TFE tubing (Item 12) should allow the RTD to pull easily out of the cement without sticking.
    f. Raise vessel slightly from lower arm (Item 17), and tilt it and lift it to remove it from stand.
6. Disassemble the CHA vessel as necessary. Pull the upper end plug (with RTD, if still connected, and metal wafer/baffle) off the top of the sample tube (Item 1).
7. Pull the bottom end cap, retainer, and diaphragm/stem assembly to remove it from the bottom of the sample tube.
8. Dispose of the sample tube with cement set up in it.
9. Clean cement from all other parts, and re-use as possible. Be careful to not scratch sealing surfaces.
10. Make sure cement has not plugged the porous metal element (Item 14) inside the stem. If it has, blow it clean or replace it.
11. Inspect, and flow water through tubes, as necessary, to make sure that tubes and filters are not plugged with cement. Replace (or clean cement from) the tubes, filter elements, or filters, as necessary. To check and purge the Pore Pressure tubing and related flow path, you can connect part #7200-1109 “TUBE, PURGE, CHA, SHORT” (or make your own with two 1/8” Swagelok unions and a piece of 1/8”-OD tubing) between the unconnected H_2O Fill/Purge tubing (“Fill Cell Top”) and the Pore Pressure tubing inside the oven (with the filters still connected to these tubes exiting from the oven wall). Then, open the 3-way valve on the front panel to the FILL CELL TOP position, open the H_2O PURGE VALVE, and allow the water pressure to flow water through the tubing. If you do not see water flowing freely out through the H_2O PURGE tubing (length of 1/8”-OD translucent PFA tubing connected to the H_2O PURGE connection on the back of the CHA cabinet, with the open end routed to a beaker), then you must clean cement from the tubes and/or filter, or replace those parts.

12. Turn off the software using the File > Exit command.
13. Turn off power to the instrument.

Section 3 - Maintenance

Removing / Installing the CHA Vessel Seals

See the #7200-1010 CHA Vessel w/Stand assembly drawing for location of the seals.

1. Lubricate the O-rings.
2. Install in place, as shown on the assembly drawing.
3. Change the seals as often as necessary, based upon experience with the instrument. This frequency will mostly depend upon the temperature and pressure conditions at which the instrument is operated.
4. Use a new diaphragm (Item 6 on the #7200-1010 CHA Vessel assembly drawing) for each test.

Corrosion

Most of the CHA Vessel w/Stand are resistant to most cements and water, but after each test, rinse all parts clean with water, as necessary, to prevent corrosion.

Prevent the unused CHA Vessel sample tubes from corroding that may prevent sealing on the ends. These are made of carbon steel, and will rust easily if not protected.

Cleaning

The CHA was designed to be used with cement slurries only. No hazardous materials or contamination of materials should take place if the instrument is used as intended.

Clean the CHA with soap and water, if necessary.

Note:

- It is the responsibility of the user to appropriately decontaminate in case of spillage of hazardous materials on or inside the instrument.
- Do not use decontamination or cleaning agents, other than soap and water, that could cause a hazard because of a reaction with parts of the equipment or with material contained with it.
- Contact Chandler Engineering if there is any doubt about the compatibility of decontamination or cleaning agents with parts of the equipment or material contained in it.

Suggested Maintenance Schedule

1. As previously mentioned, change the seals as often as necessary, based upon experience with the instrument. This frequency will mostly depend upon the temperature and pressure conditions at which the instrument is operated.
2. As previously mentioned, use a new diaphragm (Item 6 on the #7200-1010 CHA Vessel assembly drawing) for each test.
3. As mentioned in the System Shut-down and Post-test Cleanup portion of previous Section 2 (Operating Instructions), check after each test for any cement which may have plugged or restricted any tubing or filters, and clean or replace parts as necessary.
4. No other periodic maintenance should be necessary.

Section 4 - Calibration

Note: The pressure transducers, RTDs, and flow meters were all calibrated by their respective manufacturers. See their calibration sheets in the accompanying document package. The CHA instrument's measurements of pressures, temperatures, and flow rates (using those transducers, RTDs, and flow meters) were all calibrated at Chandler Engineering.

Pressure Calibration

The three pressure transducers used by the Model 7200 CHA are very-high-accuracy (+/- 0.1% of Full Scale) transducers. These transducers output a linear 0-5VDC signal corresponding to 0-1000 psig. This signal is read by the data-acquisition module and the CHA-Control software converts this voltage to a pressure value according to the calibration scaling entered on the calibration screen for that transducer. The procedure is identical for all three pressures.

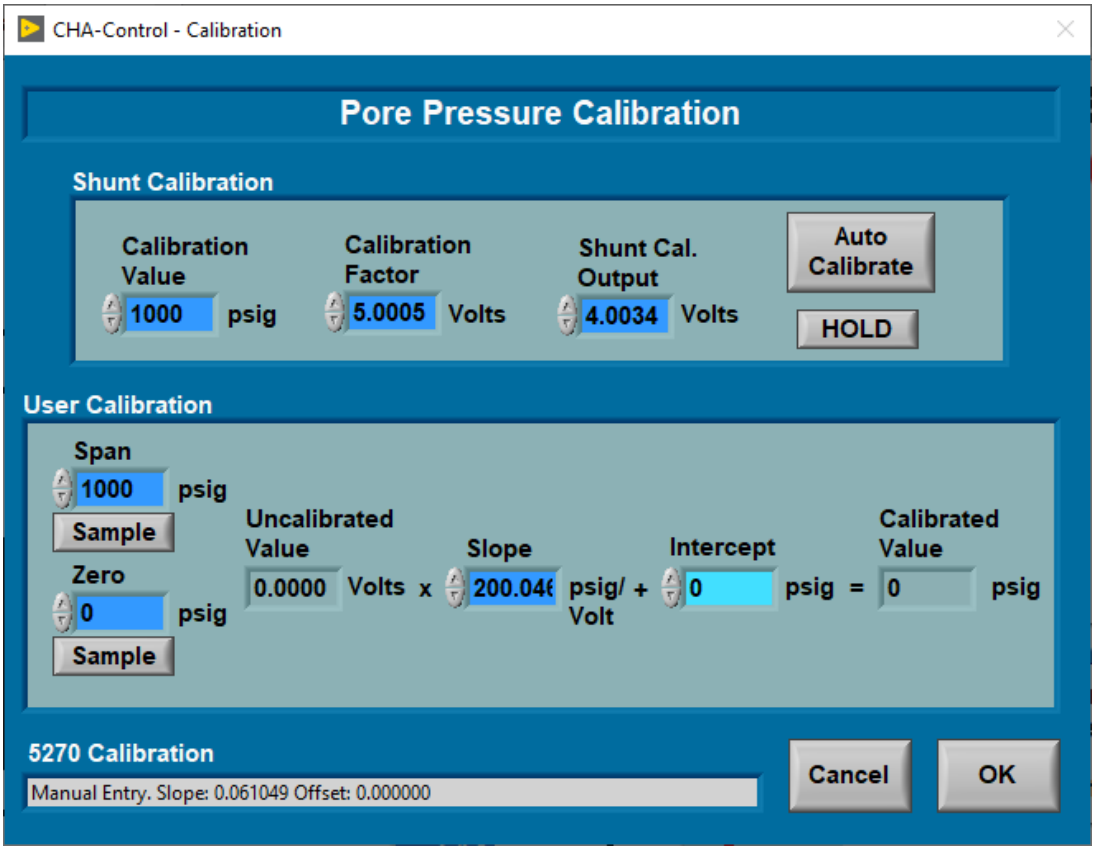

Figure 13 - Pressure Calibration

There are three methods of calibration:

1. **Auto Calibrate (Recommended):** Let the software use the Shunt Calibration feature of the transducer to automatically calibrate it and scale the conversion from voltage to pressure.
2. **Span and Zero Calibration:** Apply exactly known pressures to the transducer and the software will calculate the Slope and Intercept.
3. **Manual Entry:** Manually enter a Slope and Intercept.

Auto Calibration (recommended)

- Enter the full-scale pressure range (1000 psig) in the **Calibration Value** control.
- Enter the **Calibration Factor**: (Volts output at full-scale pressure) from the manufacturer's calibration sheet.
- Enter the **Shunt Cal. Output** (Volts output when Shunt is active) from the manufacturer's calibration sheet.
- Open the transducer to atmospheric pressure.
- Click the **Auto Calibrate** button. The software will automatically close a relay to activate the transducer internal shunt-calibration mode. The software reads the output from the transducer and automatically calculates **Slope** and **Intercept**. The software then opens the shunt relay and returns to normal operation.

Span and Zero Calibration

- Open the transducer to atmospheric pressure.
- Enter Zero (0) in the **Zero** control and click the **Sample** button below the control. The software will calculate Slope and Intercept. Ignore these values for now.
- Apply an exactly known pressure to the transducer. Often, the transducer being calibrated is removed from the instrument but still electrically connected. This pressure does not have to be the maximum of the transducer (1,000 psig) but a better calibration is achieved when the known pressure is close to the limit.
- Enter the known pressure in the **Span** control and click the **Sample** button below the control. The software will calculate Slope and Intercept.
- The pressure can be removed and the transducer re-installed (if applicable).

Manual Entry

This method uses data from the manufacturer's calibration sheet for the appropriate transducer (in accompanying document package).

- Note the "CALIBRATION FACTOR" (full-scale output voltage, at full-scale pressure).
- Divide the full-scale pressure (units of psig) by this CALIBRATION FACTOR and enter that scaling factor (psig/Volt) in the **Slope.** For example, if the CALIBRATION FACTOR for the transducer is 5.004 Volts DC, then **Slope** = 1000 psig / 5.004 Volts = 199.840 psig/Volt.
- To Zero the transducer, open it to atmospheric pressure and note the **Calibrated Value**, psig on the calibration screen. If it is not zero, enter a value in the **Intercept** entry box to make the **Calibrated Value** equal to 0.0 psig. For example, if the **Intercept** is currently 0 psig, and the **Calibrated Value** is currently shown as 6 psig, enter a value of -6 for the **Intercept.** The **Calibrated Value** should now equal 0 psig.

You can occasionally, manually re-zero the transducer, to correct for drift over time, by adjusting the **Intercept** value of the **User Calibration**.

The **5270 Calibration** shows the Manual Entry calibration values to use in the 5270 DACS software so the pressure read by 5270 matches the CHA software.

Flow Rate Calibration

The two flow meters used by the Model 7200 CHA are very-high-accuracy (+/- 1% of Full Scale) gas mass flow meters (transducers). These transducers output a linear 0-5VDC signal corresponding to 0-1000 sccm (standard cubic centimeters per minute). This signal is read by the data-acquisition module and the CHA-Control software converts this voltage to a flow rate value according to the calibration scaling entered on the calibration screen for that meter. The procedure is identical for both meters.

The flow rate is expressed as an equivalent volumetric flow rate of a specific gas (N_2, in this case) at a chosen Standard Pressure (760 mm Hg = 14.696 psia = 1.00 atm. = 101.325 kPa = 1.01325 bar) and Standard Temperature (70°F = 21.1°C).

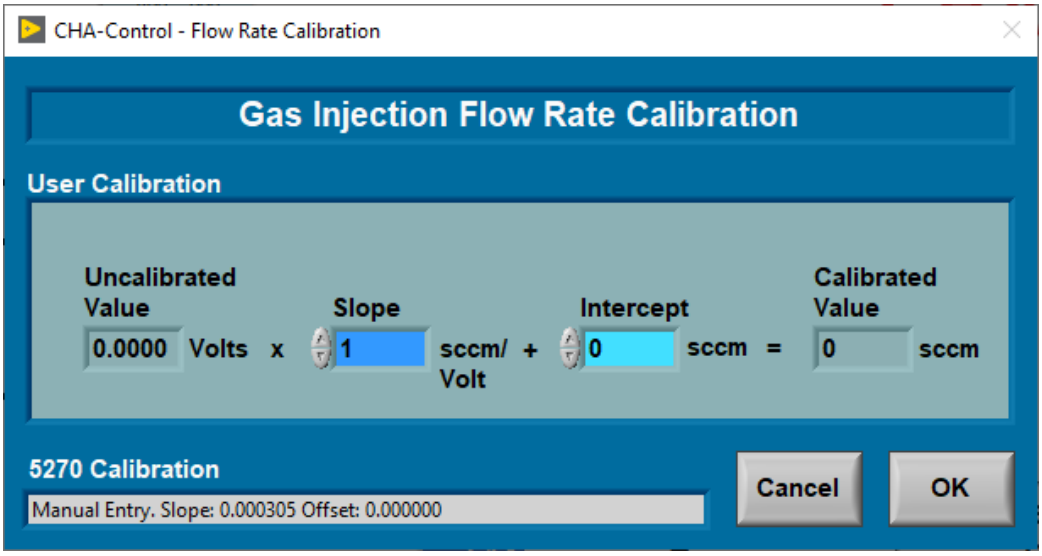

Figure 14 - Flow Rate Calibration

Unlike the pressure transducers, the flow meters can only be calibrated by manually. From the manufacturer's calibration sheet for the appropriate meter, note the full-scale output voltage at full-scale flow rate. Divide the "Full Scale Flow" rate (units of sccm) by this full-scale output voltage and enter that scaling factor (sccm/Volt) in the **Slope** control For example, if the full-scale output voltage for the transducer is 5.0 Volts DC, then **Slope** = 5 sccm / 5.0 Volts = 1.000 sccm/Volt.

To Zero the flow rate, close the appropriate Valve to stop all flow. Allow the meter reading to stabilize. If the **Calibrated Value** is not zero, enter a value in the **Intercept** entry box to make the **Calibrated Value** equal to 0.0 sccm. That is, if the **Intercept** is currently 0 sccm, and the **Calibrated Value** is currently shown as 0.2 sccm, enter a value of -0.2 for the **Intercept**. The **Calibrated Value** should now read 0 sccm.

Note that each flow meter is calibrated by its manufacturer to be within stated accuracy for only a specific gas (N_2), only at the calibrated inlet pressure to the flow meter, and only within a certain range of ambient temperature.

Each flow meter is calibrated for an inlet pressure of 1000 psig, which is the maximum working pressure of the CHA instrument. If conducting cement hydration tests at lower pressures, the flow rate will not be accurate within the stated accuracy but will be sufficiently accurate for the purposes of the CHA instrument's use of the measured flow rate.

Click **Cancel** to abort and not use any recalibration you have performed or click **OK** to save the calibration parameters and use them to measure flow rate.

The **5270 Calibration** shows the Manual Entry calibration values to use in the 5270 DACS software so the pressure read by 5270 matches the CHA software.

Temperature Calibration (RTD)

The two RTDs (Resistive Temperature Devices) used by the model 7200 CHA are very-high-accuracy (+/- 1% of Full Scale) RTDs, which provide a changing resistance linearly proportional to the temperature.

These are standard 3-wire Platinum 100-ohm RTDs using the European/DIN temperature coefficient (α = 0.00385 ohms/ohm/°C), meeting the high-accuracy Class A tolerance. The Class A tolerance specifies that the maximum deviation in resistance (output) is +/- 0.06 ohms (+/- 0.15°C) at 0°C, +/- 0.13 ohms (+/- 0.35°C) at 100°C, and +/- 0.20 ohms (+/- 0.55°C) at 200°C.

Each RTD is provided with a factory calibration (at 0°C, 100°C and 200°C) sheet, which is found in the document package.

This resistance is read by the data-acquisition module, converted to a value of temperature (°C) and then the CHA-Control software converts the **Uncalibrated Value** to a **Calibrated Value** according to the calibration scaling entered on the calibration screen for that temperature.

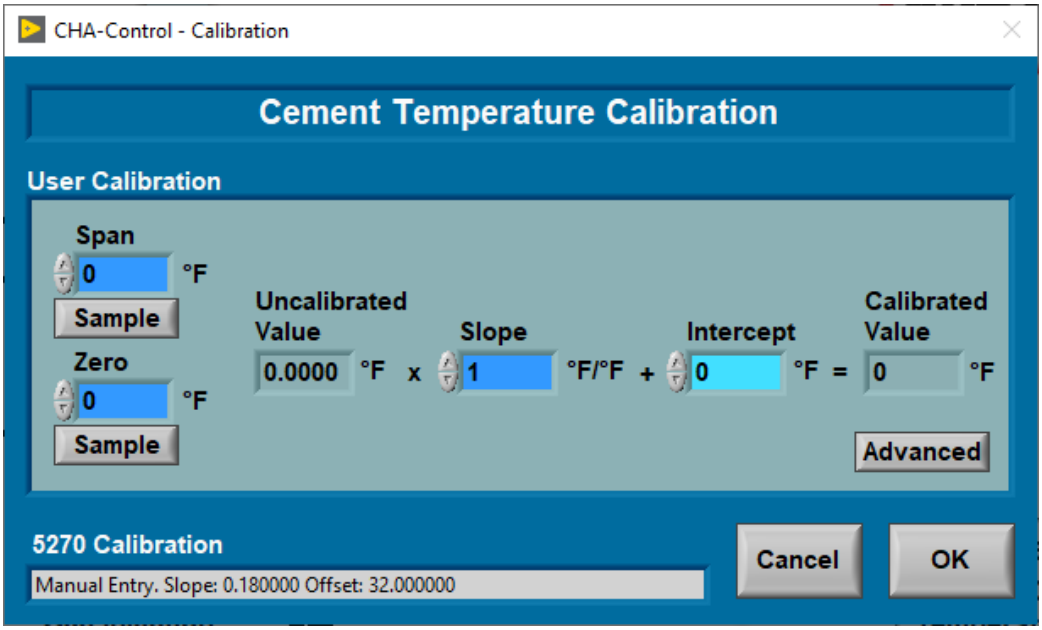

Figure 15 - Temperature Calibration

Unlike the pressure transducers, the temperatures can only be calibrated manually. To perform the calibration, place the RTD in a traceable temperature standard calibrator. The procedure is identical for both RTDs.

Use the calibrator block to heat or cool the RTD to a known temperature. Allow the sensor to stabilize. Note the known calibrator temperature vs. the **Uncalibrated Value** temperature.

Perform this calibration at several temperatures, spanning the entire range of the CHA (20°C to 163°C).

Draw a straight line through the data (or otherwise calculate a linear curve fit through the data to obtain a **Slope** value of known °C / **Uncalibrated Value** °C to be entered in the **Slope** control.

Likewise, from this same curve fit, obtain the **Intercept** value to be entered in the **Intercept** control.

Click **Cancel** to abort and not use any recalibration you have performed or click **OK** to save the calibration parameters and use them to measure temperature.

Temperature Calibration (Oven)

The two thermocouples used by the Model 7200 CHA to measure **Oven Temperature** (and independently measure the same for the **Hi-Limit** controller) are standard type J thermocouples which provide a changing voltage output relative to the temperature.

The CHA-Control software reads the **Oven Temperature** from the **Oven Temperature** controller. The CHA-Control software uses the **Oven Temperature**, as read from and displayed by the controller with no further conversion or correction.

The CHA-Control software does not read, display, or use the Hi-Limit Temperature.

These temperatures are calibrated by Chandler Engineering. If you wish to perform a re-calibration of the Oven Temperature, use Step 5 of the procedure 7200-1060 to calibrate it to match the Cement Temperature sensor (RTD), after first calibrating the Cement Temperature according to the previous section.

If you wish to calibrate the Hi-Limit Temperature, Chandler Engineering recommends that you first place the thermocouple in a traceable temperature standard calibrator.

Use the calibrator block to heat or cool the thermocouple to a known, actual traceable temperature, and make a note of the actual known calibrator temperature vs. “actual” temperature as displayed on the **Hi-Limit** temperature controller front panel.

Perform this calibration at several temperatures, spanning the entire range of the CHA instrument’s range (approx. ambient temperature 20°C to 163°C).

Draw a straight line through the data (or otherwise calculate a linear curve fit through the data. If the temperature as read by the controller is outside your acceptable limits of accuracy, you can simply enter a necessary offset correction value as the “SHif” (“PV Shift”) parameter in the Hi-Limit temperature controller (See the manufacturer’s instruction manual for the controller, for details of how to access, enter, and save this value).

Please note that in the oven instruction manual, you should ignore most of the details for how to set its Oven Temperature controller because the controller was replaced at Chandler Engineering.

See procedure 7200-1060, and the controller manual, on how to properly set up the controller.

Suggested Recalibration Schedule

1. Before each test, you should “zero” each transducer via its software calibration screen (as mentioned above): Pore Pressure, H_2O Confining Pressure, Pore Pressure, H_2O Confining Flow Rate, and Gas Injection Flow Rate.
2. All the pressure, temperature, and flow rate measurements should be recalibrated, as mentioned in the previous section, as often as you desire. Chandler Engineering suggests recalibrating every 6 months.

Section 5 - Troubleshooting Guide

PROBLEM	SOLUTION
Software is not recognizing the instrument.	Close the CHA-Control software, turn off the instrument, and restart the computer. Apply power to the instrument, wait 30 seconds, and then start the software. Check all cables to make sure that they are plugged in completely.
Air Bath is not heating.	Check the HI-LIMIT temperature controller on the oven's front panel, to see if a temperature limit has been reached, causing the HI-LIMIT controller to turn off the heaters and latch in the OFF state. Press the RESET key to resume heating.
H_2O Confining Pressure or Gas Injection Pressure will not increase to desired test pressure.	Check to make sure that the necessary minimum nitrogen Gas Supply Pressure is connected to the Gas Supply Pressure bulkhead fitting on the back of the instrumentation cabinet, and that the GAS SUPPLY VALVE is open.
During initial setup of the test, and pressurization of the cement, there is no pressure communication between the H_2O Confining Pressure and the Pore Pressure (Pore Pressure is not affected by H_2O Confining Pressure).	Check to see that the appropriate valves are opened. Check for plugged tubing in the lines between the cell and the valves, fittings, and accumulator in the instrumentation cabinet. Air underneath diaphragm, or improper filling and setup of accumulator, allows accumulator to empty (run out of stroke, with bladder at top, with no more water in accumulator), so that increasing H_2O Confining Pressure can no longer increase the Pore Pressure. Solution: either (1) discard cement sample, disassemble and refill lower assembly (underneath diaphragm) with water, without any air inclusion, and begin new test, or (2) disconnect H_2O Confining Pressure tube at cell and repeat initial filling and setup of accumulator with water, except purge only 25 ml of H_2O from accumulator, to begin test with approx. 75 ml of H_2O (and 25 ml of N_2) in the accumulator, to allow injection of more H_2O to pressurize the cement before emptying the accumulator.
N_2 Flow Rate or H_2O Flow Rate will not reach 0.00 sccm, +/- 0.05 sccm, with GAS INJECTION VALVE and H_2O CONFINING VALVE closed.	Check for gas leaks using soapy water (such as Chandler Engineering part #55-400).

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Section 6 - Replacement Parts

For replacement parts, see the following listings of the Spare Parts Kits:

Drawing Number	Description
7200-ACCESS	Accessory Kit, 7200, CHA
7200-SP	Spares Kit, CHA, 1-yr.
7200-1010-SK	Seals Kit, CHA Vessel
7200-TOOLS	Tool Kit, CHA

For parts not included in the above Spare Parts Kits, see the assembly drawings and/or bill of material of the sub-assembly which contains the part, located in *Section 7 - Drawings and Schematics* or the component manufacturer's instruction manual.

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Section 7 - Drawings and Schematics

Drawing	Description
7200A	Cement Hydration Analyzer
7200-1010	Vessel w/Stand, CHA
7200-1010-1061	Proc, Pressure Test, CHA
7200-1020	Diagram, Plumbing, CHA
7200-1030	Diagram, Wiring, CHA
7200-1042	Proc, CHA-Control Software Installation
7200-1060	Proc, CHA Temp Controller Setup

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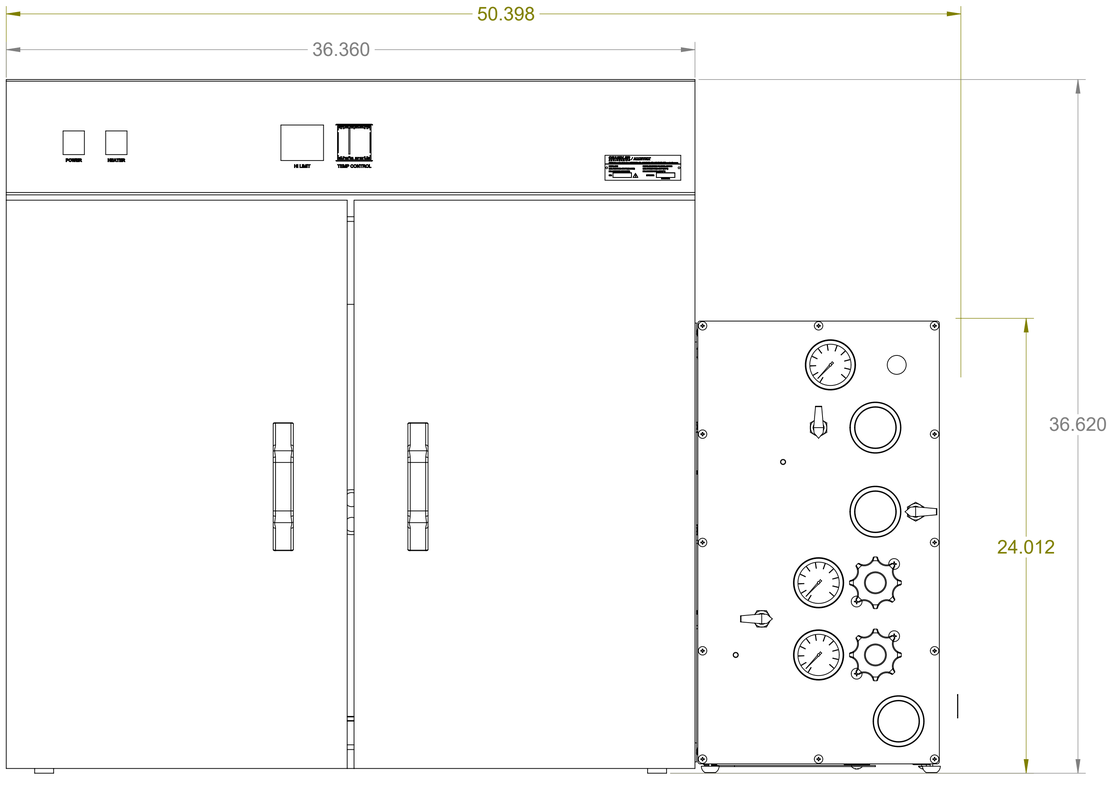
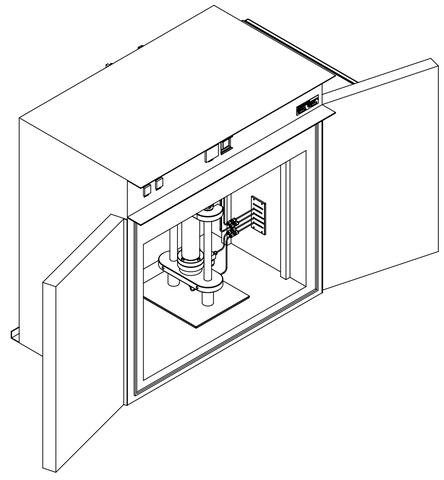
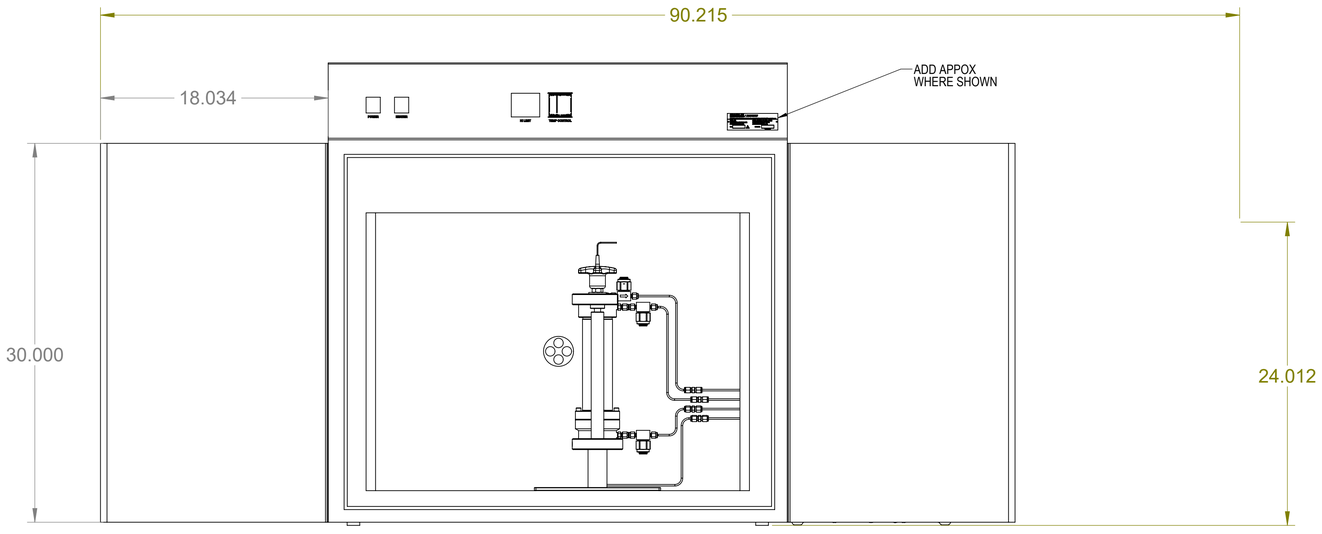
REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
	Q	ECN T6632: ADD C15756,C14023,7200-0084	6/12/2015	TC
	T	ECN T7152: UPDATED BOM	3/29/16	TC
	U	ECN T7249: ADDED ASSY VIEWS, RENUMBERED BOM	4/19/16	TC
	V	ECN T414: CHANGED QTY FROM 10" TO 72" FOR ITEM 58.	10/5/2016	JS
	W	ECN T8968: REPLACED C09772 W/ C17605	7/24/2020	JS
	Y	ECN T9115: ADDED C11266	2/22/2021	JS
	AA	ECN T9893: REPLACE 7200-0084 W/ 7200-1084	6/13/2024	JS
	AB	ECN 10345: AS BUILT CHANGES	5/7/2025	JS

NOTES:
1. PLUMBING IS FOR VISUAL PURPOSES ONLY TO SHOW COMPONENT CONNECTION. ROUTE TUBING IN THE BEST WAY FEASIBLE.





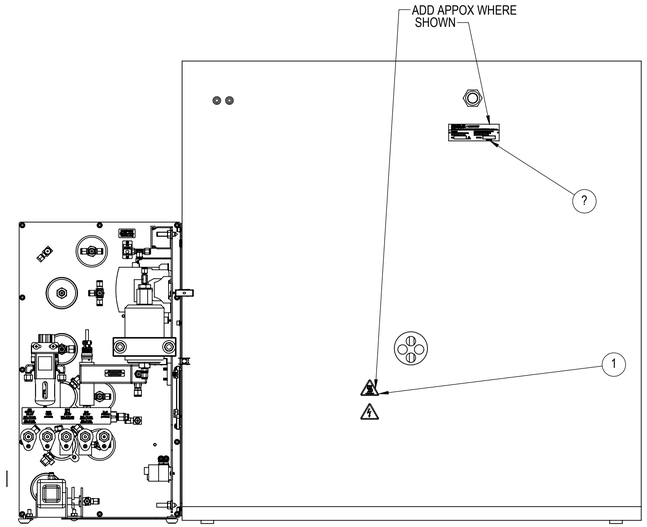


BREAK EDGES, DEBURR
UON DIMS ARE IN INCHES
1 PLC ±0.030 2 PLC ±0.010
3 PLC ±0.005 ANGL ±1/2°
SURFACE FINISH 63 RMS
THIRD ANGLE PROJECTION

DRAWN: DAH 2/1/2000
MFG: JJM 2/1/2007
ENGR: JJM 2/2/2007
TYPE:
STRUCT:

CHANDLER ENGINEERING
CEMENT HYDRATION ANALYZER
PN: 7200A
PROJ:
REV AB SIZE D
SHEET 1 OF 6

TITLE BLOCK REV 3



VIEW A-A
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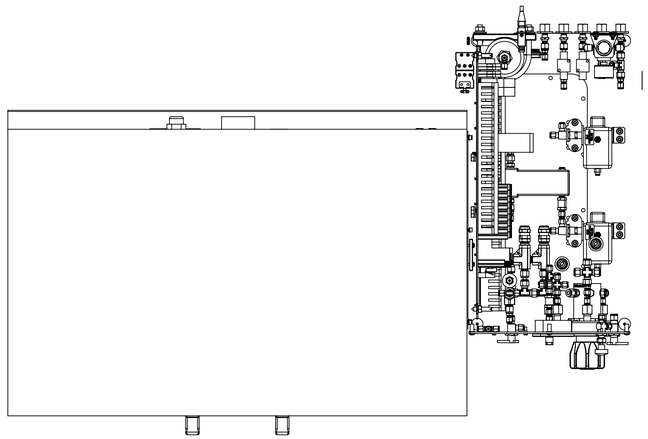
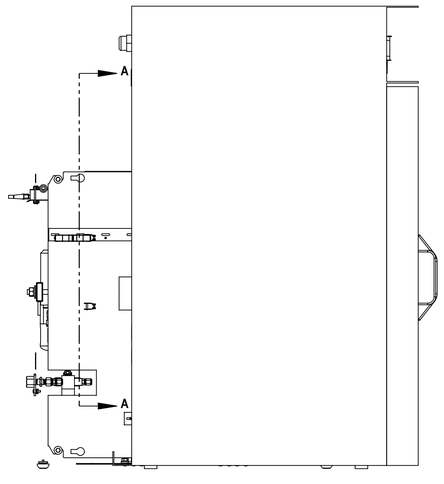
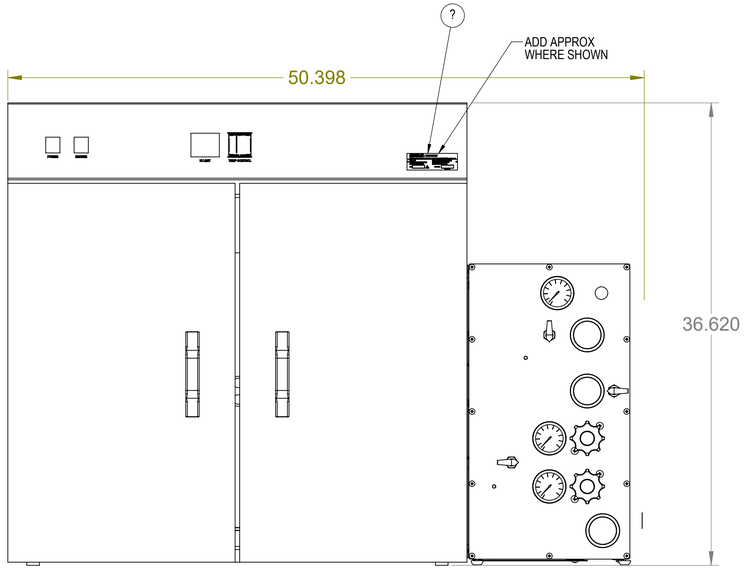
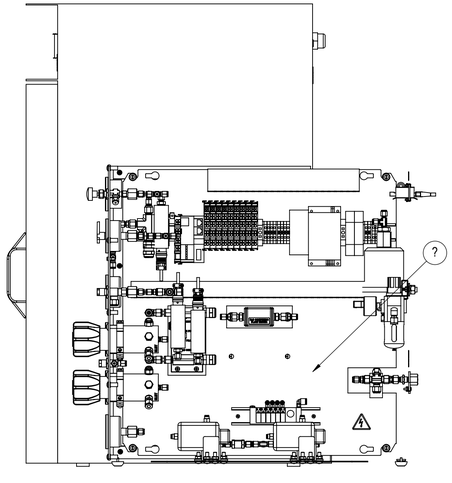






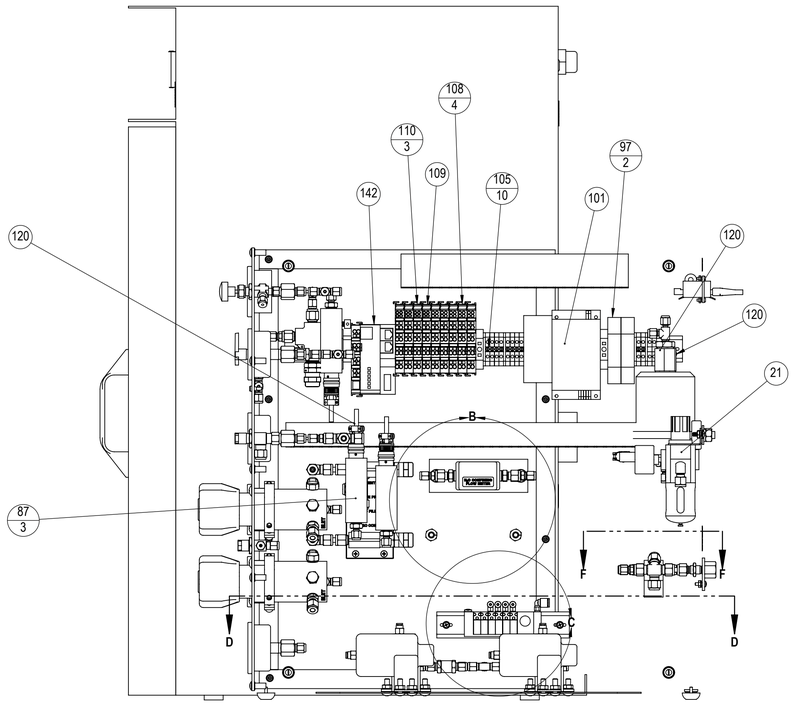


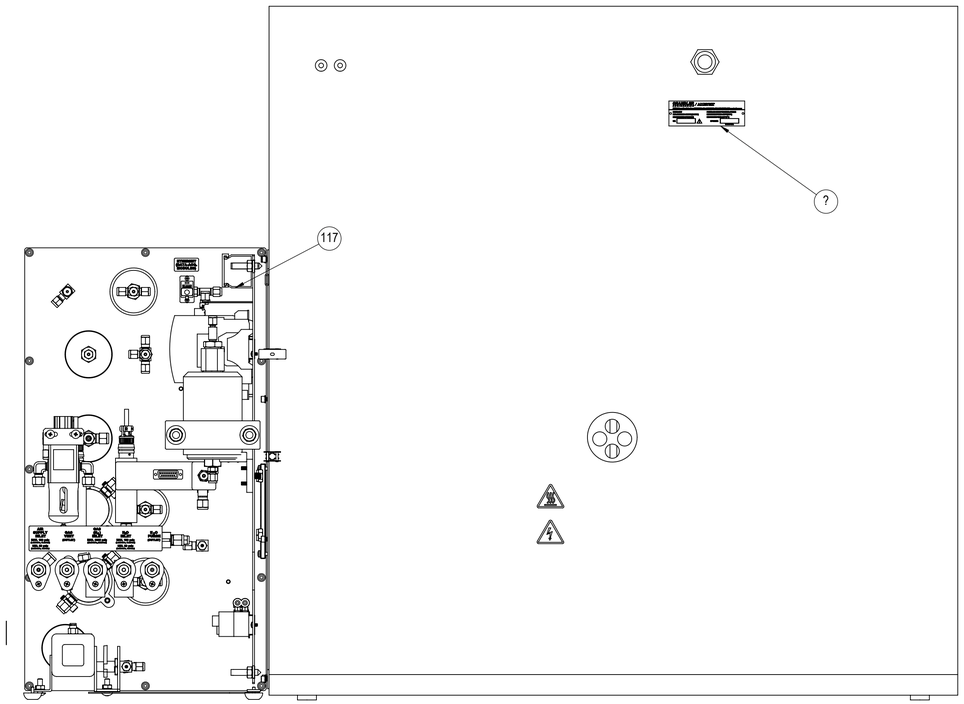
BREAK EDGES, DEBURR
UON DIMS ARE IN INCHES
1 PLC ±0.030 2 PLC ±0.010
3 PLC ±0.005 ANGL ±1/2°
SURFACE FINISH 63 RMS
THIRD ANGLE PROJECTION

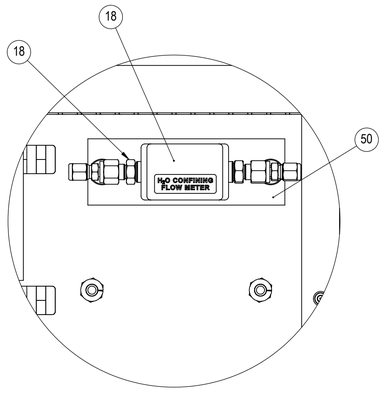
DRAWN: DAH 2/1/2000
MFG: JJM 2/1/2007
ENGR: JJM 2/2/2007
TYPE:
STRUCT:

CHANDLER ENGINEERING
CEMENT HYDRATION ANALYZER
PN: 7200A
PROJ:
REV AB SIZE D
SHEET 2 OF 6

TITLE BLOCK REV 3







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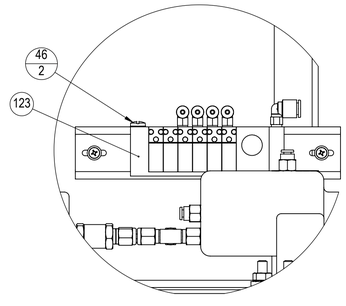

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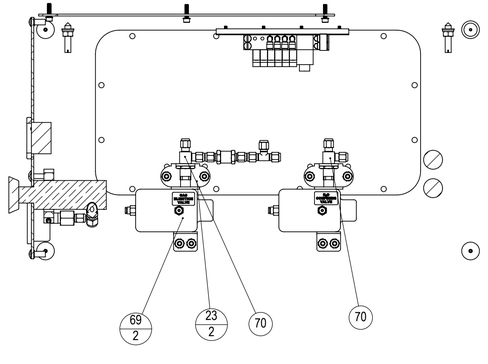

SECTION D-D
SCALE 1 : 4

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3 PLC ±0.005 ANGL ±1/2°
SURFACE FINISH 63 RMS
THIRD ANGLE PROJECTION

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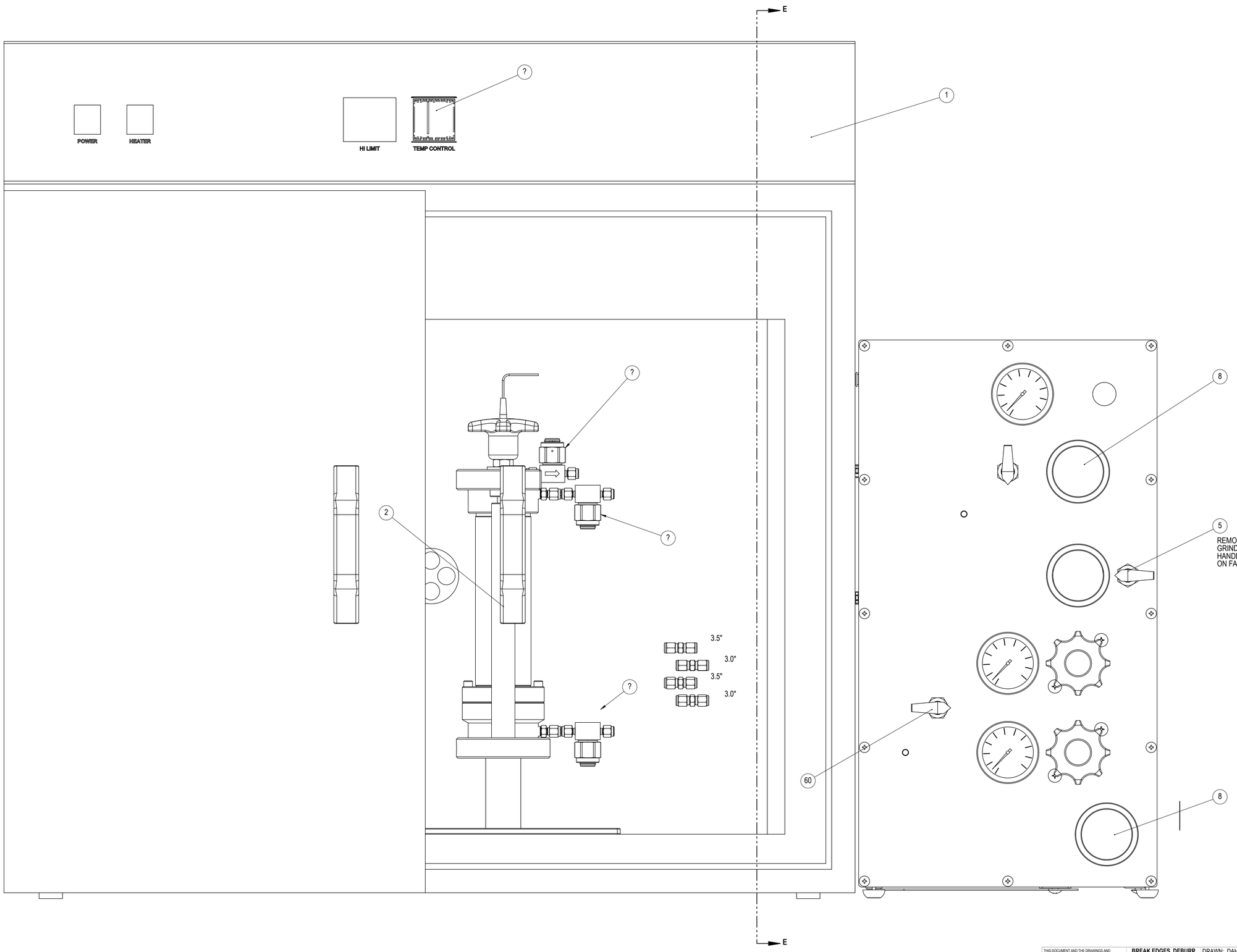
ENGR: JJM 2/2/2007
TYPE:
STRUCT:

CHANDLER ENGINEERING
CEMENT HYDRATION ANALYZER
PN: 7200A
PROJ:
REV AB SIZE D
SHEET 3 OF 6

TITLE BLOCK REV 3



BREAK EDGES, DEBURR
UON DIMS ARE IN INCHES
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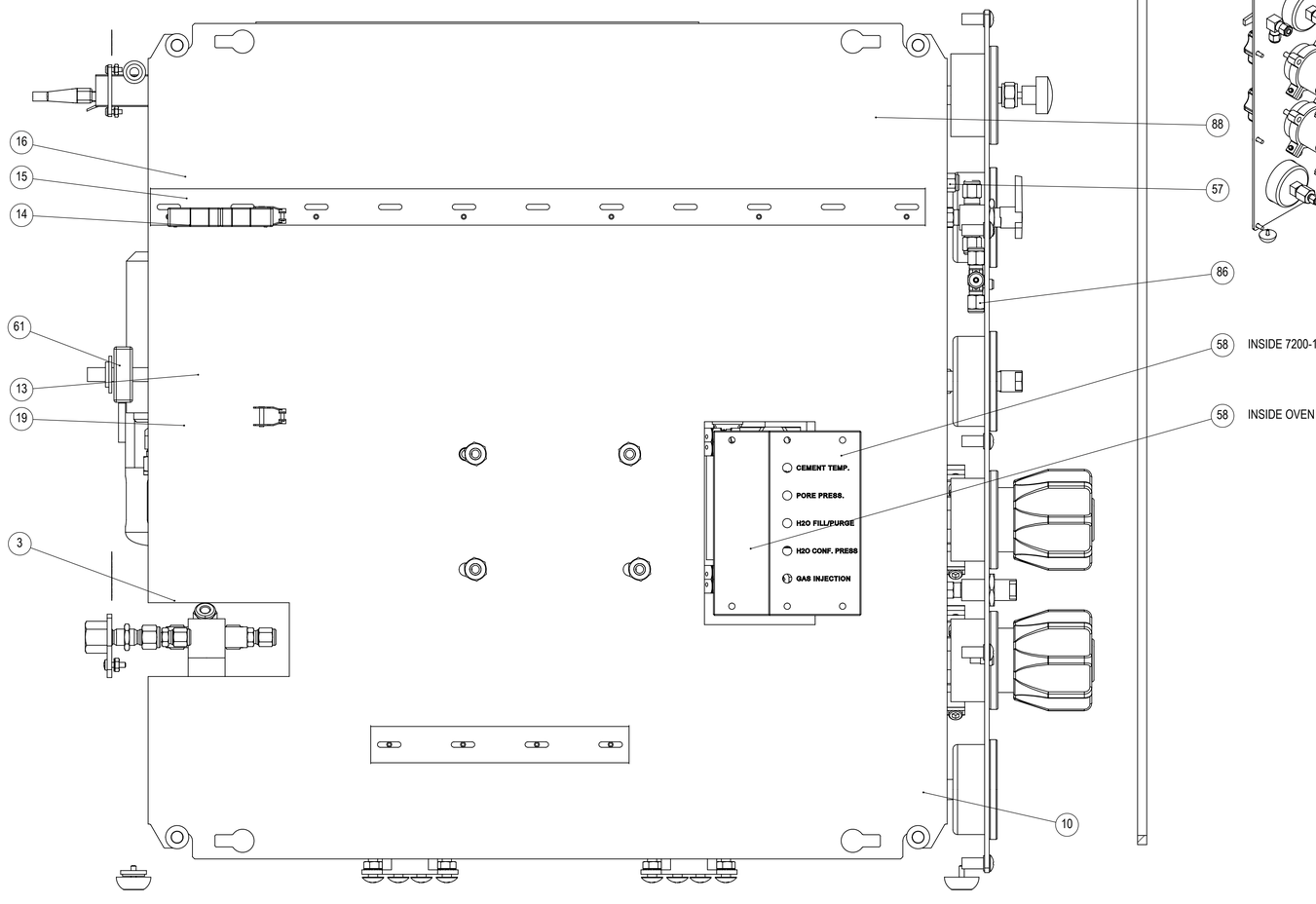
3 PLC ±0.005 ANGL ±1/2°
SURFACE FINISH 63 RMS
THIRD ANGLE PROJECTION

DRAWN: DAH 2/1/2000
MFG: JJM 2/1/2007
ENGR: JJM 2/2/2007
TYPE:
STRUCT:

CHANDLER ENGINEERING
CEMENT HYDRATION ANALYZER
PN: 7200A
PROJ:
REV AB SIZE D
SHEET 4 OF 6
TITLE BLOCK REV 3



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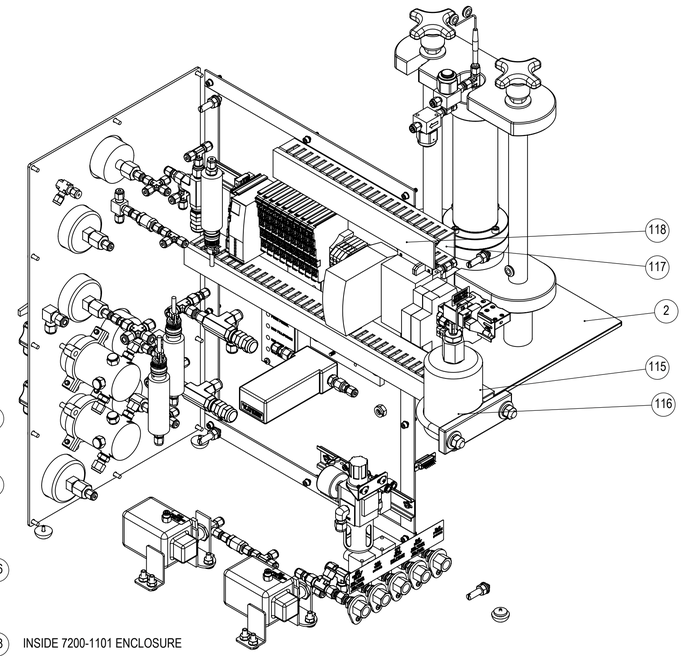

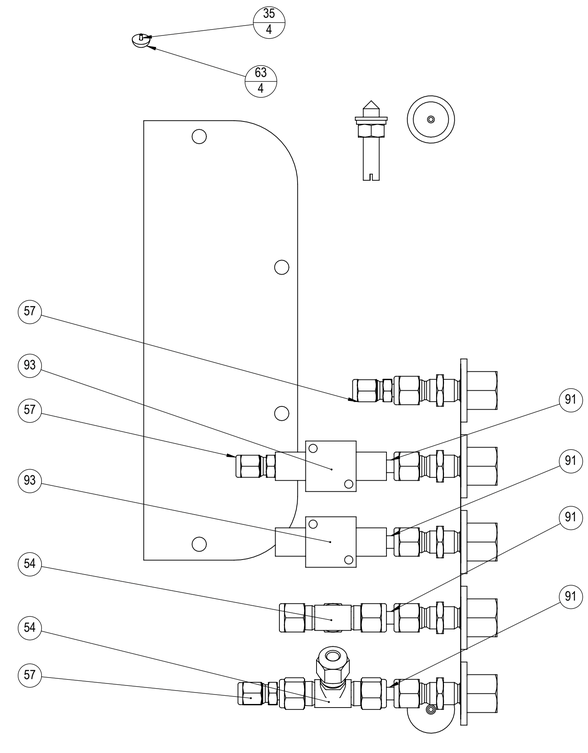

SECTION F-F
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3 PLC ±0.005 ANGL ±1/2°
SURFACE FINISH 63 RMS
THIRD ANGLE PROJECTION

DRAWN: DAH 2/1/2000
MFG: JJM 2/1/2007
ENGR: JJM 2/2/2007
TYPE:
STRUCT:

CHANDLER ENGINEERING
CEMENT HYDRATION ANALYZER
PN: 7200A
PROJ:
REV AB SIZE D
SHEET 5 OF 6

TITLE BLOCK REV 3

ITEM	PART NUMBER	DESCRIPTION	QTY	UoM
71	C09532	CONN,PNEU,1/8MPTX1/8T	4	
72	C09705	CONN,PORT,1/8	12	
73	7200-1110	DECAL SET, 7200 CHA	1	
74	C09712	CONN,BULKHEAD RJ45,BLACK PLSTC	1	
75	C09298	FILTER,TEE,SS,7 MICRON,1/8T	3	
76	C11324	ELEMENT,40 MICRON,SST	3	
77	C09238	SPRING KIT,PUR,R3A,750-1500	3	
78	7200-1020	DIAGRAM,PLUMBING,CHA	1	
79	7200-1030	DIAGRAM,WIRING,CHA	1	
80	7200-1041	SOFTWARE,CHA-CONTROL	1	
81	7200-1060	PROC,CHA TEMP CONTROLLER SETUP	1	
82	7200-1061	PROC,MODEL 7200 TEST AND SETUP	1	
83	7200-1050	MANUAL,7200 CHA	1	
84	7200-1042	PROC,CHA-CONTROL SFTWR INSTAL	1	
85	P-2053	PLUG,ELEC,250V,15A,3WIRE	1	
86	C08361	CROSS,SS,1/8T,SW	4	
87	C11264	XDCR,1000 PSI,+/-0.1%	3	
88	70607-85	TEE,UNION,SS,1/8T,HP	3	
89	P-1941	CROSS,SS,1/4T,SW	1	
90	25-131	PLUG,PIPE 1/4 CAJON SS-4-9	4	
91	C09704	CONN, PORT, 1/4	6	
92	C09434	VALVE,RLF,SS,1/4TX1/4T,6000PSI	3	
93	C09714	FILTER,TEE,2 MICRON,1/4T,SS	2	
94	C09890	FILTER,ELEM,SS,60 MICRON	1	
95	C08226	STOP,END,DIN RAIL	4	
96	C09742	BLOCK,TERM,DIN,M4/6,2COND,G/Y,GRND	2	
97	C15158	BREAKER,5A,TYPE D,DIN,1P	2	
98	C10435	BLOCK,TERM,DIN,M4/6,2COND,WHT	2	
99	C07991	END PLATE,GRY,ENTRELEC,2.5/10MM	4	
100	C09529	ELBOW,PL,1/4TX10-32,PNEU	2	
101	C11082	POWER SUPPLY,3 OUTPT,+/-15V,5V	1	
102	C10999	POWER SUPPLY,SW,DIN,24VDC,2A,WAGO	1	
103	C09738	BLOCK,TERM,DIN,M4/6,2COND,BLU	4	
104	C09743	JUMPER BAR,20 POLE	2	
105	C09744	KIT,SCREW ASSEMBLY	10	
106	C09739	BLOCK,TERM,DIN,M4/6,2COND,RED	4	
107	C10998	MODULE,WAGO END,750-600	1	
108	C11262	MODULE,RELAY,2-CH SPST	4	
109	C11261	MODULE,ANALOG IN,2-CH RTD	1	
110	C11260	MODULE,ANALOG IN,2-CH +/-10V	3	
111	C17605	CONTROLLER,EUROTHERM,EPC3016,1/16DIN,1OP	1	
112	C11084	LED,GREEN,24VDC	2	
113	P-3044	CONN,15 PIN DSUB,117D-DA15S	2	
114	C07959	HOOD ,CONN,AMPHENOL #17-1725-2	2	
115	C10481	DUCT,WIRING,1" X 2",LIGHT GREY	1	FT
116	C09692	COVER,WIRE DUCT,1",GREY	1	FT
117	C09573	DUCT,WIRE,1.5"X1.5",GREY	2	FT
118	C09574	DUCT,COVER,1.5"W,GREY	2	FT
119	C09703	CONN, REDUCING PORT, 1/4 X 1/8	1	
120	C10849	CABLE,6 COND,15-FT.,W/CONN	3	
121	C10749	CLAMP,CABLE, 3-POLE RTD CONN.	2	
122	C10748	RTD,1/8"ODX4.5",3-WIRE,W/CONN.	2	
123	C09946	MANIFOLD,AIR,6 POSITION	1	
124	C09527	VALVE,SOL,RS,PLUG-IN,3WY,24VDC	6	
125	C09528	ELBOW,SS,1/8TX10-32,PNEU	4	
126	C10024	GASKET,SMC,M-5G1	2	
127	82-433	TAPE SILICONE 3/16X1X5YD	1	
128	C10747	WIRE,RTD EXT., 3-COND.,PFA	6	
129	R-0645	SS,TBG,0.125X0.035W,316	40	
130	Q5-C-1241	TEFLON,TBG,0.125X0.030W	72	IN
131	R-0631	SS,TBG,0.250X0.035W,316	6	
132	R-1389	TEFLON,TBG,0.250X0.062W,PFA	6	
133	C09585	TUBE,8RIBBON,1/16ID,POLY,COLOR	2	
134	94-212	WIRE,18-35V BELDEN #8453	10	
135	8-732	CABLE BELDFOIL SHLD 3PRS 8777	6	
136	C16803	CORD,3 COND,14 AWG,600V,SOOW,GRN/YEL,BLU,BRN	10	
137	C07994	DIN RAIL,35MM	2	
138	C10127	CABLE,DB9 M/F 25FT MOLDED	1	
139	C10592	CABLE,ETHERNET,RJ45/45 CAT5	1	
140	C09470	CABLE,ETHERNET CROSSOVER	2	

ITEM	PART NUMBER	DESCRIPTION	QTY	UoM
1	C16485	OVEN,6.9 CU.FT.,204C,240VAC	1	
2	7200-1200	VESSEL W/STAND,CHA	1	
3	7200-1101	ENCLOSURE,CHA	1	
4	C09432	VALVE,BALL,SS,1/8T,3WY-STD	1	
5	C11271	VALVE,BALL,SS,1/4T,2WY-ANG	1	
6	C09367	VALVE,NDL,SS,1/8TX1/8T,2WY-ANG	1	
7	C08802	GAUGE,2000PSI,2.5",1/4NPT,CBM	3	
8	C11273	GAGE160PSI,2.5",DUAL	2	
9	C10333	GAUGE,3000PSI,2.5",1/4NPT,CBM,PSI/KPA	1	
10	C08517	CONN,SS,1/4FPT X 1/8T,SW	6	
11	C09283	CONN,SS,1/4FPTX1/4T,BHD,SW	5	
12	C11269	ACCUMULATOR,7 CU.IN.,SS	1	
13	C11274	BOLT,U,3.5IDX3/8-16X4.13IL,SS	1	
14	C11268	ADPTR,FTG,SS,3/4-16MSAEX1/2FNP	1	
15	25-120	FTG 1/2NPTX1/8NPTF SS-8-RB-2	1	
16	C09327	TEE,RUN,SS,1/8TX1/8MPX1/8T	1	
17	P-1488	CONN,SS,1/4MPT X 1/4T,SW	4	
18	C11263	FLOWMETER,MASS,0-5-SCCM,N2	2	
19	7200-1115	ADAPTER,3/8BSPP-Mx1/8NPT-F,SS	1	
20	188-13044	CONN,SS,1/8MPTX1/8T,SW	1	
21	C09524	REG,FLTR,W/GAGE&MNTG BRKT	1	
22	P-1487	ELBOW,SS,1/4TX1/8MP	2	
23	C11276	BRKT,AIR-ACTUATOR/VALVE	2	
24	H-37-003	NUT,HEX,SS,3/8-16	2	
25	H-31-017	SCREW,FHMS,SS,5/16-18X0.750	4	
26	H-10-110	SCREW,THMS,SS,10-32X0.500,PHIL	12	
27	H-37-002	WSHR,LOCK,SS,3/8	2	
28	H-37-001	WSHR,FLAT,SS,3/8	2	
29	H-6002	WSHR,FLAT,SS,#6	10	
30	H-6001	WSHR,LOCK,SS,#6	10	
31	H-6009	SCREW,BHMS,SS,6-32X0.250,PHIL	10	
32	H-8001	WSHR,LOCK,SS,#8	4	
33	H-8014	SCREW,BHMS,SS,8-32X0.500,PHIL	4	
34	H-25-003	NUT,HEX,SS,1/4-20,KEPS	8	
35	H-6038	SCREW,THMS,SS,6-32X0.500,PHIL	4	
36	H-10-001	WSHR,LOCK,10,INTL T,PLD	12	
37	H-10-125	SCREW,SHCS,SS,10-32X0.750,AL	10	
38	H-31-003	WSHR,LOCK,SS,5/16	4	
39	H-31-001	NUT,HEX,SS,5/16-18	4	
40	H-25-028	SCREW,THMS,SS,1/4-20X0.75,PHIL	12	
41	H-10-110	SCREW,THMS,SS,10-32X0.500,PHIL	2	
42	H-10-101	NUT,HEX,SS,10-32	2	
43	H-4108	SCREW,PHMS,SS,4-40X0.375,PHIL	2	
44	H-4001	WSHR,LOCK,SS,#4	2	
45	H-4101	NUT,HEX,SS,4-40	2	
46	H-10-103	SCREW,BHMS,SS,10-32X0.250,SLOT	2	
47	H-6041	NUT,KEPS,SS,6-32	5	
48	H-8015	SCREW,FHMS,SS,8-32X0.500,PHIL	4	
49	C08268	RETAINER,SST,3/4ID,BHD,SW	5	
50	6100-2253	MNTG PLATE, N2 METER	2	
51	7200-1102	FRONT COVER,CHA	1	
52	C09547	REG,PRES,0-1500PSI,BR	2	
53	H-6019	SCREW,BHMS,SS,6-32X0.500,PHIL	5	
54	P-1942	TEE,UNION,SS,1/4T	5	
55	187-20403	CONN,SS,1/4MPX1/8T,SW	3	
56	70601-55	UNION,SS,1/8TX1/8T,SW	4	
57	p-1944	REDUCER,SST,1/8Tx1/4OD SW	11	
58	7200-1103	OVEN FEED-THRU BLOCK	2	
59	C03318	VALVE,CHK,SS,1/8TX1/8T,3000PSI	2	
60	C10291	VALVE,BALL,SS,1/8T,2WY-ANG	1	
61	7200-1113	BRKT,ACCUMULATOR,CHA	1	
62	7200-1106	RETAINER,INNER PANEL	1	
63	P-1233	FOOT,RUBBER,0.9687OD	4	
64	P-0066	ORING,BUNA,AS113-70	1	
65	C15746	LABEL,WARNING,HOT SURFACE HAZARD,1.00" BASE	1	
66	C14023	LABEL,WARNING,HAZARD VOLTAGE,1.00" BASE	2	
67	7200-1084	NPL,SN,PWR RATING	2	
68	C15161	CONN,.7",STRAIN RLF,LIQ TIGHT	1	
69	C11275	ACTUATOR,AIR,DOUBLE-ACTING	2	
70	C10291	VALVE,BALL,SS,1/8T,2WY-ANG	2	

ITEM	PART NUMBER	DESCRIPTION	QTY	UoM
141	7200-ACCESS	ACCESSORIES,MODEL 7200,CHA	1	
142	C11266	COUPLER,ETHERNET TCP/IP	1	
143	H-6007	SCREW,THMS,SS,6-32X0.250,PHIL	2	

BREAK EDGES, DEBURR UON DIMS ARE IN INCHES
1 PLC ±0.030 2 PLC ±0.010
3 PLC ±0.005 ANGL ±1/2°
SURFACE FINISH 63 RMS
THIRD ANGLE PROJECTION

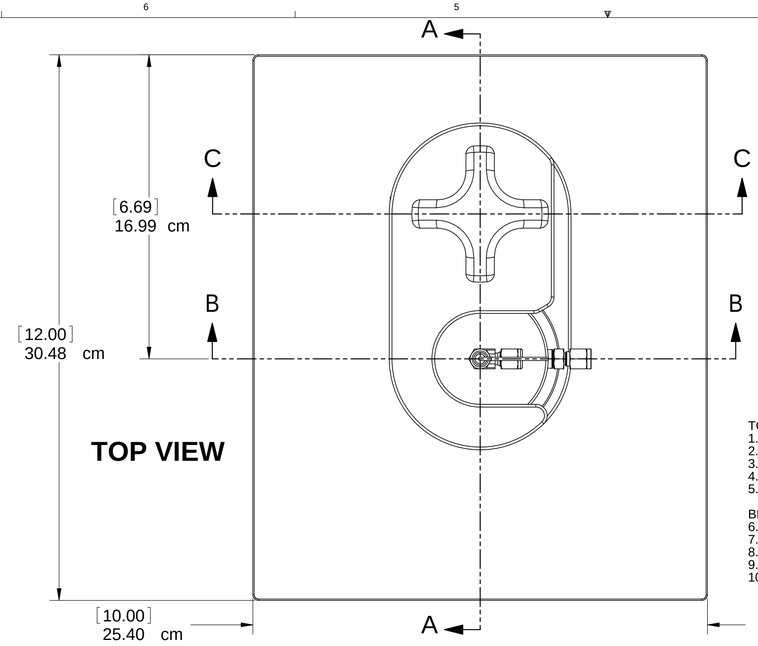
DRAWN: DAH 2/1/2000
MFG: JJM 2/1/2007
ENGR: JJM 2/2/2007

TYPE:
STRUCT:

CHANDLER ENGINEERING
CEMENT HYDRATION ANALYZER
PN: 7200A
PROJ:
REV AB SIZE D
SHEET 6 OF 6
TITLE BLOCK REV 5

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
	D	ECN T5383; REPLACE 54-903-206 WITH C15793	6/13/13	DBL

1 STAMP SERIAL NUMBER IN FIVE LOCATIONS AS SHOWN.



TOP VIEW

MAX. WORKING PRESSURE = 6.895 MPa (1000 psig, 68.95 bar, 68.05 atm.)
at MAX. WORKING TEMPERATURE = 163˚C (325˚F)

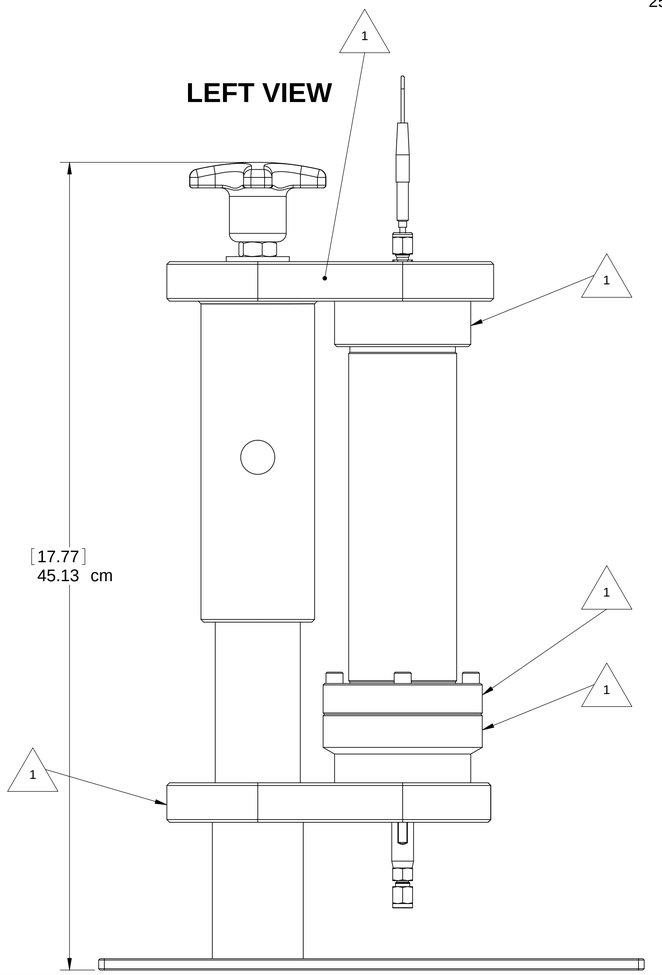
INTERNAL VOLUME OF CEMENT CHAMBER = APPROX. 417 cc

TEST ACCORDING TO PRESSURE TEST PROCEDURE/REPORT #7200-1010-1061.

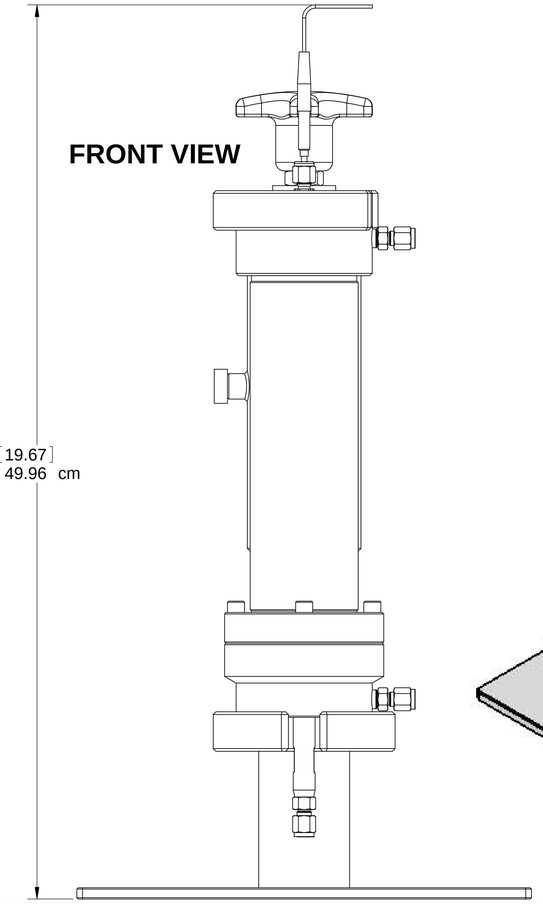
TO REMOVE VESSEL FROM STAND:
1. RELEASE ALL PRESSURE FROM ALL PARTS OF VESSEL.
2. ROTATE HAND KNOB CCW (COUNTER-CLOCKWISE) TO RAISE UPPER ARM.
3. PULL PLUNGER KNOB OUT AND ROTATE 90˚ TO HOLD IT OUT.
4. ROTATE UPPER ARM 90˚, OUT OF THE WAY OF VESSEL.
5. RAISE VESSEL SLIGHTLY FROM LOWER ARM, AND REMOVE FROM STAND.

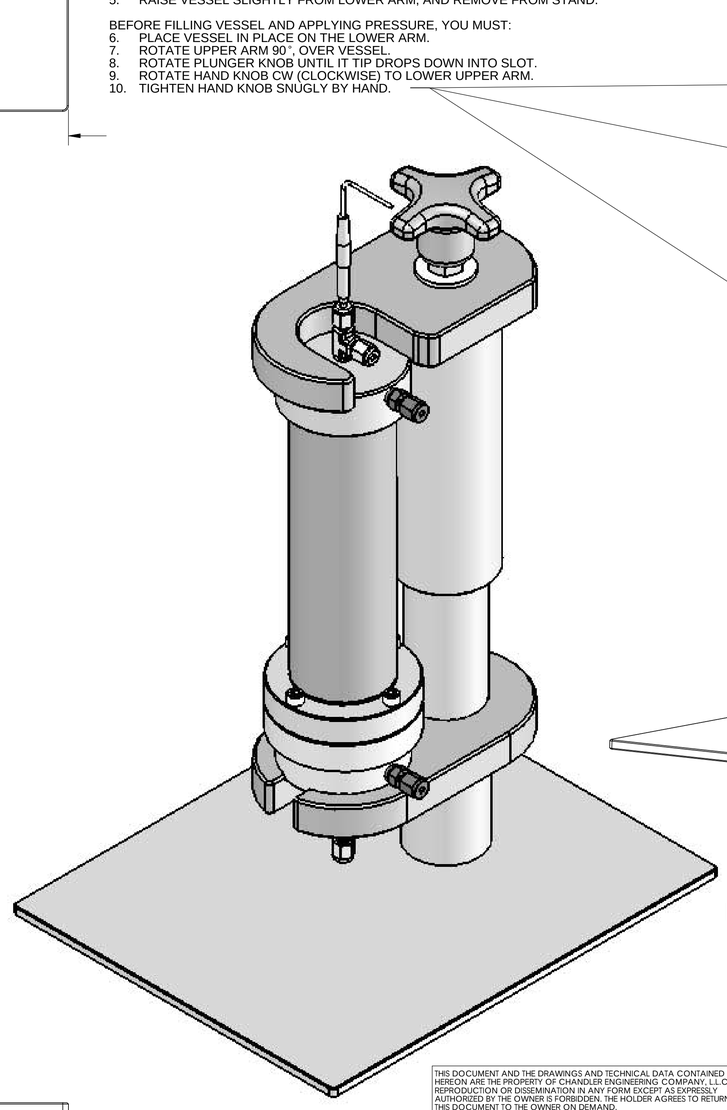
BEFORE FILLING VESSEL AND APPLYING PRESSURE, YOU MUST:
6. PLACE VESSEL IN PLACE ON THE LOWER ARM.
7. ROTATE UPPER ARM 90˚, OVER VESSEL.
8. ROTATE PLUNGER KNOB UNTIL IT TIP DROPS DOWN INTO SLOT.
9. ROTATE HAND KNOB CW (CLOCKWISE) TO LOWER UPPER ARM.
10. TIGHTEN HAND KNOB SNUGLY BY HAND.

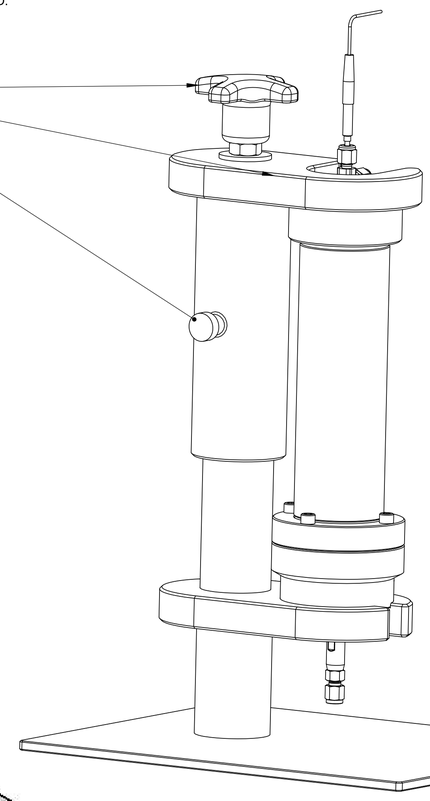
LEFT VIEW



FRONT VIEW







Dimensions shown in cm and (inches).

	APPROVALS	DATE
DRAWN:	DAH	06/10/05
CHECKED:	REW	06/10/05
ENGR.:	DAH	06/10/05

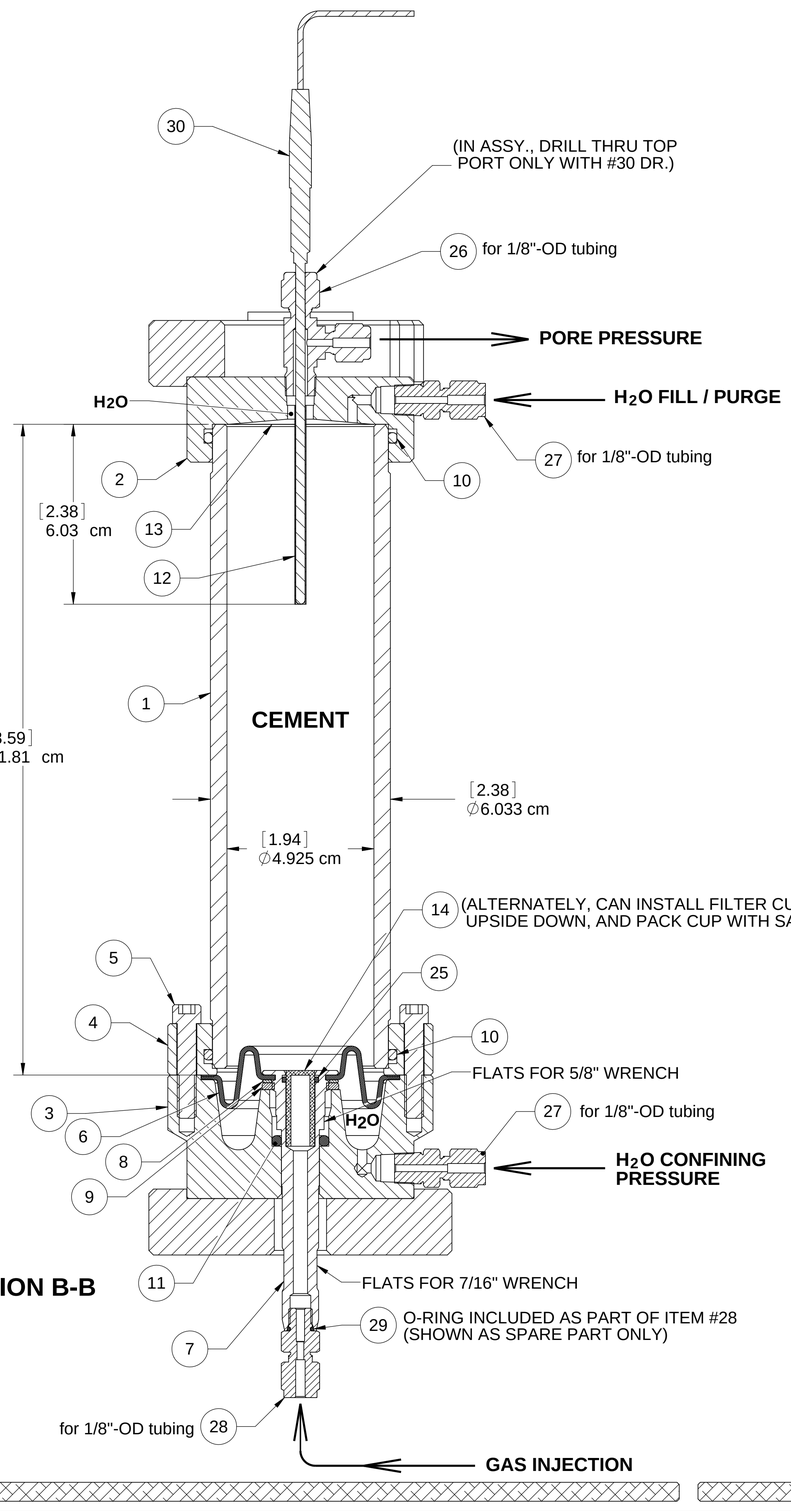
CHANDLER ENGINEERING

TITLE: **VESSEL W/ STAND, CHA**

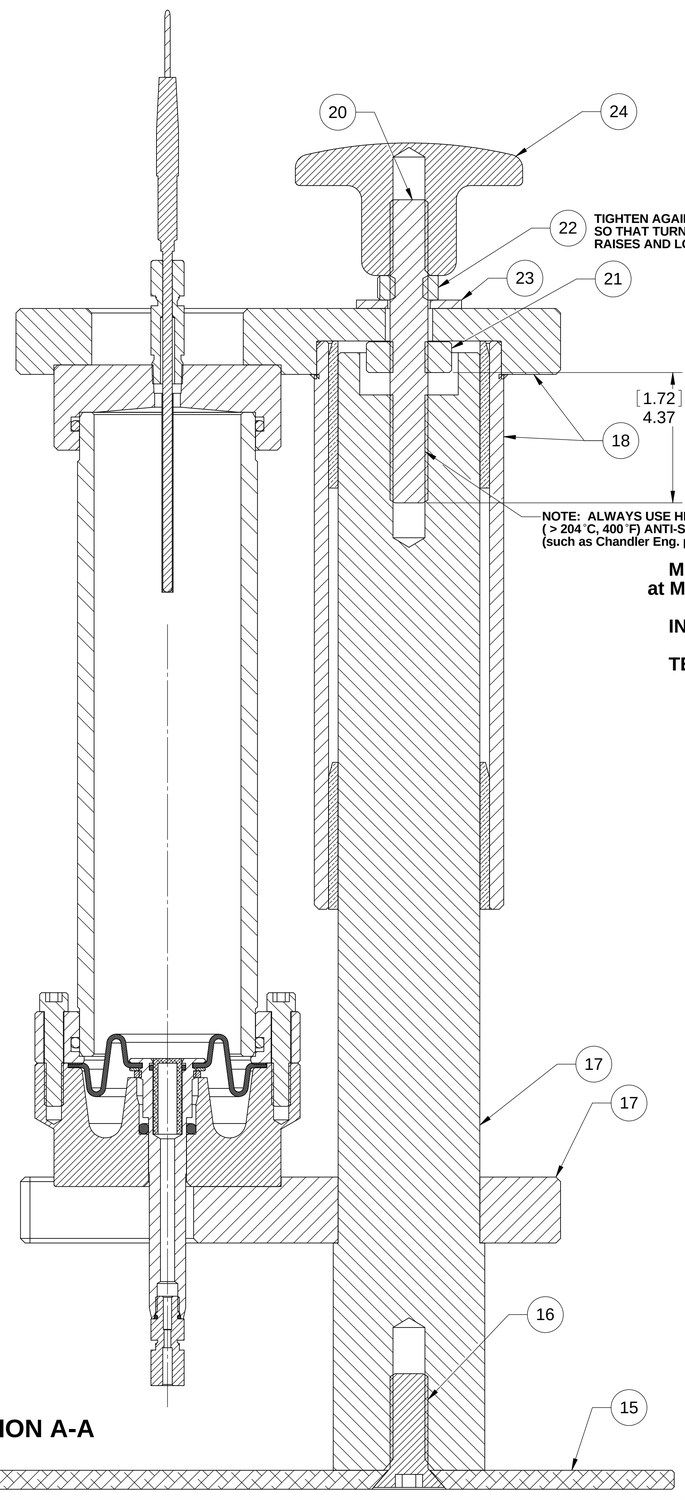
SIZE	S.O. NO.	DWG NO.	REV.
D		7200-1010	D

SCALE: 1:1 SHEET: 1 of 2

Bill of Material					
Item no.	Part no.	Description	Qty.	Units	Material
1	6990-0034	TUBE,SAMPLE,CHA	1	ea.	carbon steel
2	7200-1010-02	CAP, CHA, UPPER	1	ea.	316 SS
3	7200-1010-03	CAP, CHA, LOWER	1	ea.	316 SS
4	7200-1010-04	RETAINER, DIAPHRAGM	1	ea.	316 SS
5	H-25-031	SCREW,SHCS,1/4-20X1.25,SST	4	ea.	18-8 SS
6	7200-1010-06	DIAPHRAGM,CHA,VITON	1	ea.	fluorocarbon, 75-durometer
7	7200-1010-07	STEM,DIAPHRAGM,CHA	1	ea.	316 SS
8	7200-1010-08	WASHER,DIAPHRAGM RETAINING	1	ea.	316 SS
9	7200-1010-09	NUT,JAM,CHA DIAPHRAGM	1	ea.	303 SS
10	C11139	O-RING,VITON,AS229-75	2	ea.	fluorocarbon, 75-durometer
11	C15793	O-RING,VITON,AS206-V75	1	ea.	fluorocarbon, 75-durometer
12	70615-04	TUBG,HEAT SHRINK .121 MIN ID	0.500	ft.	TFE
13	7200-1010-13	WAFER, CHA	1	ea.	300-series SS
14	C11278	FILTER CUP,.375ODX1.00L,40-MICR.SS	1	ea.	316 SS
15	7200-1010-15	PLATE, BASE, CHA	1	ea.	Steel
16	C11151	SCREW, 1/2-13X1.5", SFHS, STL	1	ea.	Steel
17	7200-1010-17	WELDMENT,LOWER CELL SUPPORT	1	ea.	Nickel-plated Steel
18	7200-1010-18	ARM,PIVOT,COMPLETE,CHA	1	ea.	Nickel-plated Steel with Bronze
19	C11076	PLUNGER, SPRING 3/8 X 1/4	1	ea.	300-series SS
20	C11150	STUD, THREAD, 1/2-13X4",STL	1	ea.	Steel
21	C11144	COLLAR, SHAFT, THD'D 1/2-13 SS	1	ea.	303 SS
22	C11145	NUT, HEX JAM 1/2-13 ZINC PLATE	1	ea.	Zinc-plated Steel
23	H-50-002	WASHER,FLAT,.50,CS PL	1	ea.	Cadmium-plated Steel
24	C11141	KNOB,HAND,CAST IRON, .5-13THD.	1	ea.	Zinc-plated Grey Iron
25	P-2676	ORING,VITON,AS012-75	1	ea.	fluorocarbon, 75-durometer
26	C09327	TEE,SST,1/8SWx1/8SWx1/8MPT	1	ea	316 SS
27	188-13044	CONN ,SS,1/8MPX1/8T,SW	2	ea.	316 SS
28	C11277	CONN ,SS,1/8TX5/16-24SAEJ1926	1	ea.	316 SS
29	C11279	ORING,VITON,3-902-90	1	ea.	fluorocarbon, 90-durometer
30	C10748	RTD,1/8"ODX4.5",3-WIRE,W/CONN.	1	ea.	316 SS
31	C10749	CLAMP, CABLE, 3-POLE RTD CONN.	1	ea.	
32	-7200-1010-1061	PROCEDURE,PRESSURE TEST,CHA	1	ea.	



SECTION B-B

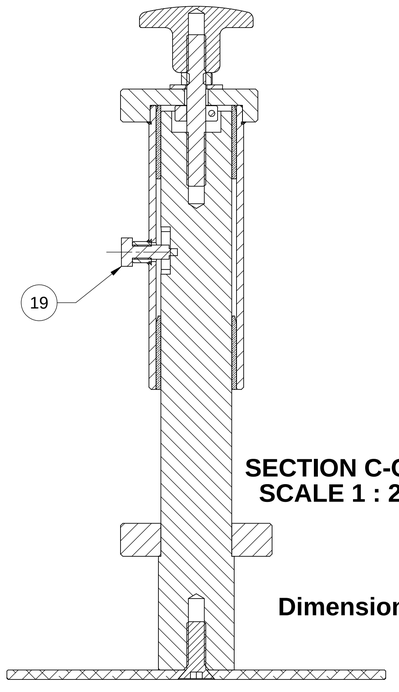


SECTION A-A

MAX. WORKING PRESSURE = 6.895 MPa (1000 psig, 68.95 bar, 68.05 atm.) at MAX. WORKING TEMPERATURE = 163 ˚C (325 ˚F)

INTERNAL VOLUME OF CEMENT CHAMBER = APPROX. 417 cc

TEST ACCORDING TO PRESSURE TEST PROCEDURE/REPORT #7200-1010-1061.



SECTION C-C
SCALE 1 : 2

Dimensions shown in cm and (inches).

APPROVALS		DATE
DRAWN:	DAH	06/10/05
CHECKED:	REW	06/10/05
ENGR.:	DAH	06/10/05

CHANDLER ENGINEERING

TITLE: **VESSEL W/ STAND, CHA**

SIZE	S.O. NO.	DWG NO.	REV.
D		7200-1010	D

SCALE: 1:1 SHEET: 2 of 2

CHANDLER ENGINEERING

PART NO: **7200-1010-1061**

TITLE: **Procedure/Report, Pressure Test, for 7200-1200 CHA Vessel**

Revision	Date	Description	By	Checked
C	5/12/16	ECN T7260	JS	JS

CELL MODEL NUMBER: 7200-1200 TEST DATE(S): _____

CELL SERIAL NUMBER: _____

TOP PLATE: _____

BOTTOM PLATE: _____

STAND ARMS: _____

PRESSURIZING FLUID: _____ (liquid) and N_2 (nitrogen) gas (See procedures.).

Step *no.*	Pressure *psig*	Fluid	Time *mins.*	Press. Drop *psi*	Temp. *°F*	Pass ✓	Fail ✓
5	500	liquid					
6	1000	liquid					
7	1500	liquid					
8	Release pressure	liquid					
9	500	liquid					
10	Release Pressure	liquid	-----	-----	-----		
11	Disassemble, check for damage	-----	-----	-----	-----		
12	Clean and reassemble dry	empty	-----	-----	-----		
13	Immerse cell in H_2O	empty	-----	-----	-----		
15	500	N_2					
16	1000	N_2					
17	Release Pressure	N_2	-----	-----	-----		
18	500	N_2					
19	Release Pressure	N_2	-----	-----	-----		
20	Disassemble, check for damage	-----	-----	-----	-----		
21	Clean and reassemble dry	dry	-----	-----	-----		
22	Tag and stamp	dry	-----	-----	-----		
23	File test report	-----	-----	-----	-----		

Tested By: _____ Test Report Approved By: _____

Test Date: _____ Date Approved: _____

TITLE: **Procedure/Report, Pressure Test, for 7200-1200 CHA Vessel**

Revision	Date	Description	By	Checked
C	5/12/16	ECN T7260	JS	JS

NOTES:

A. Record test data in table at beginning of this document. Sign completed test report. Have all pages of this report approved, signed, and certified with seal by Professional Engineer.

B. If the cell holds each test pressure, with valve closed from pressure pump, without any drop more than 25 psi (liquid) or 50 psi (gas, to allow for gas cooling) in pressure over the time period, record the test increment as "PASS". It is allowable (preferred), at each pressure step, to allow 5 – 10 minutes for pressure to stabilize (drop) after initial increase to that pressure, then re-pressurize to the desired pressure, and to then begin judging PASS/FAIL from pressure drop from that point. During gas portion of test, no more than one bubble is allowed to escape from the cell during each timed pressure step. It is allowable to tighten a leaking fitting to fix leak, until it passes this pressure step, and then resume test. Otherwise, the entire test is recorded as "FAIL" and the test must be restarted.

1. Assemble cell as shown in drawing #7200-1200.

2. Connect tubing from a hydraulic liquid pump (using Swagelok or equivalent fittings for 1/8"-OD pressure tubing) to both of the lower ports in the cell (H_2O CONFINING PRESSURE and GAS INJECTION ports). Plug the top ports with Swagelok plugs, or plumb valves to these ports.

3. Open the H_2O FILL/PURGE port (on the side of the upper cap) by opening the valve plumbed to it or by loosening the plug in it. Then, orient the cell so that this open port is at the top, and use the hydraulic liquid pump to inject liquid into the cell until the air is purged out through the top, and only liquid exits this port. Close the port by closing the valve or tightening the plug.

4. Open the PORE PRESSURE port (the side port of the tee fitting at the top of the cell) by opening the valve plumbed to it or by loosening the plug in it. Then, orient the cell so that this open port is at the top, and use the hydraulic liquid pump to inject liquid into the cell until the air is purged out through the top, and only liquid exits this port. Close the port by closing the valve or tightening the plug.

5. Use the hydraulic liquid pump to inject liquid into the cell to pressurize the cell to 500 psig and hold for a minimum of 5 minutes.

6. Increase the cell pressure to 1000 psig and hold for a minimum of 5 minutes by closing valve from pump.

7. Increase the cell pressure to 1500 psig and hold for a minimum of 15 minutes by closing valve from pump.

8. Release pressure from inside the cell.

9. Re-pressurize cell to 500 psig and hold for a minimum of 5 minutes by closing valve from pump.

10. Release pressure from inside the cell.

11. Disassemble the cell as necessary to drain all liquid from it. Note any difficulties in disassembly, any obvious change or damage, and condition of seals.

Revision	Date	Description	By	Checked
C	5/12/16	ECN T7260	JS	JS

12. If no problems are found, clean the cell of all liquid, and reassemble it dry (with O-ring lubricant on O-rings).

13. Plumb outlet of N_2 (nitrogen) gas supply (N_2 gas bottle and/or high-pressure gas booster, as necessary to provide needed pressure) to both of the lower ports in the cell (H_2O CONFINING PRESSURE and GAS INJECTION ports), with a valve between the N_2 source and the cell. Plug the top ports with Swagelok plugs, or plumb valves to these ports and close the valves. Position and orientation of cell is not important.

14. Immerse entire cell in water, so that any gas leaking from it will be visible as bubbles.

15. Inject N_2 gas into cell to pressurize it to 500 psig. With the valve open between the N_2 source and the cell, maintain this pressure for 5 minutes, then close this valve between cell and gas booster and hold pressure for a minimum of 10 minutes. Check for any leaks visible as bubbles.

16. Inject N_2 gas into cell to pressurize it to 1000 psig. With the valve open between the N_2 source and the cell, maintain this pressure for 5 minutes, then close this valve between cell and gas booster and hold pressure for a minimum of 10 minutes. Check for any leaks visible as bubbles.

17. Release pressure from inside the cell for 5 minutes.

18. Pressurize the cell with N_2 to 500 psig. With the valve open between the N_2 source and the cell, maintain this pressure for 5 minutes, then close this valve between cell and gas booster and hold pressure for a minimum of 5 minutes. Check for any leaks visible as bubbles

19. Release pressure from inside the cell.

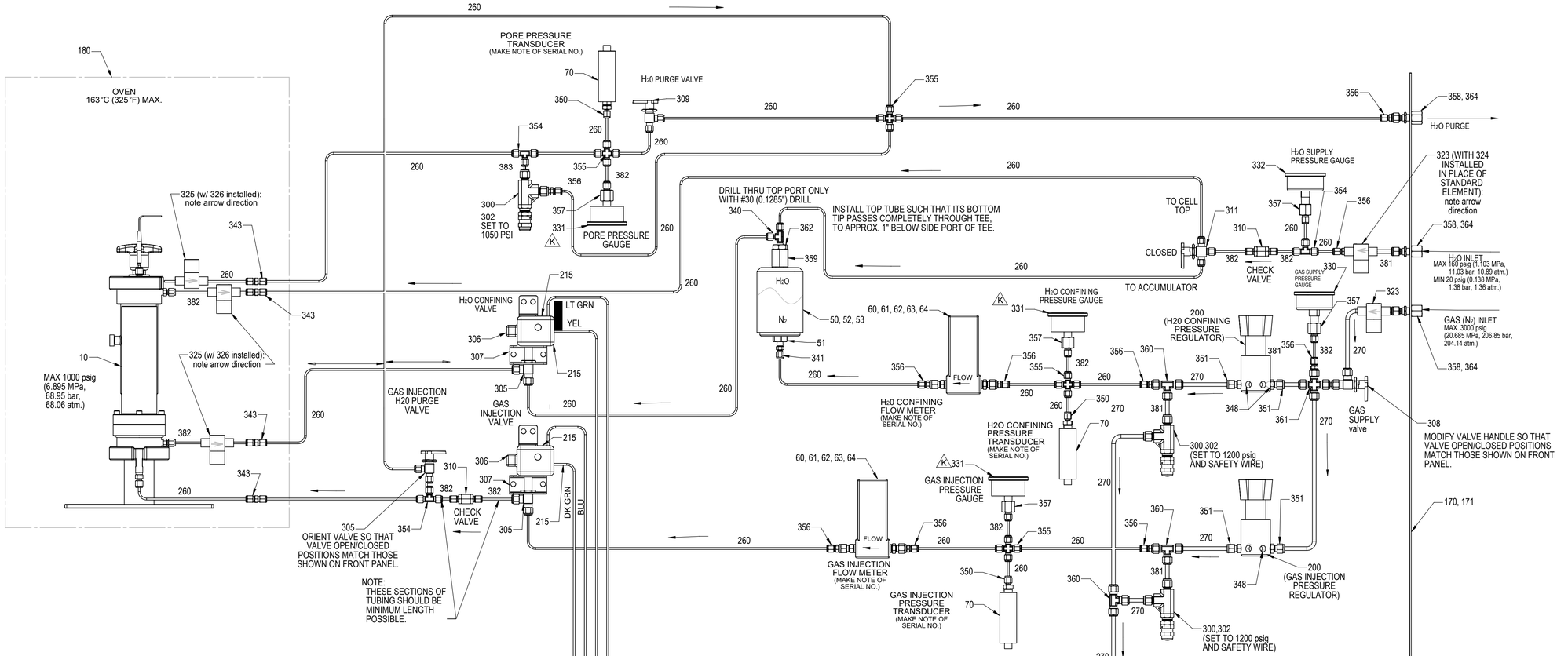
20. Disassemble cell and note any difficulties in disassembly, any obvious change or damage, and condition of seals.

21. Clean cell and re-assemble dry.

22. If cell passes test, tag the cell assembly with the date the hydrostatic test was completed. Stamp assembly Serial Number and Test Date on cell (See assembly drawing for location.).

23. Record the test results in the table of this procedure. Sign completed test report. Have all pages of this report approved, signed, and certified with seal by Professional Engineer. File copy of this signed, certified test report in instrument's serial-number file, along with copy of the work order, bill of material, and assembly drawing for this cell.

ZONE	REV.	DESCRIPTION	DATE	APPROVED
	H	ECN T5019; ADDED RELIEF VALVE	11/29/12	TC
	J	ECN T6185; CHANGED OVEN TO C16485	10/13/2014	JJM
	K	ECN T6499; DEL C11272 QTY 3, ADD C08802 QTY 3	3/25/2015	JJM/TC
	L	ECN T7414; REPLACE 187-20522 W/ QS-C-1241	10/5/2016	JS



Item no.	Part No.	Description	Qty.	Units
2	7200-1030	SCHEMATIC, WIRING	1	ea.
3	7200-1060	PROCEDURE, SETUP, TEMP.CTRL	1	ea.
4	7200-1061	PROCEDURE/REPORT,TEST,CHA	1	ea.
10	7200-1010	VESSEL W/ STAND, CHA	1	ea.
49	P-1111	ORING,BUNA,AS014-70	1	ea.
50	C11269	ACCUMULATOR,6 CU.IN.,NI-PLATED	1	ea.
51	7200-1115	ADAPTER,3/8BSPP-Mx1/8NPT-F,SS	1	ea.
52	C11274	BOLT,U,3.5"IDX3/8-16X4.13IL,SS	1	ea.
53	H-37-003	NUT,SST,HX,3/8-16	2	ea.
60	C11263	METER,MASS FLOW,N2,0-5-SCCM	2	ea.
61	6100-2253	MNTG PLATE, N2 METER	2	ea.
62	H-8015	SCREW,FLAT,8-32X.500,PHH,SST	4	ea.
63	H-31-017	SCREW,FLT,HD SST 5/16"-18X3/4	4	ea.
64	H-31-001	NUT,SST,HX,5/16	4	ea.
70	C11264	XDCR,1000 PSI, +/- 0.1%	3	ea.
170	7200-1101	ENCLOSURE, CHA	1	ea.
171	7200-1102	PANEL, CHA, FRONT	1	ea.
180	C16485	OVEN, 4.3 CU.FT.,204C,240VAC	1	ea.
200	C09547	REG,PRESSURE,0-1500 PSI	2	ea.
210	C09524	REG,FLTR,W/GAGE,MNTG BRKT	1	ea.
211	C09946	MANIFOLD,AIR,6 POSITION	1	ea.
212	C09527	VALVE,SOLENOID,PLUG-IN	6	ea.
213	C09529	ELBOW,PNEU,10-32X1/4T	2	ea.
215	C09532	CONN,PNEU,1/8MPTX1/8T	4	ea.
216	C09528	ELBOW,PNEU,10-32X1/8T	4	ea.
217	C10024	GASKET,SMC,M-5GI	2	ea.
218	H-10-103	SCREW,BDG,10-32X.250,PHH,SST	2	ea.
260	R-0645	SST,TBG,0.125ODx0.035W,316 20G	40.000	ft.
261	Q5-C-1241	TEFLON,TBG,0.125ODx0.030W	72.000	in.
270	R-0631	SST,TBG,0.250ODx0.035W,316	6.000	ft.
271	R-1389	TBG, 0.250DX.062W,PFA	40.000	ft.
272	C09585	TUBE,8RIBBON,1/16ID,POLY,COLOR	2.000	ft.
300	C09434	VAL,PRESSURE RELIEF	3	ea.
302	C09238	SPRING,REL.VALVE,177-R3A-K1-C	3	ea.
305	C10291	VALVE,2W,ANG,SS-41S2-A	3	ea.
306	C11275	ACTUATOR,AIR,DOUBLE-ACTING	2	ea.
307	C11276	BRACKET,AIR-ACTUATOR/VALVE	2	ea.
308	C11271	VALVE,2W,ANGLE,1/4 SST,SWGLK	1	ea.
309	C09367	VALVE, NDL, SST, 1/8X1/8 ANG SW	1	ea.

Item no.	Part No.	Description	Qty.	Units
310	C03318	V,NUPRO CHECK	2	ea.
311	C09432	V,3-WAY,SST	1	ea.
312	70602-62	NUT,SS,1/8T	10	ea.
313	70603-87	FER,SS,FR,1/8T	10	ea.
314	70603-86	FER,SS,BACK,1/8T	10	ea.
323	C09714	FILTER, 2 MICR TEE 1/4T SST	2	ea.
324	C09890	FLTR,REPLACEMENT,60 MICRON	1	ea.
325	C09298	FILTER, 7MIC TEE 1/8T, SST	3	ea.
326	C11324	ELEMENT, 40 MICRON, SST	3	ea.
330	C10333	GA,PRESS,3000 PSI/KPA	1	ea.
331	C08802	GAGE,2000PSI,2.5",1/4NPT,CBM	3	ea.
332	C11273	GAUGE,PRESS,160 PSI/KPA,2.5	2	ea.
340	C09327	TEE,SST,1/8SWx1/8SWx1/8MPT	1	ea
341	188-13044	CONN ,SS,1/8MPX1/8T,SW	1	ea.
343	70601-55	UN ,SS,1/8TX1/8T,SW	6	ea.
348	25-131	PLUG,PIPE 1/4 CAJON SS-4-P	4	ea.
350	187-20403	CONN ,SS,1/4MPX1/8T,SW	9	ea.
351	P-1488	CONN ,SS,1/4MPX1/4T,SW	9	ea.
354	70607-85	TEE ,SS,UN,HP,1/8TX1/8TX1/8T	3	ea.
355	C08361	CROSS,SS,1/8T,	4	ea.
356	P-1944	RDCR,SST,1/8Tx1/4OD ,1/8" T	11	ea.
357	C08517	CONN ,SS,1/4FPX1/8T,SW	6	ea.
358	C09283	CONN ,SS,1/4FPX1/4T,BHD,SW	5	ea.
359	C11268	ADAPTER,1/2 FNPTX3/4-16 SAE,SS	1	ea.
360	P-1942	TEE ,SS,UN,1/4TX1/4TX1/4T,SW	5	ea.
361	P-1941	CROSS,SS,UN,1/4T,SW	1	ea.
362	25-120	FTG 1/2NPTX1/8NPTF SS-8-RB-2	1	ea.
363	P-1487	ELBOW,SS,1/8MPX1/4T,SW	2	ea.
364	C08268	RTNR ,SST,3/4ID,BHD,SW	5	ea.
372	C10695	CONN, 3MM TUBE,1/4MNPT,SST	5	ea.
373	C10696	CONN, 6MM TUBE-1/4MNPT,SS	5	ea.
374	P-3412	ADPTR,BRS,1/4HOSEX1/4MP,SW	5	ea.
375	C10227	CONN,BRS, 1/2"TX1/4"MNP,SW	5	ea.
376	25-670	MHC 1/4NPTX1/4TPRTBG SS	5	ea.
377	C10697	CLAMP,HOSE,0.75-1.75ID,SS	5	ea.
378	C09836	CLAMP, HOSE,DIXON 1.25"	5	ea.
379	P-3409	CLAMP,HOSE,7/8ID	5	ea.
380	P-3553	CLAMP,HOSE,1/2ID	5	ea.
381	C09704	CONN,PORT,1/4	6	ea.
382	C09705	CONN,PORT,1/8	12	ea.
383	C09703	CONN, REDUCER	1	ea.

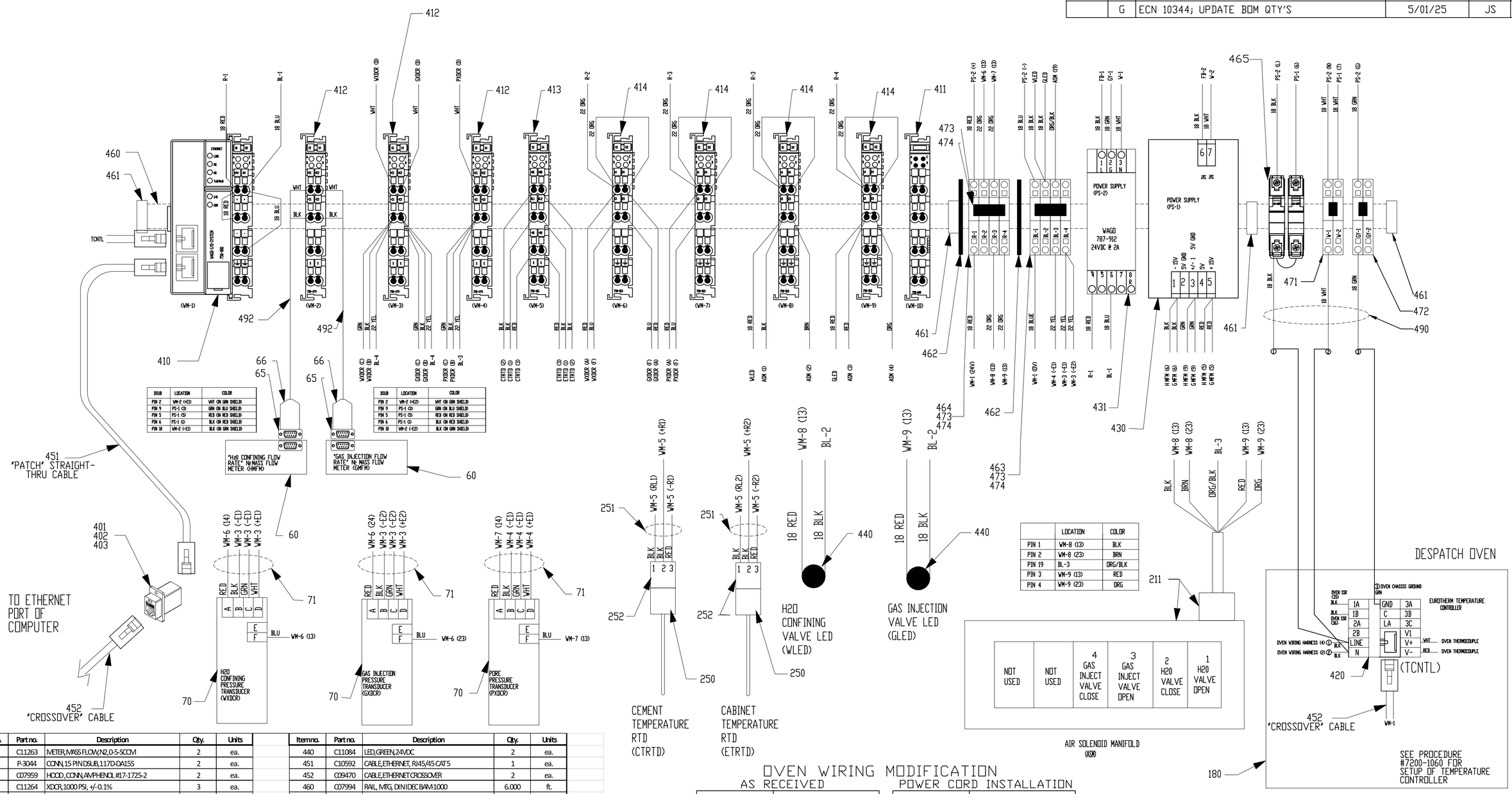
TEST PER PROCEDURE/REPORT #7200-1061.

BREAK EDGES, DEBURR
UON DIMS ARE IN INCHES
1 PLC ±0.030 2 PLC ±0.010
3 PLC ±0.005 ANGL ±1/2°
SURFACE FINISH 63 RMS
THIRD ANGLE PROJECTION

DRAWN: SCS 6/29/2005
MFG: DAH 7/7/2005
ENGR: DAH 7/7/2005
TYPE:
STRUCT:

CHANDLER ENGINEERING
DIAGRAM,PLUMBING,CHA
PN: 7200-1020
PROJ: 7200
REV L SIZE D
SHEET 1 OF 1
TITLE BLOCK REV 1

REVISIONS				
ZONE	REV	DESCRIPTION OF REVISION	DATE	APPROVALS
	D	ECN T6504; DEL26-237 QTY2,ADD09083-24 QTY2	3/25/15	TC JJM
	E	ECN T6632; REPL C08228 W/C15158	6/3/15	TC TAS
	F	ECN T8485; UPDATE TCNTL	3/26/19	WJW JS
	G	ECN 10344; UPDATE BOM QTY'S	5/01/25	JS GM

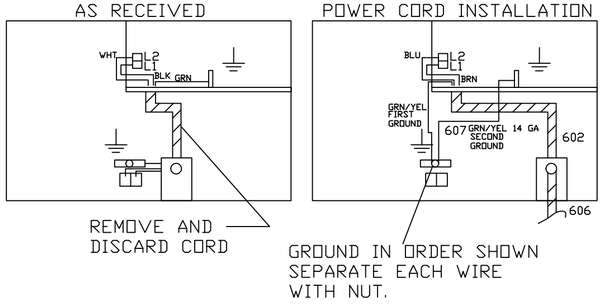


DSUB	LOCATION	COLOR
PIN 2	VM-2 (+E1)	WHT ON GRN SHIELD
PIN 9	PS-1 (3)	GRN ON BLU SHIELD
PIN 5	PS-1 (5)	RED ON RED SHIELD
PIN 6	PS-1 (1)	BLK ON RED SHIELD
PIN 10	VM-2 (-E1)	BLK ON GRN SHIELD

DSUB	LOCATION	COLOR
PIN 2	VM-2 (+E2)	WHT ON GRN SHIELD
PIN 9	PS-1 (3)	GRN ON BLU SHIELD
PIN 5	PS-1 (5)	RED ON RED SHIELD
PIN 6	PS-1 (1)	BLK ON RED SHIELD
PIN 10	VM-2 (-E2)	BLK ON GRN SHIELD

	LOCATION	COLOR
PIN 1	VM-8 (13)	BLK
PIN 2	VM-8 (23)	BRN
PIN 19	BL-3	DRG/BLK
PIN 3	VM-9 (13)	RED
PIN 4	VM-9 (23)	DRG

OVEN WIRING MODIFICATION



Item no.	Part no.	Description	Qty.	Units
60	C11263	METER,MASS FLOW,N2,0-5 SCCM	2	ea.
65	P-3044	CONN,15 PIN DSUB,117D-DA15S	2	ea.
66	C07959	HOOD,CONN,AMPHENOL #17-1725-2	2	ea.
70	C11264	XDCR,1000 PSI, +/-0.1%	3	ea.
71	C10849	CABLE, 15-FT., W/CONN., 6-COND.	3	ea.
180	C16485	OVEN, 4.3 CU.FT., 204C, 240VAC	1	ea.
211	C09946	MANIFOLD,AIR,6 POSITION	1	ea.
250	C10748	RTD,1/8"ODX4.5",3-WIRE,W/CONN.	2	ea.
251	C10747	WIRE, RTD EXT., 3-COND., PFA	10.000	ft.
252	C10749	CLAMP, CABLE, 3-POLE RTD CONN.	2	ea.
401	C09712	CONN,BULKHEAD R145,BLACK PLST	1	ea.
402	H-4108	SCREW,4-40X.375,PPH,SST	2	ea.
403	H-4101	NUT,SST,HX,4-40	2	ea.
404	H-4001	WASHER,LOCK,4,SST	2	ea.
410	C11266	COUPLER, ETHERNET TCP/IP	1	ea.
411	C10998	MODULE,WAGO END,750-600	1	ea.
412	C11260	MODULE, ANALOG IN, 2-CH +/-10V	3	ea.
413	C11261	MODULE, ANALOG IN, 2-CH RTD	1	ea.
414	C11262	MODULE,RELAY,2-CH SPST	4	ea.
416				
420	C17605	CONTROLLER,EUROTHERM,EPC3016,1/16DIN,1CP	1	ea.
421				
423				
430	C11082	SUPPLY,PWR 3 OUTPUT +/-15V 5V	1	ea.

Item no.	Part no.	Description	Qty.	Units
440	C11084	LED,GREEN,24VDC	2	ea.
451	C10592	CABLE,ETHERNET, RJ45/45 CAT 5	1	ea.
452	C09470	CABLE,ETHERNET CROSSOVER	2	ea.
460	C07994	RAIL, MTG, DIN IDEC BAM-1000	6.000	ft.
461	C08226	STOP, END, ENTRELEC #1030002.26	4	ea.
462	C07991	SECT,END,GRAY,ENT. #1 18368.16	4	ea.
463	C09738	TERMINAL BLOCK, BLUE	4	ea.
464	C09739	TERMINAL BLOCK, RED	4	ea.
465	C15158	BREAKER,5A,TYPE D,DIN,1 POLE	2	ea.
469				
471	C10435	TERMINAL BLOCK, WHITE	2	ea.
472	C09742	TERMINAL BLOCK,YEL/GRN,GROUND	2	ea.
473	C09743	JUMPER BAR, 20 POLE	1	ea.
474	C09744	SCREW KIT ASSEMBLY	20	ea.
475	C09573	DUCT,WIRE,1.5"x1.5"x6',GREY	2	ft.
476	C09574	DUCT,COVER,1.5"W,GREY	2	ft.
477	C10481	WIRING DUCT, 1"X2" LIGHT GRAY	1	ft.
478	C09692	COVER,WIRE DUCT,1",GRAY	1	ft.
490	94-212	WIRE 18-35V BELDEN #8453	10.000	ft.
491				ft.
492	8-732	CABLE BELDFOIL SHLD 3PRS 8777	6.000	ft.
602	C16803	CORD,14AWG,600V,3 COND,SOOW	10	ft.
606	C15161	CONN.,.7",STRAIN RELIEF,LIQTIGHT	1	ea

UNLESS OTHERWISE SPECIFIED DIMENSIONS IN INCHES [mm]

TOLERANCES:
1 PLACE ±0.030 [.76]
2 PLACE ±0.010 [.25]
3 PLACE ±0.005 [.127]
ANGLES ±1/2°
SURF. FINISH 63

APPROVALS		DATE
DRAWN:	SCS	6/28/05
CHECKED:	DAH	7/6/05
ENGR.:	DAH	7/6/05

CHANDLER ENGINEERING

TITLE
SCHEMATIC, WIRING
7200 CEMENT HYDRATION ANALYZER

SIZE	S.O. NO.	DWG NO.	REV.
C		7200-1030	G
SCALE: 1 = 1	TITLE BLOCK REV: 1.0	SHEET: 1 of 1	

TITLE: Procedure, CHA-Control Software Installation and/or Re-Installation Instrument: Model 7200 CHA (Cement Hydration Analyzer)

Revision	Date	Revised By	Description
A	10/16/2007	DAH/WJW	ECN T1161

This procedure is for installation of the CHA-Control software onto a new computer, for re-installation of the software on the same computer, or for upgrading the software with a new version. These instructions assume that Microsoft Windows XP is installed and that you are logged in with "Administrator" privileges.

Steps:

(1) If you are upgrading the software, or re-installing it on the same computer, and have calibration data for the CHA instrument that you wish to re-use, then first copy the "globals" file from the folder **C:\Program Files\Chandler Engineering\CHA** to another folder. This file contains the calibration constants and settings, and other information used by the software.

(2) Install the CHA-Control software by running **setup.exe** from the root folder of the software distribution CD. Follow the on-screen instructions; restart the computer if instructed to do so.

(3) Install the support files by running **setup.exe** from the **9000Utils** folder on the software distribution CD. Follow the on-screen instructions; restart the computer if instructed to do so.

(4) If you previously copied the "globals" file to another folder in Step 1 above, now copy this file back to the folder **C:\Program Files\Chandler Engineering\CHA**.

(5) Set up the network interface (Ethernet, LAN) card of the computer to communicate with the Wago I/O Ethernet controller (part of the bank of data-acquisition modules inside the CHA instrument cabinet):

   a. First, navigate to the "Network Connections" window in Windows XP. This may be done in several ways:
      i. "Network Connections" may appear on the Start… Settings menu.
      ii. Click "My Network Places" from the Start menu, and select "View network connections" from the "Network Tasks" pane on the left.
      iii. Right-click on the network connection icon located in the System Tray of the Taskbar, and select "Open Network Connections".
   b. Right-click on the appropriate Network Connection ("Local Area Connection") and select "Properties". The Properties window will appear.
   c. Under the General tab, select the "Internet Protocol (TCP/IP) icon in the "This connection uses the following items:" list, and click on the "Properties" button. The "Internet Protocol (TCP/IP) Properties" window will appear.
   d. Select "Use the following IP address:".
   e. Enter "10.1.1.1" in the "IP address" field.
   f. Enter "255.0.0.0" in the "Subnet mask" field.
   g. Click the "OK" button to close the "Internet Protocol (TCP/IP) Properties" window.
   h. Click the "OK" button to close the "Connection Properties" window.
   i. Close the "Network Connections" window.

(6) The CHA-Control software should now be installed.

(7) Click on the "CHA-Control" icon located on the desktop to run the software. You can also go to Programs… CHA… CHA-Control.

TITLE: Procedure, CHA Temperature Controller Setup
Instrument: Model 7200 CHA (Cement Hydration Analyzer)

Revision	Date	Revised By	Description
B	1/30/2007	DAH/TC	ECN 558
C	10/15/2007	DAH/TC	ECN T1161
D	04/10/2019	BW/JS	ECN T8485
E	07/31/2023	WJW/JW	ECN T9692; Updated Logo and changed to two-point calibration

Steps:

(1) Configure the Eurotherm EPC 3016 (C17605) using the latest revision of the 7200 EPC clone file on the server.

(2) On the oven's HI LIMIT control, change its HSP.H (upper limit of hi-limit setpoint in the Setup Parameters) to 184°C (363°F), and then change its HSP1 (Hi-Limit Setpoint 1) to 184°C (363°F). See the oven instruction manual for how to make these changes.

(3) Determine Cement-to-Oven Temperature Offset:
   a. First, calibrate the Cement Temperature RTD temperature sensor in the CHA-Control software, as mentioned in the user manual, and as required by the #7200-1061 Test Procedure/Report for the Model 7200 CHA.
   b. Install the CHA Vessel inside the oven, with tubing connected, and fill and purge with H_2O, as in preparation for the maximum-pressure-and-temperature test with H_2O.
   c. Set the Oven Temperature to a value slightly higher than room temperature (e.g. 26°C / 80°F) and allow the displayed Oven Temperature and Cement Temperature to reach equilibrium (steady, nonchanging) at that temperature. Enter level 3 of the controller, "Cal S. List". Set the low value in the controller to match the Cement Temperature value from the software. (See Appendix A instructions) Do not adjust the high value yet.
   d. Set the Oven Temperature to 163.0°C (325°F) and allow the displayed Oven Temperature and Cement Temperature to reach equilibrium (steady, non-changing) at that temperature. Enter level 3 of the controller, "Cal S. List". Set the high value in the controller to match the Cement Temperature value from the software. (See Appendix A instructions)

(4) Make a color copy of this document. Sign and date both documents. Place one in instrument's serial number file, and the other in the user manual for customer. See manual for proper section of manual to be placed.

Procedure performed by:

Date:

Appendix A
EPC two-point process value offset.

Operation	Action	Display	Notes
In Level 3 or Configuration level select the Instrument List then CAL S.LIST		CAL S. LIST	
Select the Analog input AI.1	1. Press ↵ to until the Mode parameter is displayed	I dLE MODE	If the MODE shows 'AdJ.d' (adjusted) select 'diSC' (discard). This returns the controller to Factory Calibration.
Select Start	2. Press ^ or v to select	Strt MODE	The display will change to Lo Lo MODE
Set the mV source to the input value representing the required offset. In this example +1.80mV			
Enter the value of the reading required on the controller display for an input of 1.80mV	3. Press ↵ to scroll to C.VAL 4. Press ^ or v to enter the value	0.0 C. VAL	In this example the controller display will read 0.00 for an input of +1.80 mV
Scroll back to Lo	5. Press ↵ Scroll back to Lo 6. Press ^ or v to SEt.L	SEt.L MODE	The low calibration point will be entered and the display will change to Hi Hi MODE
Set the mV source to 17.327. This is the offset value (+1.00mv) at which a type J thermocouple is required to read 300.0 (in this example).			
Enter the value of the reading required on the controller display for an input of 17.327mV.	7. Press ↵ to scroll to C.VAL 8. Press ^ or v to enter the value	300.0 C. VAL	The display will read 300.0OC for an input of 17.327mv (an offset of +1.000 mV)
Scroll back to Hi	9. Press ↵ Scroll back to Hi 10. Press ^ or v to SEt.H	SEt.Hi MODE	The high calibration will be entered and the display will changeAdJ.d. showing that the controller has been calibrated by the user AdJ.d MODE
To return to Factory calibration select diSc (discard) in place of Adj.d. If the calibration is unsuccessful the controller will revert to Factory Cal.			

cut out postcards on dotted lines

Please Send Us Your Comments on This Manual

Model Number _____ Serial Number _____

Printing Date of this manual (from the Title Page) _____

Please circle a response for each of the following statements. Use:

(1)= Strongly agree (2) =Agree (3) =Neutral, no opinion (4) =Disagree (5) =Strongly disagree

a) The manual is well organized.	**1**	**2**	**3**	**4**	**5**
b) I can find the information I want.	**1**	**2**	**3**	**4**	**5**
c) The information in the manual is accurate.	**1**	**2**	**3**	**4**	**5**
d) I can easily understand the instructions.	**1**	**2**	**3**	**4**	**5**
e) The manual contains enough examples.	**1**	**2**	**3**	**4**	**5**
f) The examples are appropriate and helpful.	**1**	**2**	**3**	**4**	**5**
g) The manual layout is attractive and useful.	**1**	**2**	**3**	**4**	**5**
h) The figures are clear and helpful.	**1**	**2**	**3**	**4**	**5**

i) The sections I refer to most often are _____

_____

Other comments _____

_____

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Email: chandler@chandlereng.com

Please add me to your mailing list-

for Product Updates and New Product Releases, Information,

Technical Articles, and General Announcements of interest to users of this instrument.

Name _____

Company _____

Address _____

Email address _____

My instrument is Chandler Model _____

Serial Number _____

REGISTERED ISO 9001 MANAGEMENT SYSTEM

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WARRANTY STATEMENT

All products of Chandler Engineering are warranted for a period of one year from the date of shipment to be free from defective workmanship and material. Providing written notice is made and authorization by us is given, any of our products claimed to be defective may be returned freight prepaid to our factory. If found to be defective and after examination by us, our obligation will be limited to repairing or replacing the product, at our option, free of charge, F.O.B. our factory.

COMMERCIAL INSTRUMENTATION MANUFACTURED BY OTHERS

Commercial instrumentation manufactured by others is covered by separate manufacturer warranty, generally for one year. Contact Chandler Engineering for instructions on obtaining the service directly from the manufacturer.

Our warranty does not cover damage or failure caused by abuse, misuse, abnormal usage, faulty installation, improper maintenance, or any repairs other than those provided by authorized Chandler Engineering personnel.

This warranty is in lieu of all other warranties, expressed or implied, and of all obligations or liabilities on its part for damages including but not limited to consequential damages, following the use or misuse of instruments manufactured by Chandler Engineering Company L.L.C.

NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE SHALL APPLY.

Our total liability for any claim shall not exceed the price allocable to the product or service or part thereof that gives rise to the claim.

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