

INSTRUCTION MANUAL  
MODEL 6265  
Mechanical Properties Analyzer (MPRO®)  
Revision Õ – November 2015  
P/N: 348-1050

S/N: \_\_\_\_\_



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# General Information

## Introduction

### Purpose and Use

The 6265 Mechanical Properties Analyzer (MPRO<sup>®</sup>) is an instrument that continuously measures the elastic mechanical properties (Poisson's ratio, Young's modulus, Bulk Modulus), and compressive strength of API cement under high-temperature and high-pressure conditions.

The instrument measures the compressional and shear sound velocities through the cement sample and uses industry-accepted equations to determine the Poisson's Ratio and Young's Modulus. The data is presented graphically using the 5270 Data Acquisition and Control System (DACS).



Figure 1 - Model 6265 Mechanical Properties Analyzer

### **Description**

Each 6265 MPRO is equipped with a programmable temperature controller that provides the capability to investigate the impact of temperature variations on the cement mechanical properties. With the external Quizix pump system, the user can simulate realistic pressure conditions to evaluate the impact on the mechanical properties of the cement.

## Features and Benefits

- Continuous measurement of mechanical properties.
- Single vessel curing to preserve sample conditions and testing integrity, avoiding the need for separate curing and mechanical property measurement procedures.
- Easy to install and use.
- Measures the development of Poisson's ratio, Young's modulus, Bulk Modulus, and compressive strength of API Cement slurries.
- Uses Chandler Model 5270 Data Acquisition and Control System for data retrieval, analysis, and storage.
- Separate pressure control system for accurate sample pressure control.
- Optional external chiller system.

## Specifications

<b>Measurements:</b>	Poisson's Ratio, Young's Modulus, Bulk Modulus, Compressive Strength
<b>Operating Conditions:</b>	50°F - 110°F / 10°C - 43°C – non-condensing
<b>Maximum Temperature:</b>	400°F / 204°C
<b>Maximum Pressure:</b>	7500 psi / 52 MPa
<b>Input Voltage:</b>	220 VAC $\pm$ 15%; 50/60 Hz $\pm$ 10%
<b>Input Power:</b>	750 VA
<b>Dimensions:</b>	16 in. / 41cm high x 18 / 46cm wide x 17 in. / 43cm deep

# Safety Requirements

## ***READ BEFORE ATTEMPTING OPERATION OF THE INSTRUMENT***

The Chandler Engineering Model 6265 Mechanical Properties Analyzer is designed for operator safety. Any instrument that is capable of high temperatures and pressures should always be operated with **CAUTION!!**

To ensure safety:

- Locate the instrument in a low traffic area.
- Post signs where the instrument is being operated to warn non-operating personnel.
- Read and understand instructions before attempting instrument operation.
- Observe caution notes!
- Observe and follow the warning labels on the instrument.
- Never exceed the instrument maximum temperature and pressure ratings.
- Always disconnect main power to the instrument before attempting any repair.
- Turn off the heater at completion of each test.
- Locate appropriately rated fire extinguishers within close proximity to the instrument.

Before attempting to operate the instrument, the operator should read and understand this manual.



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# Section 1 – Installation

## Unpacking the Instrument

Remove the instrument from the packing crate carefully. The unit comes fully equipped with all the necessary components and ordered spare parts. Make sure that no parts are lost when discarding the packing materials. Place the instrument on a firm table, close to the water source and required electrical outlets.

After the instrument is removed from the shipping crate, the equipment and spare parts should be checked against the packing list to ensure that all parts have been received and none are damaged.

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

## Utilities Required

- Power: 220  $\pm$ 15% VAC, 50/60 Hz, 750VA
- Water: Clean pressurizing water, 5-150 psi / .34-10.4 bar
- Coolant: Clean water or ethylene glycol and water solution
- Air: Clean, dry compressed air or nitrogen; 75-125 psi / 5.2-8.6 bar
- Drain: Suitable for hot water

## Tools/Equipment Required

- 5/8 inch Wrench
- 1/2 inch Wrench
- 1/8 inch drill bits (or 3mm)
- Teflon Tape
- Hex wrenches
- Screwdrivers (flat blade, Phillips head)
- Bench Vise

## Installing the Instrument

1. Locate the MPRO<sup>®</sup> analyzer near power, air, water, and drain connections.
2. Connect power to the instrument using the power cord supplied with the analyzer. A 10A fuse or circuit breaker is recommended. A 1 KVA uninterruptible power supply (UPS) is recommended to protect the data acquisition electronics and test data from brief power failures. The MPRO<sup>®</sup> is equipped with an internal circuit breaker.
3. Connect the COMM 1 serial port to the 5270 Data Acquisition System. Each signal provided by the MPRO<sup>®</sup> must be assigned a unique I/O address.
4. Connect the COMM 2 serial port to the 5270 Data Acquisition System. This port is used to capture binary waveform data. The instrument may be operated without this port

- unless diagnostic data captures are required. Refer to the 5270 DACS manual for configuration details.
5. The DIAG port is used with a remote keypad. The keypad is not used during normal operation of the instrument.
  6. Connect the air, water, and drain lines to the MPRO Analyzer using the pre-assembled tube set provided in the accessory kit. The tube fittings have labels to match the port they connect to. Refer to the tubing connection diagram (348-1036). The accessory kit also contains spare nuts and ferrules.



**Figure 2 - Back View of MPRO<sup>®</sup> Instrument**

*Note: The drain system must be capable of handling hot water up to 212 °F / 100 °C or brief surges of up to 400 °F / 204 °C steam for short periods during initial cooling of the instrument. If two or more analyzers are connected to a common drain line, it is recommended that the common drain be 3/8 inch / 10mm inside diameter, minimum. It is also recommended to use metal drain lines. Copper tubing with brass fittings is satisfactory.*

*Note: The ports use 1/4 inch or 1/8 inch female NPT threaded connections. The NPT ports are adapted for use with 1/4 inch and 1/8 inch tubing using Swagelok® fittings. For high pressure connections, the 1/8 inch stainless steel tubing must have 0.035 inch wall thickness required for use at 7,500 psi. If metric size tubing is required, the port adapters may be changed to adapt the female NPT ports to metric tube connections. In all cases, the high pressure tubing and connections must be rated for 7,500 psi / 52 MPa.*



**Figure 3 - Back View of MPRO® Tube Connections**



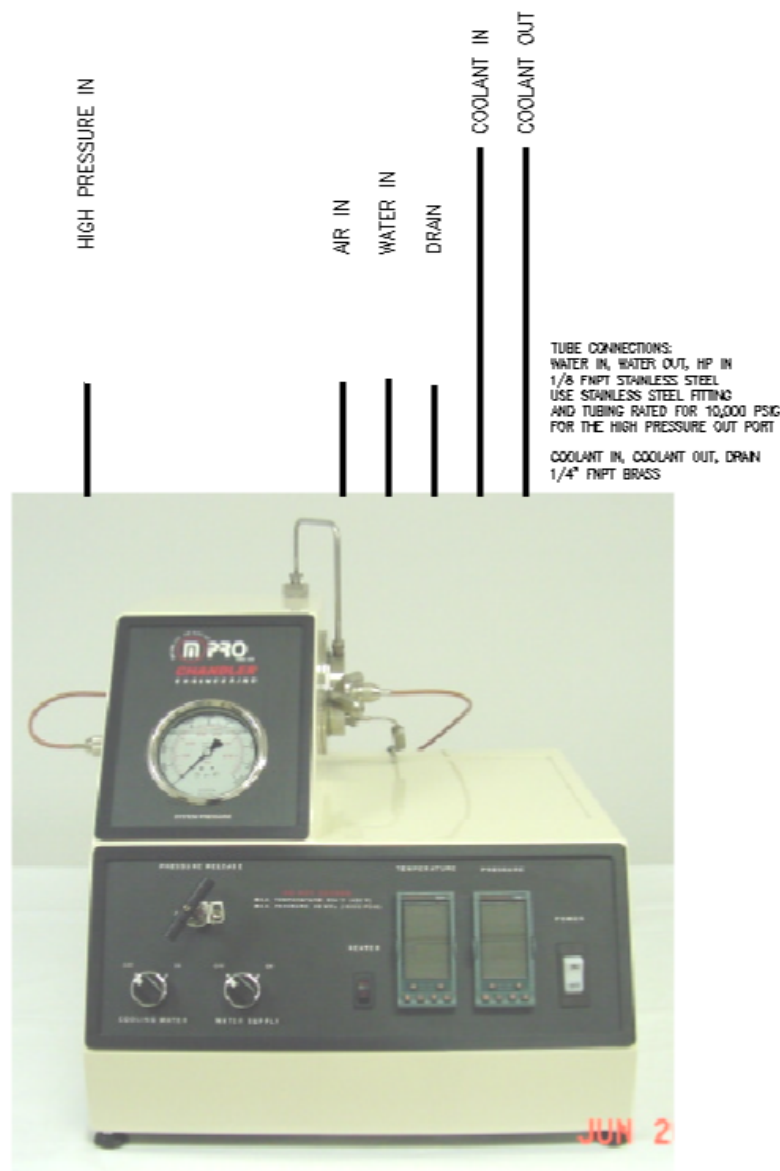


Figure 4 - MPRO® Tubing Connections

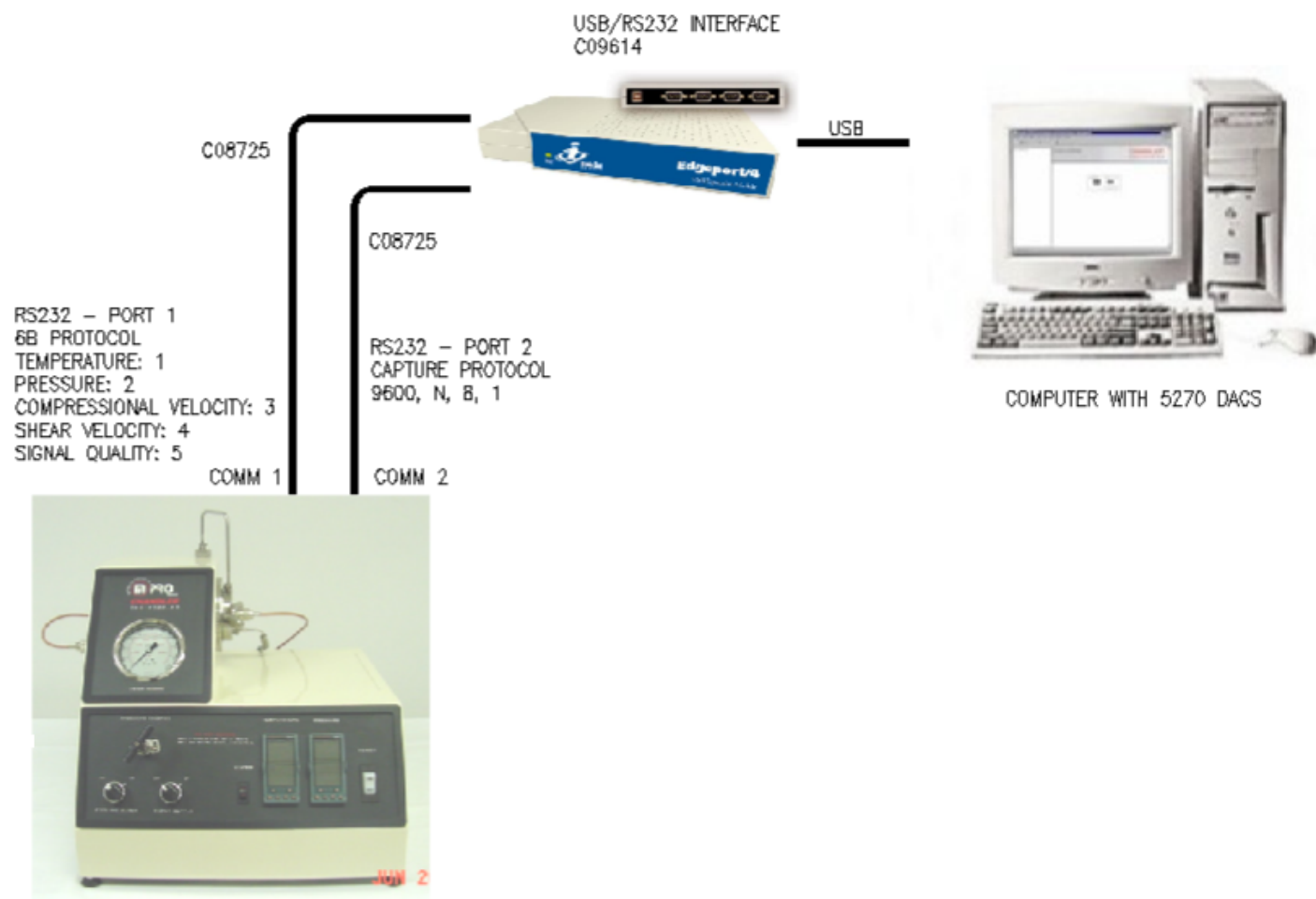
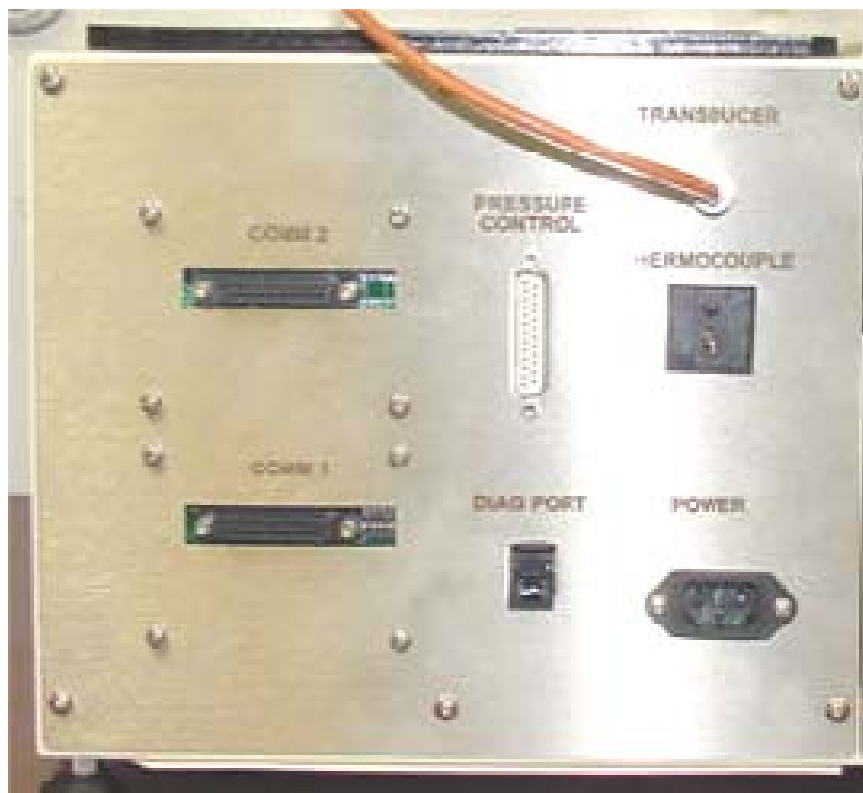


Figure 5 Serial Communication Connections





**Figure 6 MPRO® Electrical Connections**

## Configuring the 5270 DACS Software

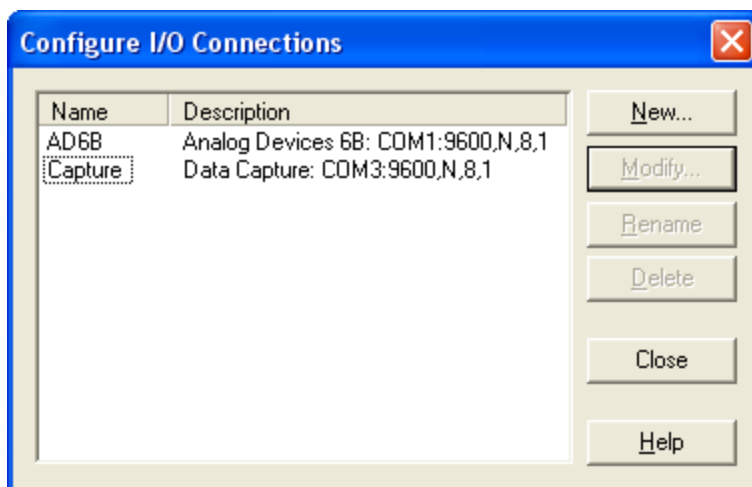
The 5270 software is used with the MPRO®. A standard instrument is provided that contains pre-defined graphs and configurations for the MPRO®.

Generally, the instrument is supplied with a computer that has the instrument pre-configured. If not, 5270 must be installed on the computer involving hardware address definitions for temperature, pressure, compressional wave velocity and shear wave velocity. Each vessel is calibrated and these values must be entered into the calibration section for compressional wave velocity and shear wave velocity.

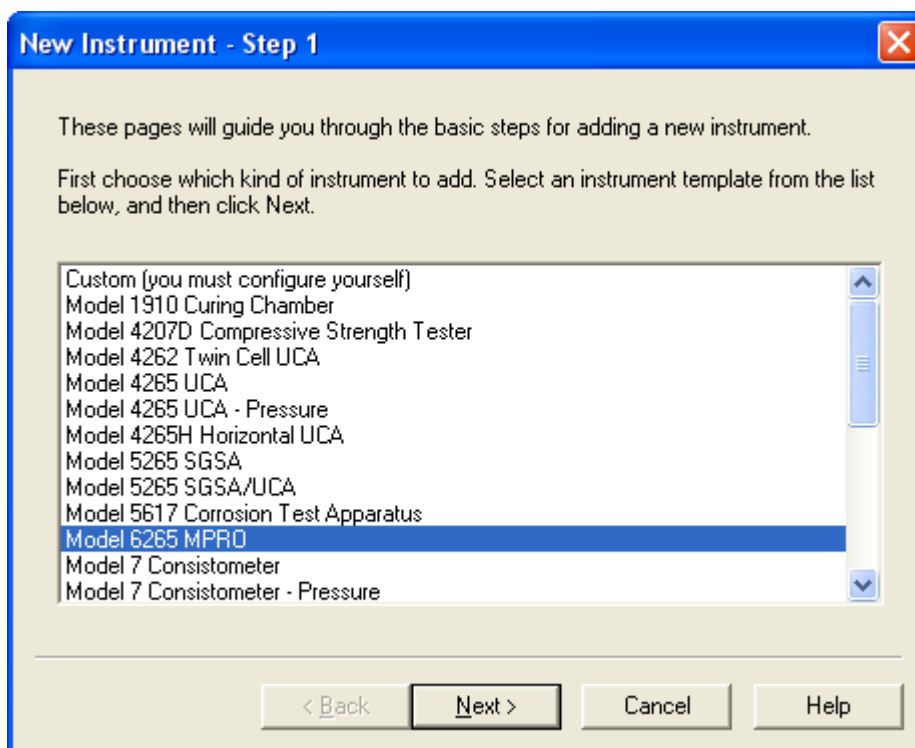
Use the following steps to configure 5270 for use with an MPRO®:

1. Start 5270.
2. Select Tools-Configure-I/O Connections





3. Create two I/O connections as shown above. One connection is used for normal data collection, the Capture port is used for diagnostic waveform captures.
4. Select Tools-Configure-Instruments
5. Select the Model 6265 MPRO as shown below:



6. Enter the desired instrument name and a file name prefix:

New Instrument - Step 2

Enter a unique name and serial number for the new instrument.

Name: Model 6265 MPRO

Test file prefix/serial number: 6265

NOTE: Tests that are run using this instrument are saved in separate files, and the default names given to those files will be composed of the test file prefix entered above followed by an automatically-incrementing number.

Often the instrument serial number is used as the test file prefix.

< Back Next > Cancel Help

7. Define the I/O Connection and I/O addresses as shown below. Note that the actual I/O addresses may differ. The values are recorded on a data sheet that is provided with the instrument.

## Model 6265 Mechanical Properties Tester (MPRO®) Final Testing Summary

Date: \_\_\_\_\_ Tested By: \_\_\_\_\_ Serial Number: \_\_\_\_\_

### Vessel Material Information

Vessel Material Heat Number: \_\_\_\_\_

Top Plug Heat Number: \_\_\_\_\_

Bottom Plug Heat Number: \_\_\_\_\_

Heat Number stamped on vessel and plugs? (Yes/No) \_\_\_\_\_

### Instrument Pressure Testing

<i>Initial Pressure (psi)</i>	<i>Final Pressure (psi)</i>	<i>Time (minutes)</i>
2,500		5
5,000		5
7,500		20

### Interface Configuration

Channel Addresses				
<i>Switch Setting</i>	<i>Parameter</i>	<i>Data Type</i>	<i>Data Format</i>	<i>Address</i>
SW1	Temperature	"J" Thermocouple	Engineering Units	1
SW2	Pressure	0-5 Vdc	Engineering Units	2
	Compressional Transit Time		Engineering Units	3
	Shear Time		Engineering Units	4
	Signal Quality		Engineering Units	5

### Transit Time Offsets

Compressional wave velocity offset value: \_\_\_\_\_

Shear wave velocity offset value: \_\_\_\_\_

Compressional wave threshold value: \_\_\_\_\_ (configured using the diagnostic keypad)

Shear wave threshold value: \_\_\_\_\_ (configured using the diagnostic keypad)

### Engineering Units

Temperature units: \_\_\_\_\_ °F or °C

Pressure units: \_\_\_\_\_ psi or MPa

### Software Versions

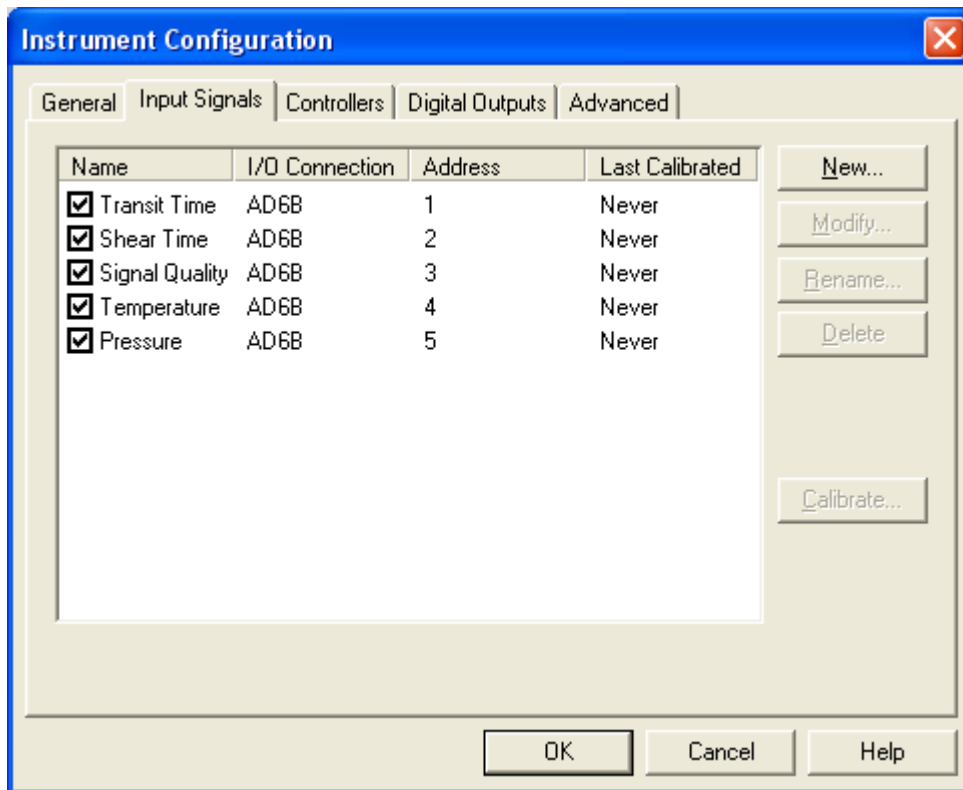
5270 Version: \_\_\_\_\_

MPROCAL Version: \_\_\_\_\_

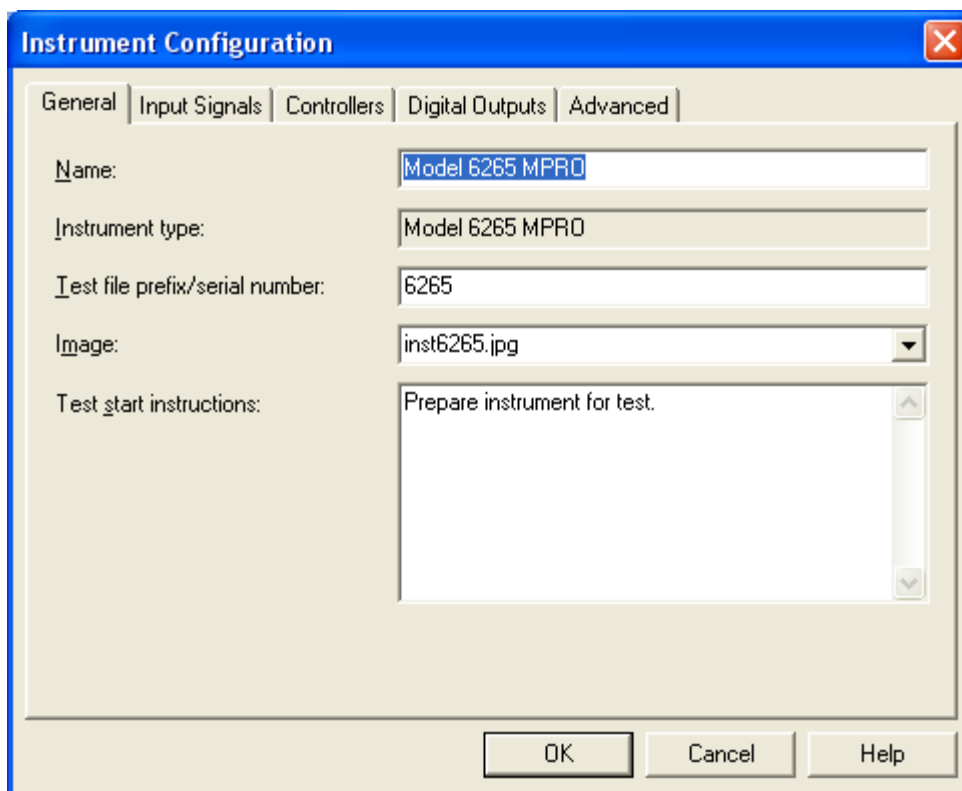
Attach the final cement test plots for Compressive Strength, Poisson's Ratio, Young's Modulus, Bulk Modulus.

Final Compressive Strength: \_\_\_\_\_ (must be greater than 2000 psi to be acceptable)

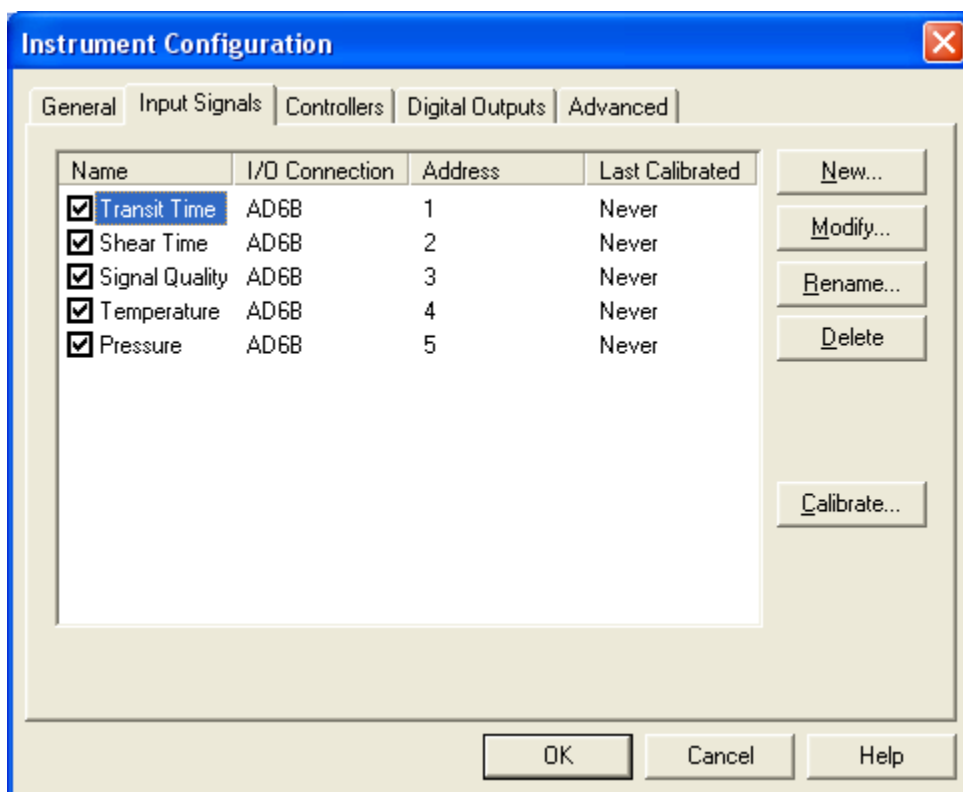
Final Poisson's Ratio: \_\_\_\_\_ (greater than 0.22, less than 0.32 to be acceptable)



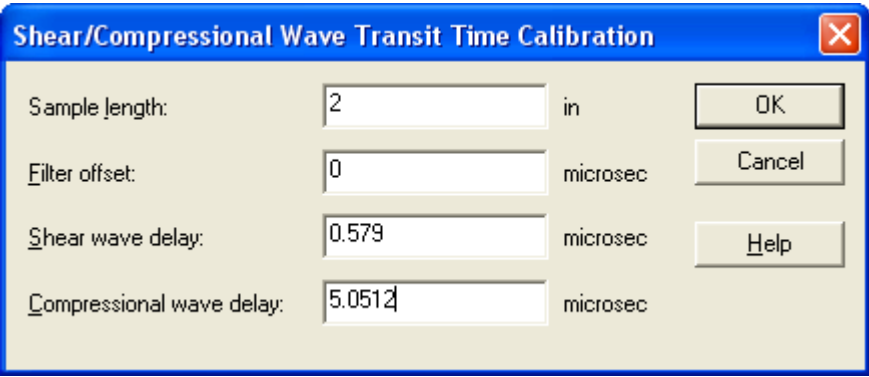
8. The Transit Time and Shear Time values must be calibrated before the instrument is used. The calibration values are provided as “offset” values on the data sheet with the instrument.
9. Select Tools-Configure-Instruments. Select the MPRO<sup>®</sup> instrument that was created.
10. Select Modify.



11. Select the Input Signals tab.



12. Select the Transit Time signal and press Calibrate. Enter the values from the data sheet provided with the instrument. The Sample Length and Filter Offset values are always 2 and 0, respectively. The Shear Wave Delay and Compressional Wave Delay values vary with vessel.



The image shows a software dialog box titled "Shear/Compressional Wave Transit Time Calibration". It contains four input fields with labels and units, and three buttons on the right. The input fields are: "Sample length:" with a value of "2" and unit "in"; "Filter offset:" with a value of "0" and unit "microsec"; "Shear wave delay:" with a value of "0.579" and unit "microsec"; and "Compressional wave delay:" with a value of "5.0512" and unit "microsec". The buttons are "OK", "Cancel", and "Help".

Parameter	Value	Unit
Sample length:	2	in
Filter offset:	0	microsec
Shear wave delay:	0.579	microsec
Compressional wave delay:	5.0512	microsec

13. The Shear Time calibration is identical to the Transit Time calibration.
14. Calibrating the Temperature and Pressure signals involve the use of a simulated thermocouple calibrator and a master pressure transducer. In each case, Zero and Span values are provided to calibrate the input channels.

## Section 2 – Operating Instructions

### Description of Valves and Switches



Figure 7 - MPRO® Valves



Figure 8 - MPRO® Controls

For the following descriptions, refer to the above Figure.

### **Main Power Switch**

The main power switch supplies all of the power to the unit.

### **Pressure Controller**

The pressure controller is no longer a part of the MPRO system. The Quzix pump system is used to control the sample pressure.

### **Temperature Controller**

The temperature controller, coupled with the heater switch, controls the heat-up of the sample in the vessel. The desired temperature schedule is programmed into the controller (ramp and dwell segments). The heater switch must be in the ON position for heating of the sample to occur.

### **Heater Switch**

The heater switch controls the power to the heaters and must be placed in the ON position for the heaters to begin heating. Upon completion of a test, the Heater switch should be placed in the OFF position.

### **Pressure Release Valve**

The Pressure Release valve is used to relieve the pressure from the MPRO<sup>®</sup> unit.

### **Cooling Water Switch**

The Cooling Water switch supplies the MPRO<sup>®</sup> unit with cooling water when in the ON position.

### **Water Supply Switch**

The Water Supply switch supplies the MPRO<sup>®</sup> unit with water when in the ON position.

## **Pressure Vessel Preparation**

The pressure vessel consists of a vessel, top plug assembly, bottom plug assembly, and seals. The elastomer seals and backup rings may be replaced as required by the user.

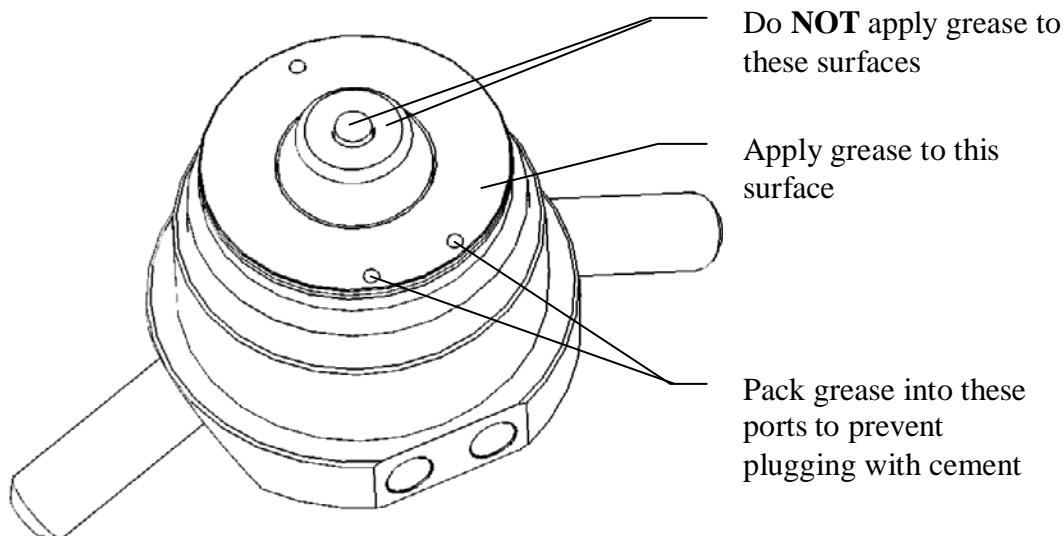
The plug assemblies are not user serviceable. The vessel and the plug assemblies must be used as a matched set of components. Do not attempt to remove the transducer assemblies since they are easily damaged.

To prepare the vessel for use:

1. Remove the top and bottom plugs from the vessel.
2. Replace the o-ring if wear is apparent.
3. Apply lithium grease to the inner tapered surface of the vessel.



4. Apply lithium grease to the surfaces of each plug that contact the cement slurry as illustrated below. **DO NOT** apply grease to the center transducer element on each plug.
5. Verify that the pressure port passages are free of cement. If plugged, carefully use a 1/8 inch / 3mm drill bit to remove the cement. Note that the passages are drilled at an angle.



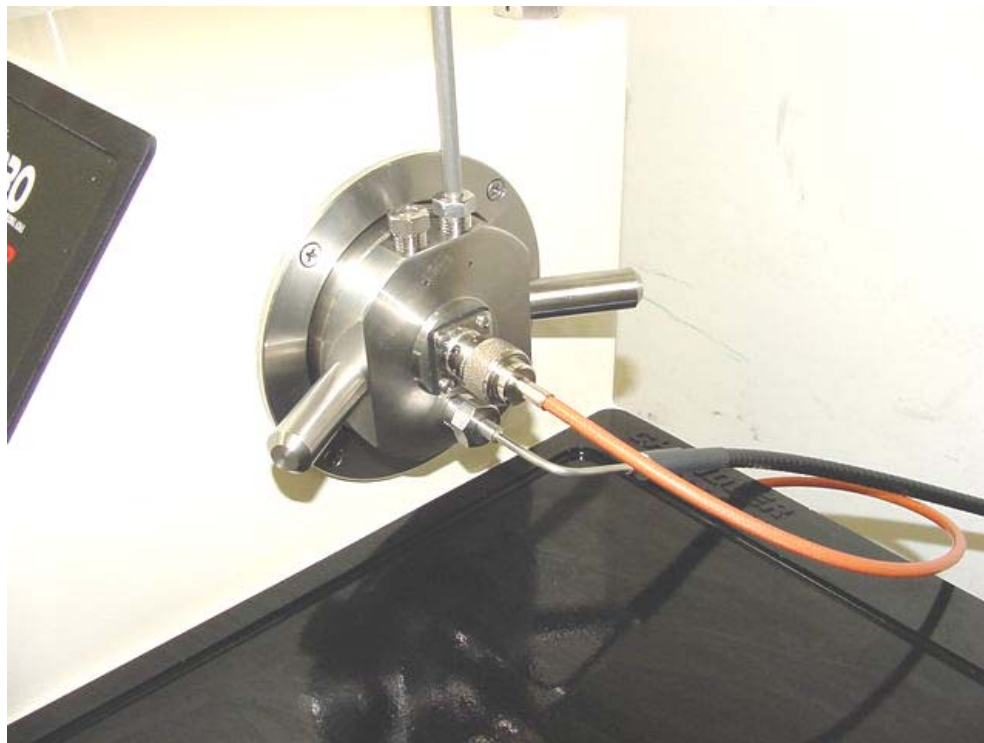
**Figure 9 MPRO® Top Plug**

6. Insert the bottom plug assembly into the vessel. The vessel must be oriented with the label TOP upwards. Hand-tighten the plug until the shoulder meets the vessel.
7. Mount the vessel in a bench vise in preparation for filling with prepared cement slurry.

## Filling the Pressure Vessel

1. Prepare the vessel using the “Pressure Vessel Preparation” procedures above.
2. Fill the vessel with slurry until level with the slurry level gauge. Do not allow cement to contact the sealing surface or the threads.
3. Insert the top plug assembly into the vessel. Hand-tighten the plug until the shoulder meets the vessel.
4. Insert the high pressure plug into the left port.
5. Apply a thin layer of grease on the thermocouple.
6. Insert the thermocouple in the vessel and hand-tighten the fitting.
5. Carry the vessel to the MPRO®.
7. Slide the vessel into the heating and cooling jacket on the MPRO® instrument with the pressure port oriented vertically.
8. Connect the U-tube and filter assembly between the top pressure ports. Tighten both ports using a 1/2 inch open-end wrench.

9. Tighten the thermocouple port using a 5/8 inch open-end wrench.
10. Connect and hand-tighten the signal cables to the top and bottom connectors on the vessel.



**Figure 10 - MPRO® Pressure Vessel Connections**

## Starting a Test

Once the vessel is filled and connected to the MPRO® instrument, the temperature and pressure schedules must be defined.

Pressure control is provided using Pumpworks software. Use the following information as a preliminary guide to using Pumpworks and pump. Additional details may be found in the Quizix Pumpworks manual.

## Quizix First Start-Up Operations

1. Assure there is an air source connected to the pump, and that the inlet of the pump is plumbed with tubing to a refill reservoir, and that the outlet of the pump is plumbed to an open reservoir or back to the refill vessel; at this time, we do not want to plumb the outlet of the pump to the test apparatus, UNLESS we have a method of diverting the outlet flow of the pump to an open reservoir. Turn the pump(s) on via the switch on the AC inlet. The two digit LED display on the front of the pump (or on the front of the pump controller) will cycle through a start up sequence for about a minute and then flash “d0”.
2. Launch PumpWorks on your computer.

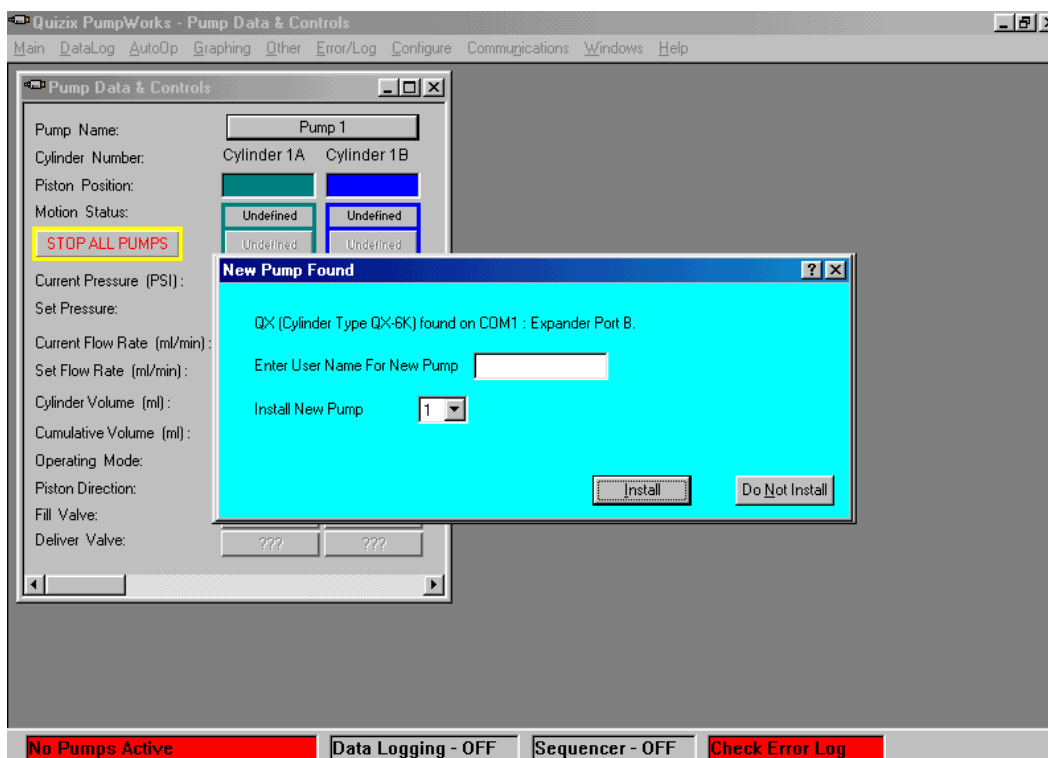


Figure 1 Starting PumpWorks software

PumpWorks will automatically search for the serial expander and then for a connected pump. After about a minute, PumpWorks should inform you that a new pump has been found. Click the “Install” button as shown in Figure 1. The Pump Data and Control window in PumpWorks will fill in with information and the two digit display on the pump controller will change to a flashing “\_1” (indicating this is the first pump installed.) The “\_1” will continue alternating with “d0” until the safety pressure is set.



NOTE: If more than one pump is being installed, subsequent pumps will flash “\_2”, “\_3”, and so on indicating the position each pump is installed at.

- When “d0” is being displayed, PumpWorks will require you to enter safety pressures for the pump and a dialog box will appear. Enter appropriate safety pressures for all cylinders and click on the “Send Safety Pressures to Pumps” button.

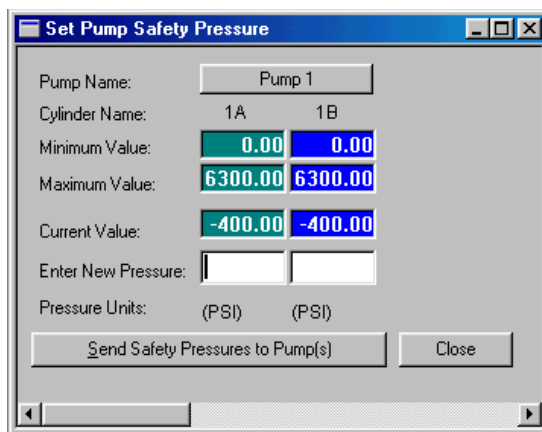


Figure 2- Safety pressure settings window

Each pump type has a maximum pressure it will support, but the user should set a lower safety pressure if other components in the flow system cannot support the pump's maximum pressure rating. Generally, safety pressures should be set according to one or more of the following criteria:

- a. Maximum pressure capability of the test apparatus.
- b. Maximum pressure the sample should be exposed to

NOTE: When installing multiple pumps, occasionally pumps will install in wrong positions, i.e. Pump 1 should really be Pump 2 or 3, and so on. To change the pump position within PumpWorks software, go to the CONFIGURE tab, select "Reassign Pump Number", and move the pump to the correct position.

## PRIMING THE PUMP

4. Before starting the pump, you need to prime the pump (i.e., get fluid into the pump's cylinders.) On the main Pump Data and Control window, click on the "Operating Mode" button for Pump 1 Cylinder A; this will bring up the dialog box with the pump operating modes. Select Mode 1C "Individual Constant Rate-Cycled". Click on the "Set Flow Rate" button and set any desired flow rate up to the maximum indicated.

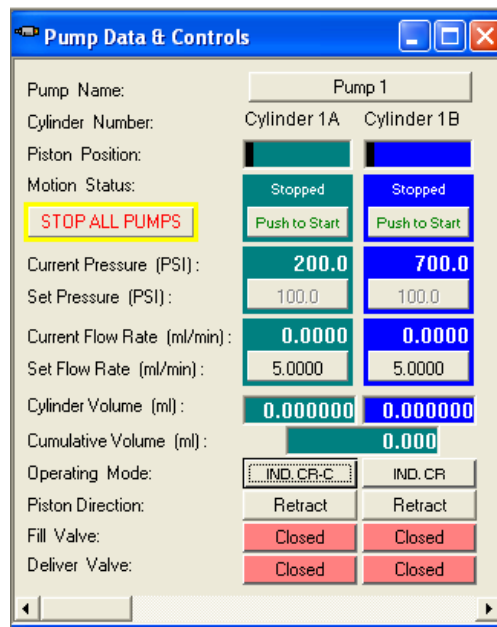


Figure 3 Pump Data and Control Window

5. Assure all valves for both cylinders are CLOSED. You can click on the Fill Valve and Deliver Valve buttons located on the bottom of the Pump Data and Control window to toggle the valves open or closed.
6. Now you can start Cylinder 1A in motion by clicking the button marked “Push to Start”. The pump will automatically open/close the deliver and fill valves for Cylinder 1A as appropriate and begin to automatically fill itself. Allow the pump to run for two to ten piston strokes to remove the air from the cylinder. Once you can no longer see air bubbles exiting the outlet line, the cylinder is full of fluid. Stop the cylinder with piston in the fully retracted position.
7. Now you need do the same steps to Cylinder 1B. It is recommended that we fill/purge only one cylinder at a time. If multiple pumps are connected, you can fill/purge multiple pumps at the same time, as long as we only fill one cylinder from each pump at a time.

## ZERO PRESSURE TRANSDUCERS AND SET COFIGURATIONS

8. After filling both cylinders, leave the fill valves open. If the fill valves are closed, you can open them by clicking on the Fill Valve button located on the Pump Data and Control Window near the bottom of the window. The pressure transducers are calibrated at the factory, but the initial value for ambient pressure may be different. You can set the initial value of the pressure transducers at this time by clicking on the “Other” item on the main menu and then selecting “Software Pressure Transducer Calibration”. The dialog box shown in Figure 4 will show the current pressure value for each transducer, as well as the Current Offset gain (zero gain) and Current Gain (high span gain). Since the Fill Valves are open, the Current Pressure value should be at or near ambient, and can be set to zero by clicking the “Current Offset” button and selecting “Auto Zeroing” button. If you have a version of PumpWorks software greater than 6.02, you can click the check-boxes for “cylinders to change”, and then click the “Auto-Zero All Checked Cylinders”. Do not change Current Gain, as this is the factory span calibration factor.

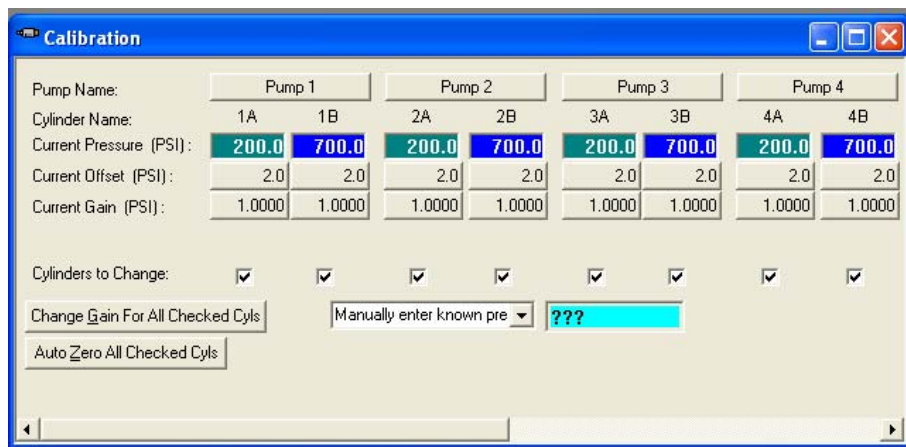


Figure 4 Pressure Transducer Auto Zero Calibration

9. Now go to the CONFIGURE tab, and select “Pump Operating Parameters”. A window should open as in Figure 5. Criteria for setting the configuration parameters are as follows:

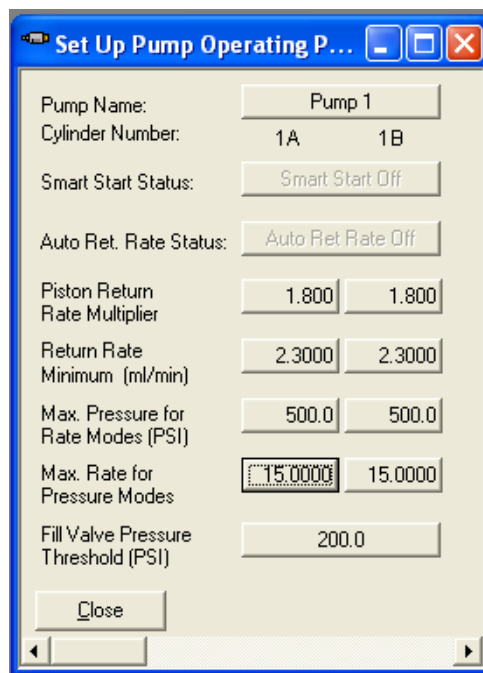


Figure 5 example of operating parameter window

*Note: Settings shown in Figure 5 are specific to a QX-5000 pump module; settings for Max Pressure for Rate Mode and Max Rate for Pressure Mode will be different than shown for other Quizix pump models.*

## PUMP PRESSURE SERVO CONTROL GAINS

10. PumpWorks allows the user to set proportional and differential pressure servo gains. Of most importance is correct Closed Valve gain settings; this assures the pump correctly matches cylinder pressures before switchover without excessive overshoot or undershoot. Open Valve gains are provided to assure the pump reacts correctly to larger system volumes when operated in pressure control modes. Essentially, proportional gain is like stepping on the gas in your car; a

higher value will cause the pump to react quicker to reach a pressure. Differential gain is like stepping on the brake; this will dampen (or reduce the rate of change) once the pressure is close to the target. See the PumpWorks manual for complete discussion on this feature. Typical values for Closed Valve gains are 2000 and 2000. Check these values before operating the pump is assure

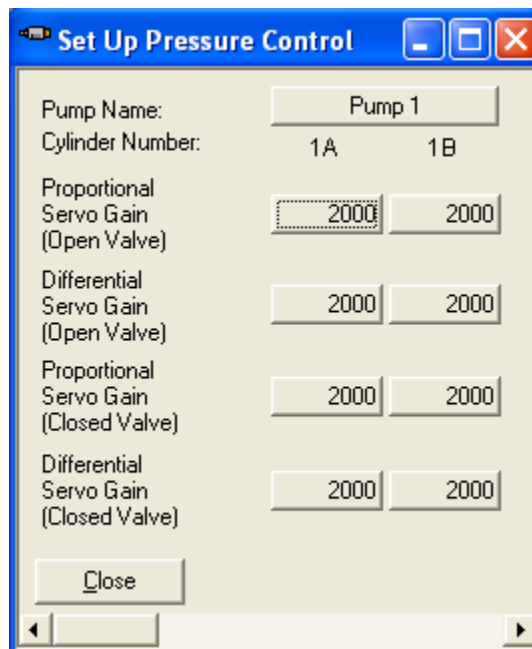


Figure 6 Pressure Servo control Window

## RESETTING CYLINDER VOLUMES TO ZERO

11. Now we need to reset our cylinder volumes to zero. Click the MAIN tab, and select “Reset Volumes to Zero”. You can select individual cylinder volumes or cumulative volume, or click “Reset All Volumes to Zero”. Resetting the cylinder and cumulative volumes to zero provides the user with a distinct starting point for volume calculations, and is typically done once the pump is primed and both cylinders are in the correct position for running the necessary mode of operation.

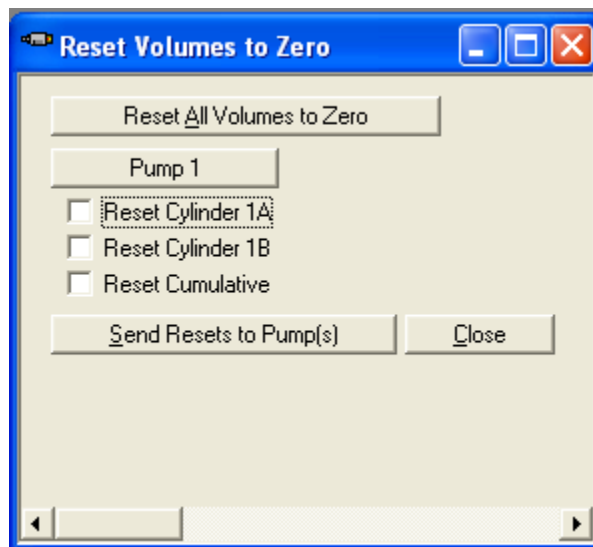


Figure 7 Reset Volumes to Zero window



## PUMP SET UP FOR DUAL CYLINDER BI-DIRECTIONAL MODE (pressure)

12. Bi-directional mode is used when the application requires that the pump be capable of delivering AND receiving fluids at a pressure set point. Pumps operated in Bi-Directional Pressure Mode should have their pistons set at 50% extended position for correct start-up. See Figure 6C, and look at the graphical piston position bar located at the top of the Pump Data and Control window for pump 4 (Bi-Directional Mode) for an example of proper piston position for this mode.
  - a. To manipulate pistons into the correct position, click on the Operating Mode button, and select Mode 1, Independent Constant Rate mode.
  - b. Enter a flow rate of 50% of pump maximum.
  - c. Open the FILL valve by clicking the FILL VALVE button located under each cylinder.
  - d. Click the Push to Start button for each cylinder, and allow the piston to extend until it reaches approximately 50% of its travel, and stop the cylinder.
13. Click the Operating Mode button, and select Mode 12, Paired Constant Pressure Bi-Directional Mode. Enter a pressure set point, and click the Push to Start button.

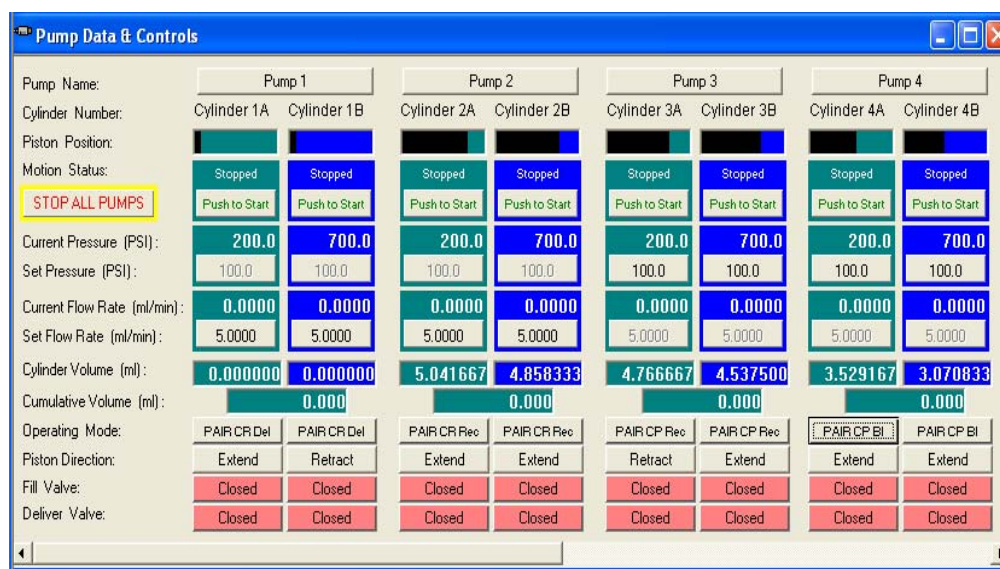


Figure 6C, Pump 4 Piston Position for Bi-Directional Mode

*Note: In Constant Pressure Bi-Directional mode, the pump will first extend the cylinders to reach the pressure set point; this is normal. Once the pressure set point is reached, the pump will automatically begin receiving fluids at the desired pressure set point.*

### Temperature Schedule

The controllers may be programmed to heat and pressurize the sample using programmable ramp and soak segments. The maximum number of segments that may be used by each controller is 8.

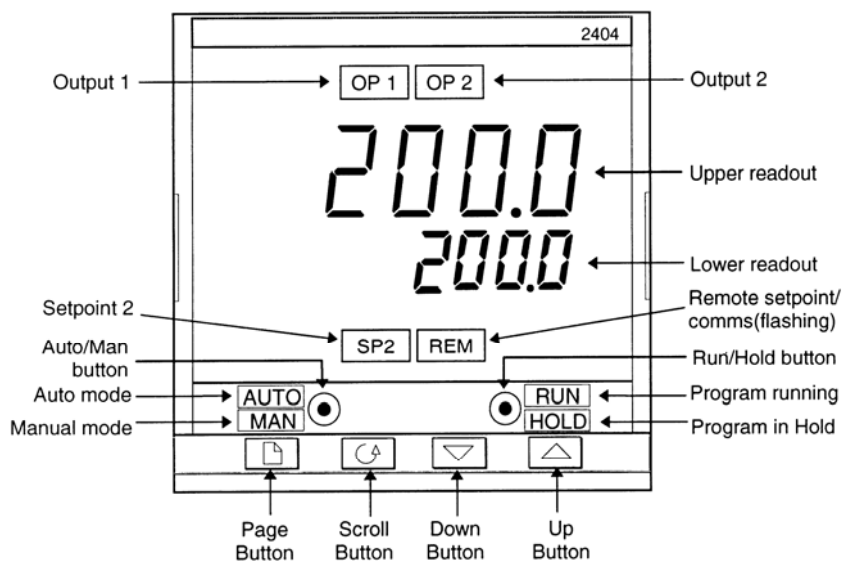
Configuring the controller involves defining the time to ramp to a new temperature or pressure from the current temperature or pressure and the final stable temperature or pressure. This process is commonly referred to as the **ramp time** and the **dwel**. The time to ramp to a new set point may be defined as the time between two set points (*minutes*).



Once the program exists, the program is executed by pressing the **Run** button. To suspend the program the **Run/Hold** button may be pressed briefly (*Run* light flashes) and restarted by pressing the **Run/Hold** button again. To terminate the program, the **Run/Hold** button is pressed until the Run light is OFF.

*Note: For a temperature control program, it is safe practice to place the controller in **Manual** after terminating a program by pressing the **Auto/Man** button and use the **Up/Down** keys to set the controller output at **0.0%**. This will prevent the heater from being turned **ON** inadvertently. Always turn **OFF** the heater switch when the heater is not used.*

Use the following procedure to enter and run a temperature or pressure control program:



**Figure 11 - Temperature or Pressure Controller**

1. Press the **Page** button until the **Prog** menu appears.
2. Press the **Scroll** button until the Segment number is displayed (**SEGn**).
3. Enter a segment value=1. This will define the ramp segment of the program.
4. Press the **Scroll** button.
5. Enter the segment type (**tYPE**). Use the Up/Down buttons to enter a ramp time (**rmP.t**) type.
6. Press the **Scroll** button.
7. Enter the target set point (**tGt**). This is the temperature (or pressure) at the end of the ramp.
8. Press the **Scroll** button.
9. Enter the duration of the ramp (**dur**) in minutes.
10. Press the **Scroll** button.
11. Enter a segment value 2. This will define the dwell segment of the program.
12. Press the **Scroll** button.

13. Enter the segment type (**tYPE**). Use the Up/Down buttons to enter dwell (**dwELL**) type.
14. Press the **Scroll** button.
15. Press the **Page** button until the controller displays the current process value.
16. Press the **Auto/Man** button to place the controller in the Auto mode.
17. Press the **Run/Hold** button to start the program.

*Note: Be certain to turn the heater switch on the front panel of the instrument to the ON position.*

*Note: Once a program has been entered into the controllers, they may be reused by pressing the **Run/Hold** button to run the program again.*

To stop the program, use the following procedure:

1. Press and hold the **Run/Hold** button until the Run light turns **OFF**.
2. Press the **Auto/Man** button to place the controllers in manual mode.
3. Use the **Up/Down** keys to change the output power percentage to 0.0%.
4. Turn the heater switch on the front panel of the instrument to **OFF**.

# Section 3 – Maintenance

## Tools Required

- 5/8 inch Wrench
- 1/2 inch Wrench
- Teflon Tape
- Hex wrenches
- Screwdrivers (flat blade, Phillips head)
- Bench Vise

## Cleaning and Service Tips

- Keep the test cell surfaces exposed to cement coated with a thin layer of grease. The tips of the MPRO<sup>®</sup> transducers must be free from grease. This reduces the chance of corrosion and prevents cement from adhering to the metal.
- Keep cement off threads and out of the high-pressure ports on the top plug of the test cell.
- Lubricate the threads on the test cell plugs periodically with anti-seize lubricant.
- Thoroughly clean test cell of all cement immediately after each test.
- Keep the sensor faces and cavities inside each test cell plug clean and flat.

## Calibration Procedure

The temperature and pressure controllers require periodic calibration. The procedures related to calibrating the controllers are found in the controller manuals.

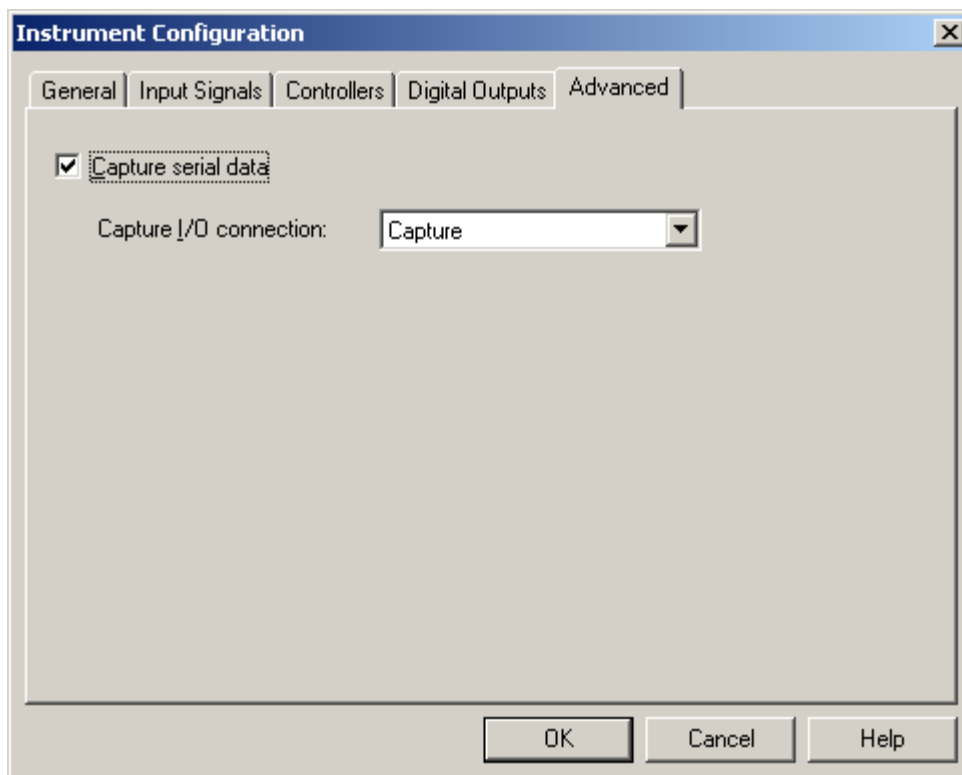
The instrument does not require calibration for the measurement of Poisson's ratio and Young's modulus. These measurements are absolute and there are no user accessible adjustments.

The acoustic vessel performance is characterized at the factory and reference data is delivered with the instrument. The MPROCAL program is used to compare the acoustic performance with the original reference data. If the performance exceeds pre-determined tolerances, the vessel must be returned to the factory for reconditioning.

The procedure to gather performance data is listed as follows:

1. Remove the cell from the instrument.
2. Thoroughly clean the vessel assembly.
3. Fill the cell with distilled water.
4. Install the cylinder assembly into the instrument. Connect the top and bottom transducer cables, pressure line, and thermocouple.
5. Pressurize the cell to 3000 psi using the Quizix pressure control system to maintain a highly accurate pressure.
6. Stabilize the temperature to within  $\pm 0.20^{\circ}\text{C}$ .

7. Configure 5270 to Capture Data as shown below. Note that the secondary serial cable must be connected to the instrument to allow capture of waveform data (CAP file).



**Figure 12 - 5270 Software Instrument Configuration**

1. Start a 5270 test and capture at least 10 minutes of data using the distilled water as the sample. Save the file as SNxxx Data.TST. Note that a file SNxxx Data.CAP is also created in the same folder.
2. The MPROCAL program may be used to view the contents of the SNxxx Data.CAP file. This program is not a means to calibrate the vessel.
3. The acoustic signal performance may be evaluated using the MPROCAL program. Use procedure 348-2101 to evaluate the vessel performance characteristics using water. This procedure provides a means to verify the compressional wave velocity through water at a known temperature and pressure.

## Replacing the O-rings

1. Disconnect the signal cables from the top and bottom of the cell.
2. Disconnect the thermocouple cable; do not remove the thermocouple to avoid spilling water.
3. Disconnect the pressure line and filter assembly from the top of the cell.
4. Remove the cell from the MPRO<sup>®</sup> unit as shown below.



**Figure 13 - MPRO<sup>®</sup> Pressure Vessel and High Pressure Filter Assembly**

5. Unscrew the top and bottom plugs from the test cell as shown on the following page.
6. The O-ring and back-up ring should be changed on both the top and bottom plugs if there is any evidence of wear. Grease replacement O-rings thoroughly before installing.

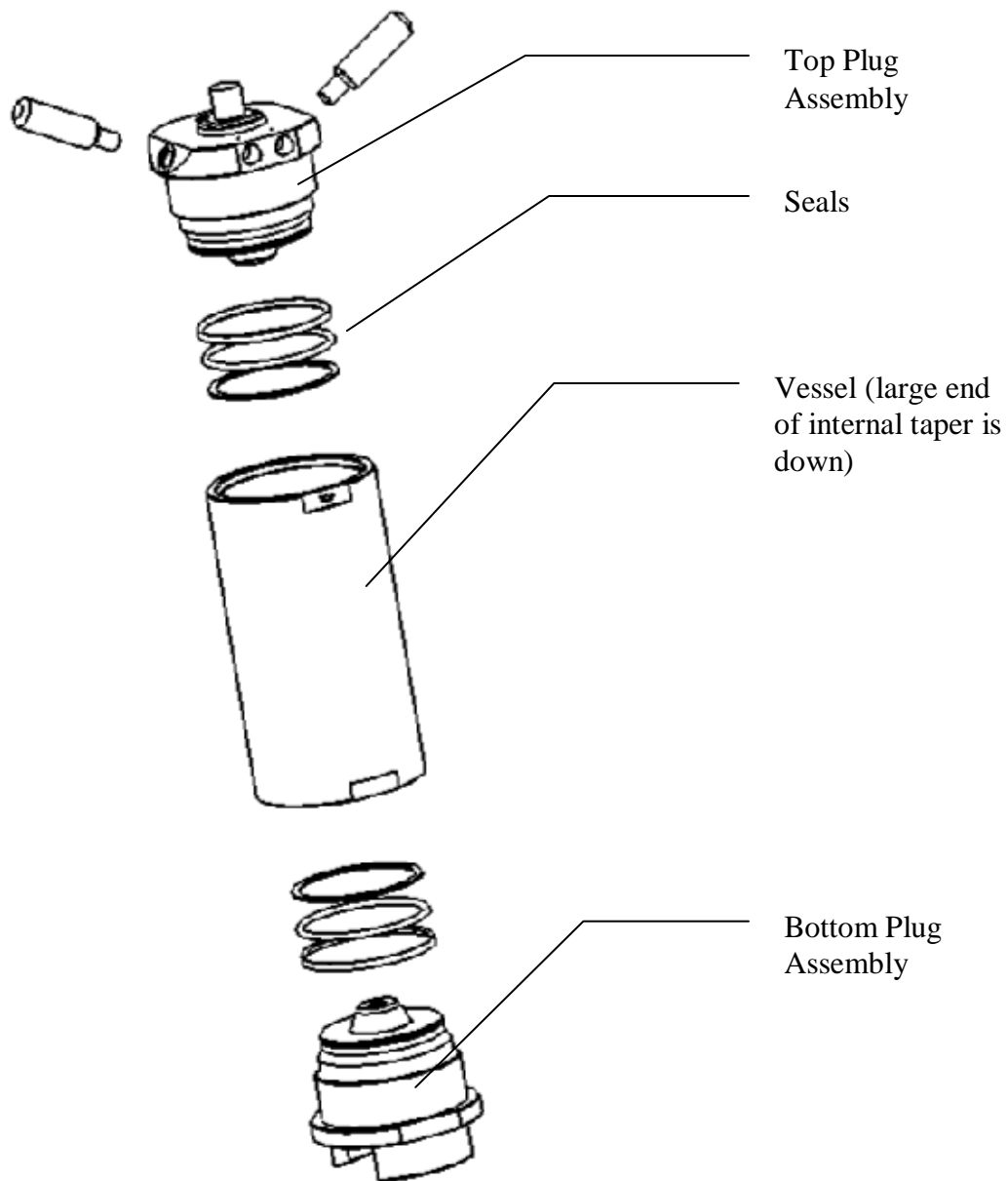


Figure 14 - MPRO® Pressure Vessel Exploded Assembly

# Maintenance Schedule

MAINTENANCE SCHEDULE Model 6265 Mechanical Properties Analyzer (MPRO®)					
COMPONENT	EACH TEST	MONTHLY	3 MONTHS	6 MONTHS	ANNUAL
Vessel Seals	Inspect & replace as required				
Vessel Assembly	Clean				
Rupture disc					Replace
Signal Cables					Inspect & replace as required
Temperature Controller				● Calibrate	
Pressure Controller				● Calibrate	
This maintenance schedule applies to normal usage of two tests per day. Detailed procedures for these operations are contained in your manual. ● Per API Specifications σ Where Applicable					

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## Section 4 – Troubleshooting Guide

Problem	Solution
No compression transit time signal	<ol style="list-style-type: none"> <li>1. Connect signal cables to vessel.</li> <li>2. Apply pressure to sample.</li> <li>3. Inspect end plugs to verify that cement has not invaded the annual groove surrounding the transducers.</li> <li>4. Load vessel with water and pressurize.</li> <li>5. Start a test using 5270. If no signal exists, contact Chandler Engineering.</li> </ol>
No shear transit time signal	<ol style="list-style-type: none"> <li>1. Verify that the sample is solid.</li> <li>2. Connect signal cables to vessel.</li> <li>3. Apply pressure to sample.</li> <li>4. Inspect end plugs to verify that cement has not invaded the annual groove surrounding the transducers.</li> </ol>
System will not pressurize	<ol style="list-style-type: none"> <li>1. Verify that the water supply is present and turned ON.</li> <li>2. Verify that the air supply is present.</li> <li>3. Verify that air is not present in the lines by flowing water to drain.</li> <li>4. Check for water leaks.</li> <li>5. Check the pressure control program.</li> </ol>
System will not heat	<ol style="list-style-type: none"> <li>1. Verify that the heater switch is ON.</li> <li>2. Verify that the thermocouple is plugged into the port on the back panel of the instrument.</li> <li>3. Check the temperature controller program.</li> <li>4. Verify that the over-temperature limit switch is not open (vessel temperature exceeds 450°F).</li> </ol>

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## Section 5 – Replacement Parts

Part Number	Description
348-1013-1	Cable Assembly, External
348-1013-2	Cable Assembly, External
348-1014-1	Cable Assembly, Internal
348-1014-2	Cable Assembly, Internal
348-1015	Heater Assembly
348-1025	Vessel Assembly
348-1104	Ring, Plug Sealing
348-1107	Tube, High Pressure
348-1116	Gasket, Heater Flange
348-1151	Processor, MPRO®
348-1157	Gauge, Slurry Level
70616-90	Receptacle, Power
7150-0045	Interface, I/O, Data
7750-0115	Plug Top Handle
80-0021	Thermocouple, Plug
80-0112-01/O QF "*****"	Interface, I/O, 5270 Data
C08459	Module, DAQ, Temperature
C08460	Module, DAQ, Pressure
C08564	Seal Retaining Ring
C08565	Plug Oring Seal
C08725	Cable, Serial Comm, 25-9
C08970	Transducer, Pressure
C08973	Controller, Temperature
C09318	Valve, Panel, Low Pressure
C09319	Adapter, Valve, Low Pressure
C09320	Handle, Valve, Low Pressure
C09860	Relay, Solid-state, Heater
C10380	Valve, Check, Low Pressure
C10382	Gauge, 4 inch
C10383	Filter, Inline, High Pressure
C10385	Union, Bulkhead, High Pressure
C10388	Nut, High Pressure
C10396	Valve, Panel, High Pressure
C10402	Plug, High Pressure
C10770	Disc, Rupture, 8750 psi
C11011	Filter, High Pressure
P-2334	Foot, Support
P-2881	Switch, Panel, Rocker

To ensure correct part replacement, always specify model and serial number of instrument when ordering or corresponding.

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## Section 6 - Drawings and Schematics

<b>Drawing Number</b>	<b>Description</b>
348-1030	Diagram, Wiring, MPRO
348-1031	Diagram, Tubing, MPRO
348-1035	Diagram, Cabling, Serial Communication
348-2010	Assembly, Vessel, MRO®
348-2101	Procedure, Field Calibration, Vessel



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12

11

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5

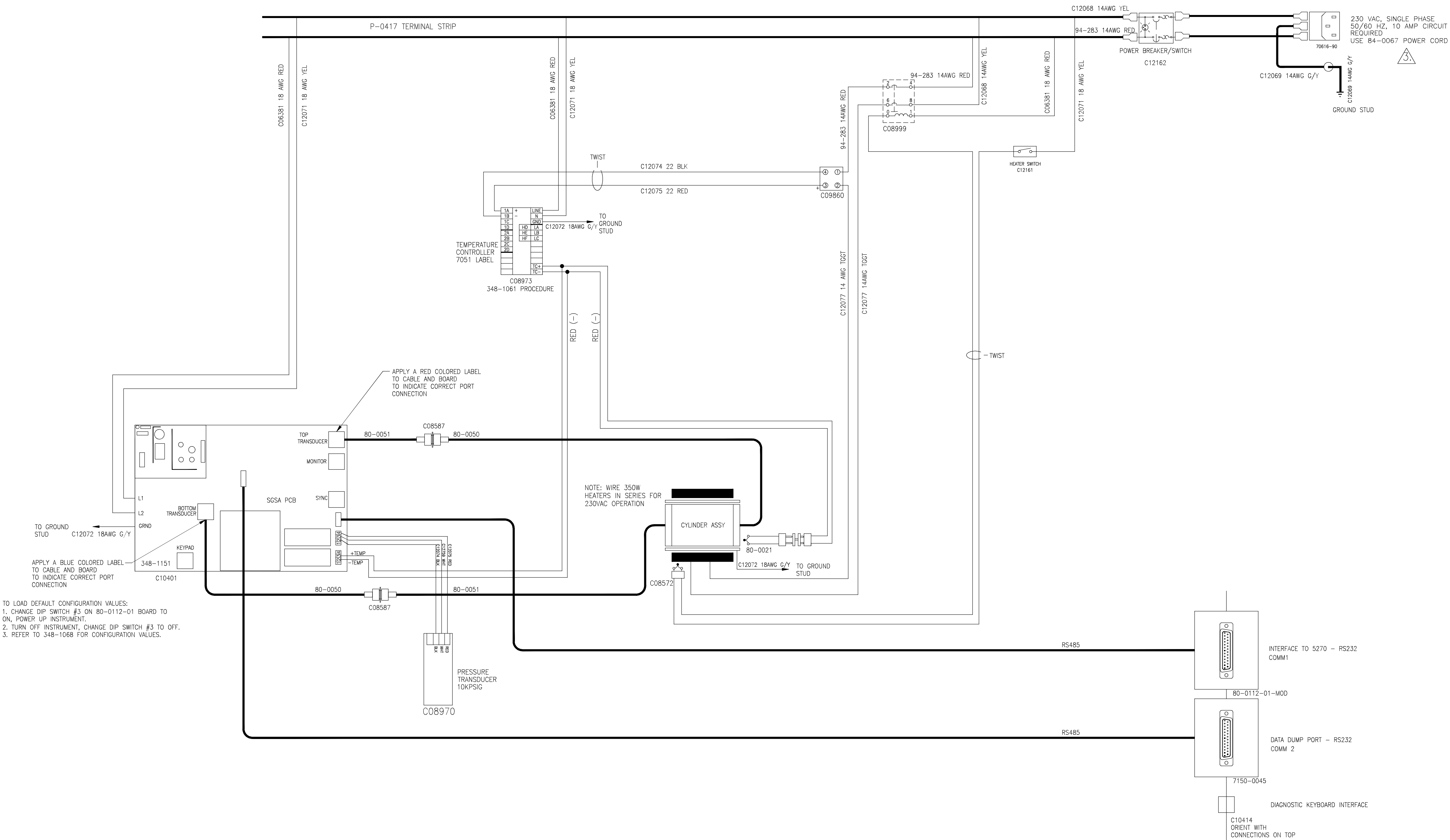
4

3

2

1

REVISIONS			
ZONE	REV	DESCRIPTION	DATE
D-11	E	ECN# T3955, REPLACE 83-0102 W/348-1151	6/21/11
	F	ECN T6611; CHANGED CABLES	5/14/15
	G	ECN T6889; CHG 80-0112-01 TO 80-0112-01-MOD	11/24/15
		APPROVED	
		SS/JS	
		TC	



## NOTES:

- USE THE WIRE PART NUMBERS AS INDICATED IN THIS DRAWING - NO SUBSTITUTIONS ARE ALLOWED.
- ROUTE AC AND DC WIRING SEPARATELY.
- CLEARLY MARK CHASSIS GROUND CONNECTIONS WITH C12232 LABEL (GROUND SYMBOL): SECURE THE INLET POWER GROUND WIRE (GREEN/YELLOW) UNDER ITS OWN NUT (ALL OTHER GROUND WIRES CAN BE HELD UNDER A SINGLE NUT).
- APPLY SAFETY COVERS TO ALL HEATER POWER CONNECTION TERMINALS.

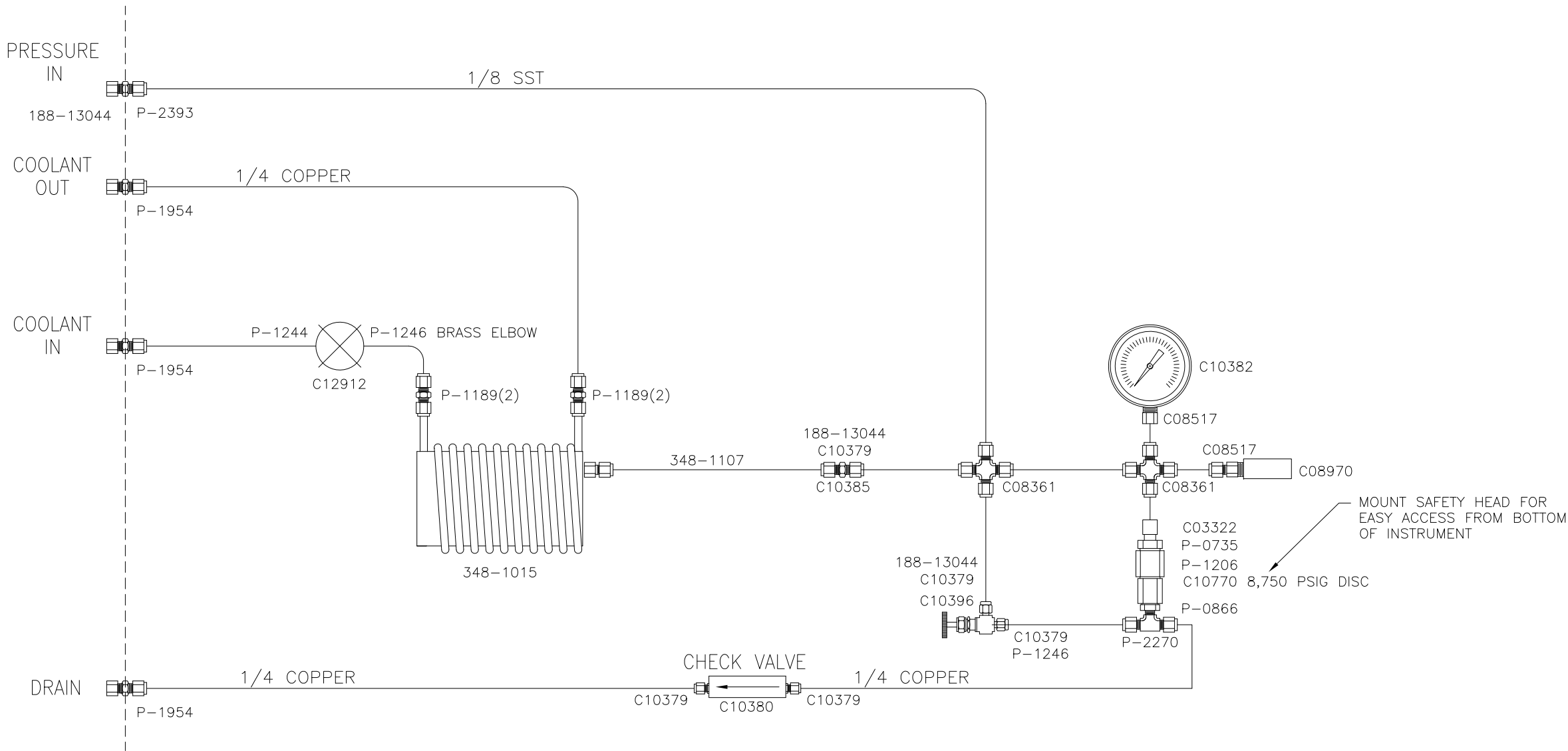
INSULATION PART NUMBER: R-0596 16"L x 7" WIDE  
INSULATION: ZETEX 800 ALUMINIZED 21"L x 7" WIDE

				PART NUMBER		DESCRIPTION		MATERIAL SPEC.		ITEM
-04	-03	-02	-01							
QTY. REQD.						PARTS LIST				
						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		32/		
				NEXT ASSY		USED ON				
						APPLICATION				
						APPROVALS		DATE		
						DRAWN: JJM		01/31/02		
						CHECKED: BA		03/01/03		
						ENGR.: JJM		01/31/02		
						SIZE		S.O. NO.		
						C				
						DWG NO.				
						348-1030				
						REV.				
						G				
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						DO NOT SCALE DRAWING		SHEET:		
						1 of 1				

CHANDLER ENGINEERING

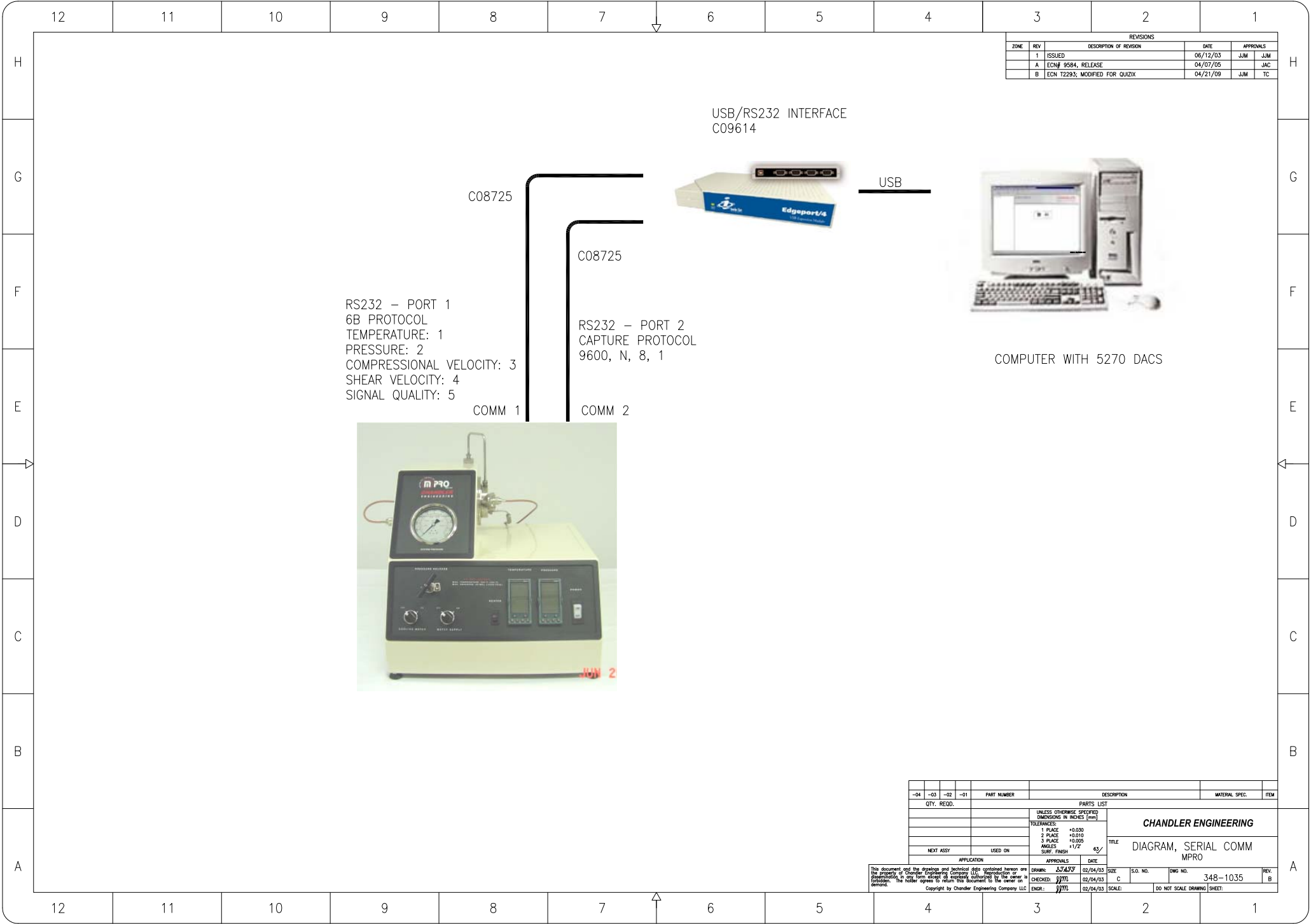
WIRING DIAGRAM  
MODEL 6265 MPRO

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED
ALL	C	ECN T2293; MODIFIED DESIGN FOR USE WITH QUIZIX	04/21/09	JJM
E-10	D	ECN T2352, REMOVE C09318, C09319, C09320	6/25/09	SS/TC



-04    -03    -02    -01				PART NUMBER	DESCRIPTION				MATERIAL SPEC.	ITEM		
QTY. REQD.				PARTS LIST								
				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    32/							CHANDLER ENGINEERING	
NEXT ASSY				USED ON				TITLE		TUBING DIAGRAM MODEL 6265 MPRO		
APPLICATION				APPROVALS		DATE						
This document and the drawings and technical data contained hereon are the property of Chandler Engineering Company LLC. Reproduction or dissemination in any form except as expressly authorized by the owner is forbidden. The holder agrees to return this document to the owner on demand.  Copyright by Chandler Engineering Company LLC				DRAWN: <i>00770</i>		01/31/02		SIZE	S.O. NO.	DWG NO.	REV.	
				CHECKED: <i>004</i>		03/01/03		A1		348-1031	D	
				ENGR: <i>00770</i>		01/31/02		SCALE: N/A	DO NOT SCALE DRAWING		SHEET: 1 of 1	

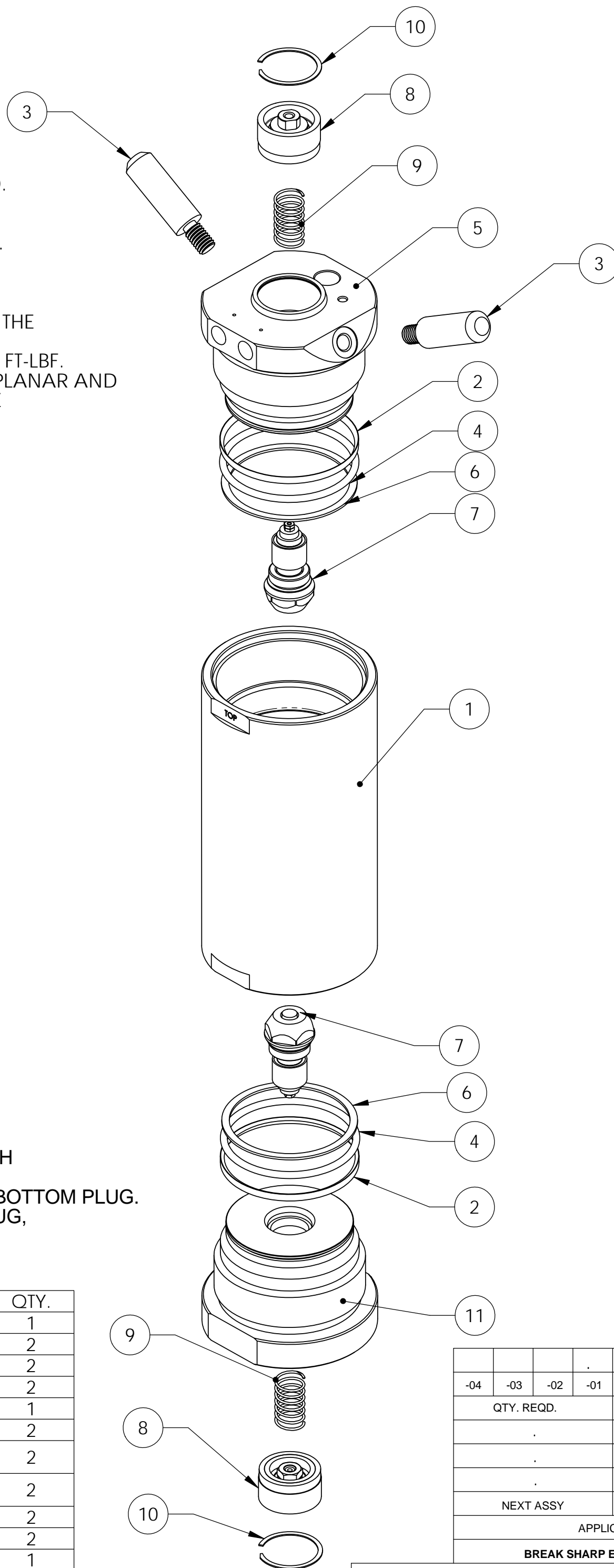




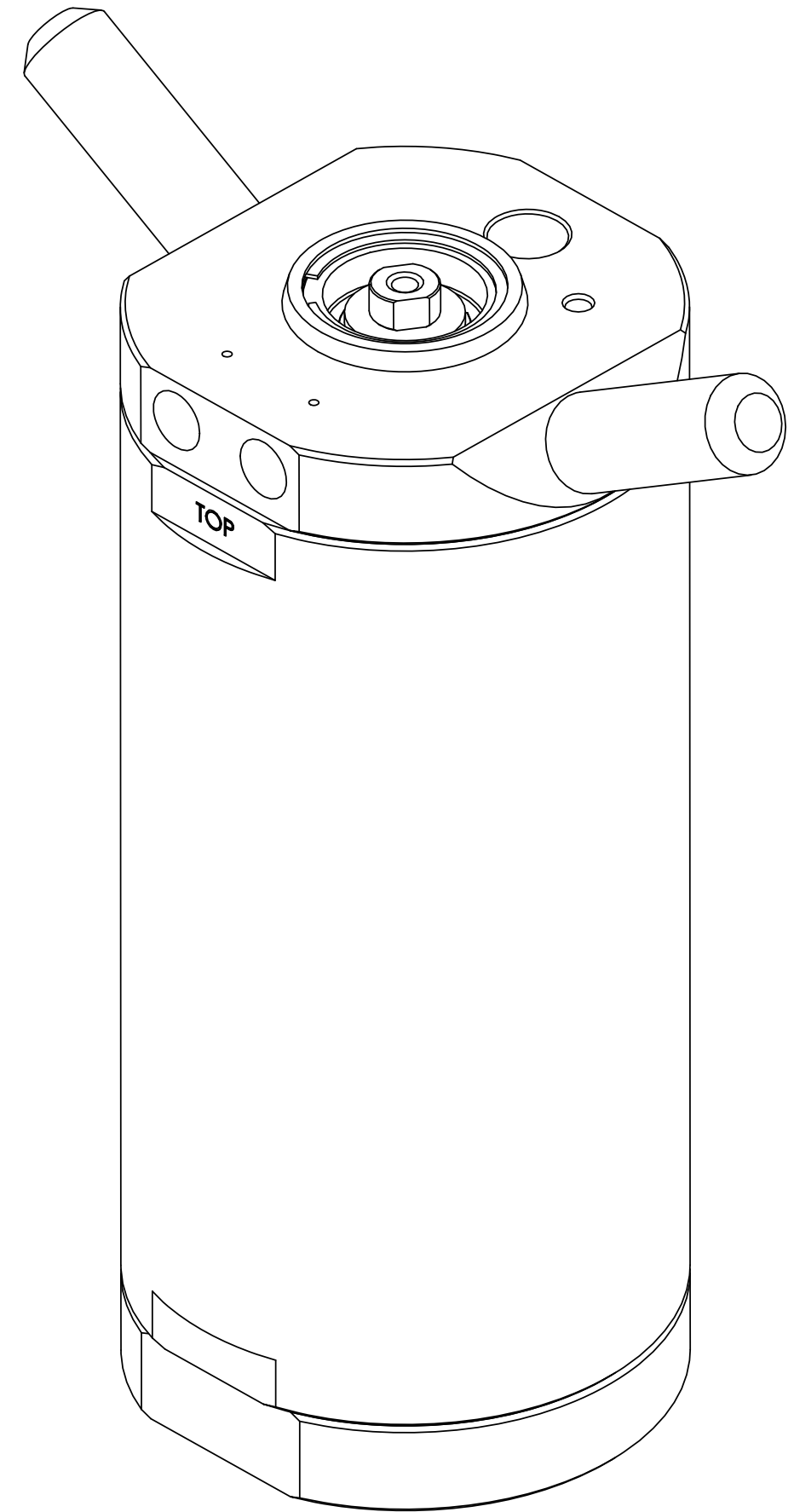
1. VERIFY THAT PIEZO FLAT IS ALIGNED WITH ONE OF THE WRENCH FLATS. MARK THE WRENCH FLAT WITH A CHARPY PEN.
2. INSTALL TRANSDUCER ASSEMBLY IN TOP PLUG, TIGHTEN TO 25 FT-LBF.
3. MARK THE ORIENTATION OF THE MARKED FLAT ON THE TOP PLUG OD.
4. ASSEMBLE THE BOTTOM PLUG IN THE VESSEL WITHOUT THE TRANSDUCER ASSEMBLY.
5. TRANSFER THE INDEX MARK ON THE TOP PLUG TO THE BOTTOM PLUG.
6. INSTALL TRANSDUCER ASSEMBLY IN BOTTOM PLUG, TIGHTEN TO 25 FT-LBF.
7. TRANSFER INDEX MARK TO THE TRANSDUCER ASSEMBLY.
8. REMOVE BOTTOM TRANSDUCER ASSEMBLY AND ALIGN THE FLAT ON THE PIEZO ELEMENT TO ALIGN WITH THE INDEX MARK.
9. REINSTALL THE BOTTOM TRANSDUCER ASSEMBLY AND TORQUE TO 25 FT-LBF.
10. ONCE COMPLETED, THE FLATS ON THE PIEZO ELEMENTS MUST BE COPLANAR AND THE LOCATION OF THE TRANSDUCER ASSEMBLIES MAY NOT CHANGE BETWEEN TOP AND BOTTOM PLUGS.

1. FINAL ASSEMBLY MUST BE PRESSURE TESTED IN ACCORDANCE WITH PROCEDURE 348-2063.
2. VERIFY THAT HEAT NUMBERS ARE MARKED ON VESSEL, TOP PLUG, BOTTOM PLUG.
3. VERIFY THAT INSTRUMENT SERIAL NUMBER IS STAMPED ON TOP PLUG, BOTTOM PLUG, VESSEL.
4. INCLUDE C15142 IN A SEPERATE BAG FOR THE CUSTOMER.

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	348-1101-A286	CYLINDER - MPRO	1
2	348-1104	SEAL RING - CYLINDER - MPRO	2
3	7750-0115	HANDLE, PLUG, CYLINDER	2
4	C08565	ORING, VITON, AS230-90	2
5	348-2103	PLUG, TOP	1
6	C08564	RING, RETAINING, RS-250	2
7	348-2027	ASSEMBLY, TRANSDUCER, CENTER MOUNT	2
8	80-0369	CONNECTOR ASSEMBLY, TRANSDUCER	2
9	C11320	SPRING, COMPRESSION	2
10	C10917	RETAINING RING, SS	2
11	348-2102	PLUG, BOTTOM	1
12	C15142	ADPTR, BNC, BANANA W/GND LD	2
13	80-0050	CABLE, ASSY 36" LG	1
14	80-0051	CABLE, COAX ASSY 12"	1



REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
	A	ECN T5595: ADDED C15142	11/6/13	TC
	B	ECN T5934; INCREASE QTY OF C15142 FROM 1 TO 2; ADD 80-0050 AND 80-0051	5/5/14	TC



				ASSEMBLY - VESSEL - MPRO				1									
-04		-03		-02		-01		PART NUMBER		DESCRIPTION				MATERIAL SPEC.		ITEM	
QTY. REQD.				PARTS LIST													
.				.		UNLESS OTHERWISE SPECIFIED DIMENSIONS IN INCHES  TOLERANCES: 1 PLACE           ±0.030 2 PLACE           ±0.010 3 PLACE           ±0.005 ANGLES           ±1/2" SURF. FINISH     ✓				<div>CHANDLER ENGINEERING</div>							
.				.													
.				.													
NEXT ASSY				USED ON				TITLE  ASSEMBLY - VESSEL - MPRO									
APPLICATION																	
BREAK SHARP EDGES, DEBURR																	
THIS DOCUMENT AND THE DRAWINGS AND TECHNICAL DATA CONTAINED HEREON ARE THE PROPERTY OF CHANDLER ENGINEERING COMPANY, LLC REPRODUCTION OR DISSEMINATION IN ANY FORM EXCEPT AS EXPRESSLY AUTHORIZED BY THE OWNER IS FORBIDDEN. THE HOLDER AGREES TO RETURN THIS DOCUMENT TO THE OWNER ON DEMAND.								DRAWN: JJM		03/21/10		SIZE C		DWG NO. 348-2010		REV. B	
								CHECKED: TC		3/22/10							
								ENGR.: JJM		03/21/10		SCALE: 1:8		TITLE BLOCK REV: 2.0			

TITLE: Procedure, Field Calibration, Vessel

REF. NEXT ASSY: Model 6265 Mechanical Properties Tester (MPRO)

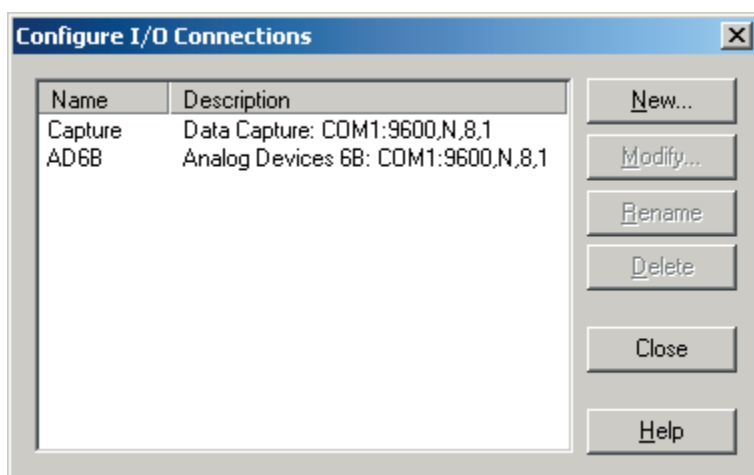
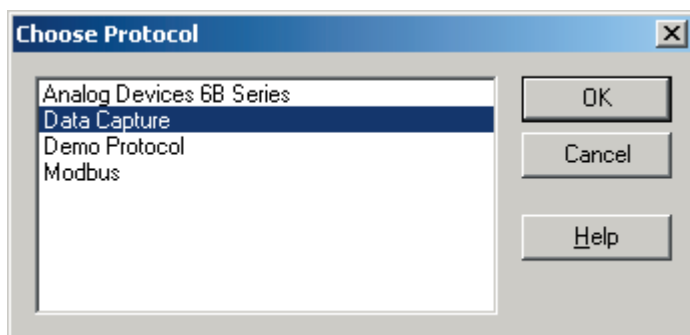
Revision	Date	Revised By	Description
A	05/09/2011	JJM	ISSUED

The MPRO vessel is calibrated using distilled water at a known temperature and pressure. The measured transit time is compared with the value provided by the NIST REFPROP software. Refer to the section at the end of this document for installing and configuring REFPROP for use with the worksheet.

Once data values are obtained, the results are entered into an Excel worksheet that computes the calibration offset values.

Use the following procedure to calibrate the vessel:

1. Fill the vessel with water, preferably distilled water.
2. Configure the pressure controller (Eurotherm or Quizix) to pressurize and maintain the pressure at 3000 psi.
3. Allow the temperature of the vessel and water to reach ambient temperature. Wait until the temperature is stable within 0.20°F for at least 5 minutes.
4. Start 5270 and verify that the transit time, temperature, and pressure signals are present. The shear wave signal will not be present, this is normal.
5. Connect the secondary serial cable to the MPRO.
6. Enable the signal capture feature in 5270. This will involve creating an I/O Connection named "Data Capture" as shown below.

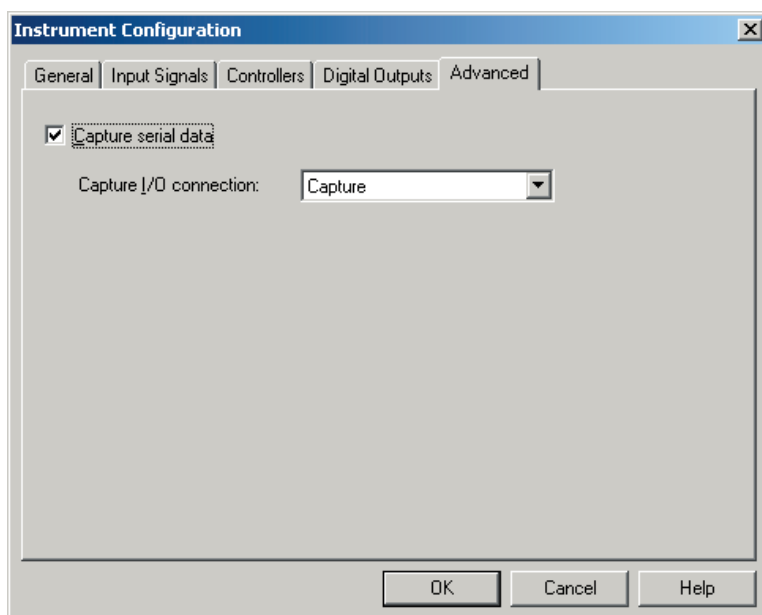


Note that the Capture port uses a separate COM port, unlike what is illustrated above.

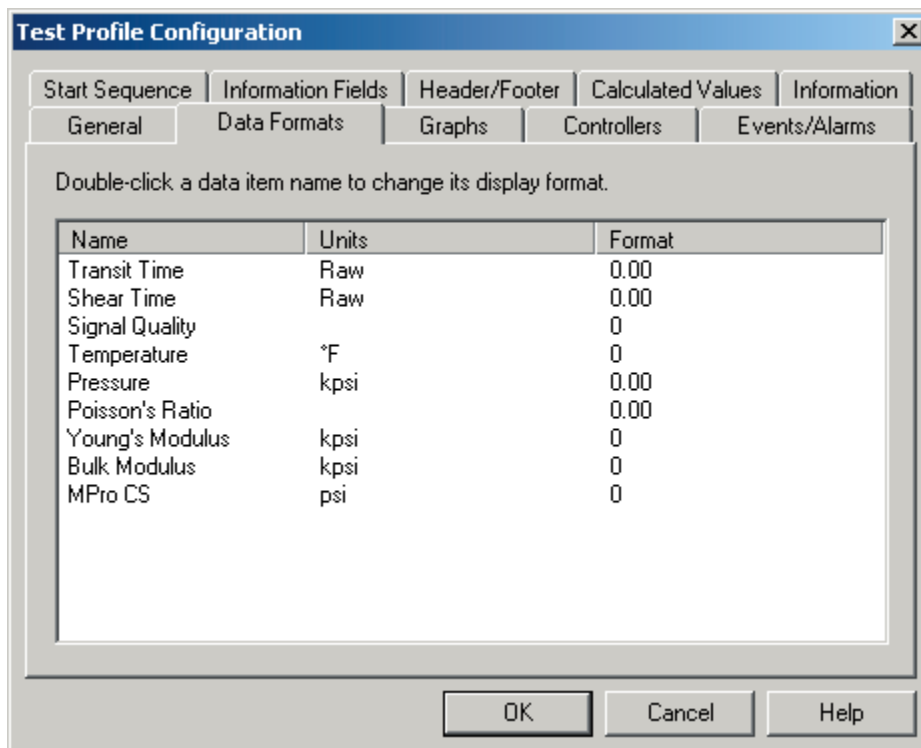
7. Enable the "Capture serial data" feature in 5270 Tools – Configure – Instruments – Modify – Advanced. This will capture and save RAW data from the MPRO, stored at a \*.CAP file in the Tests folder. Start a test and verify that the CAP file is created with a file size other than 0 kB, If not, check the COM port assignment and/or cable connections.

TITLE: Procedure, Field Calibration, Vessel

REF. NEXT ASSY: Model 6265 Mechanical Properties Tester (MPRO)



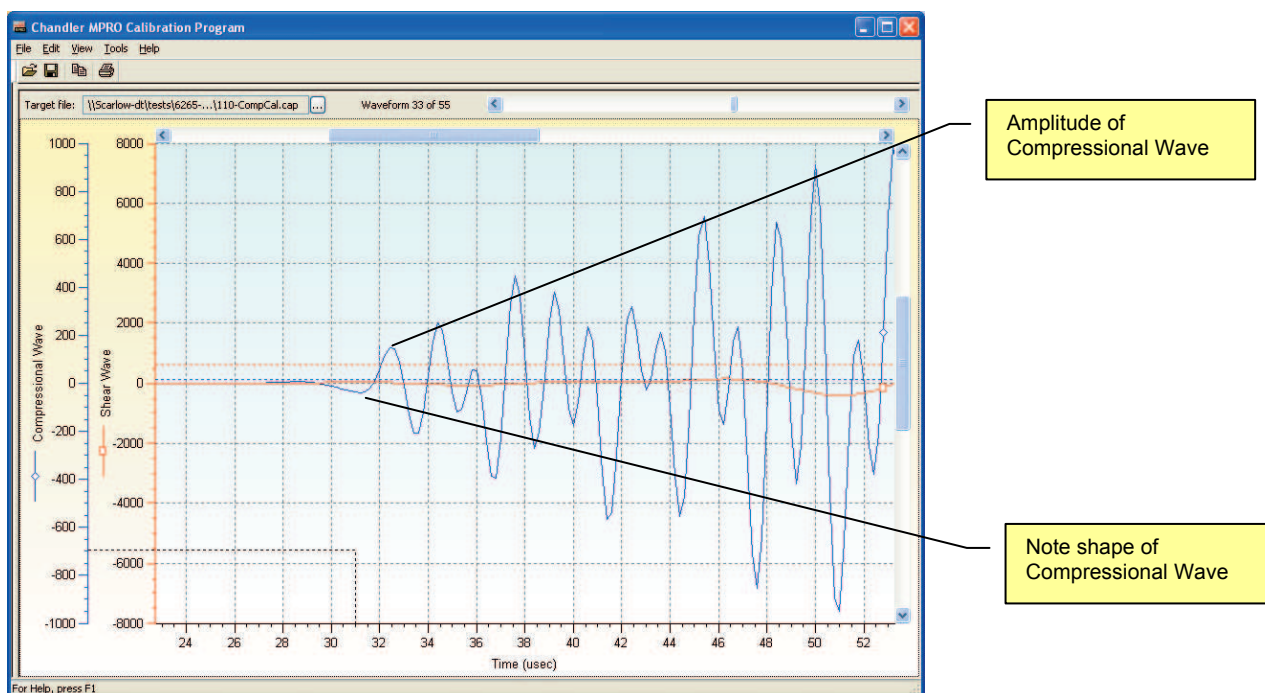
8. With the vessel full of water, with the temperature and pressure stable, start a 5270 test, name the TST file SNxxx COMP CAL.TST. Set the sampling period to 60 seconds. Run the test for 15 minutes to capture the data values. Set the Data Format in 5270 for the Transit Time and Shear Time to "Raw".



9. Using the MPROCAL program that is provided with 5270, open the .CAP file that was created from test using distilled water in the vessel at stable temperature and pressure.
10. Set the Y-Axis scaling for Compressional Wave to +1000 and -1000.
11. Using the sidebar in MPROCAL, view the data near the middle of the test.

TITLE: Procedure, Field Calibration, Vessel

REF. NEXT ASSY: Model 6265 Mechanical Properties Tester (MPRO)



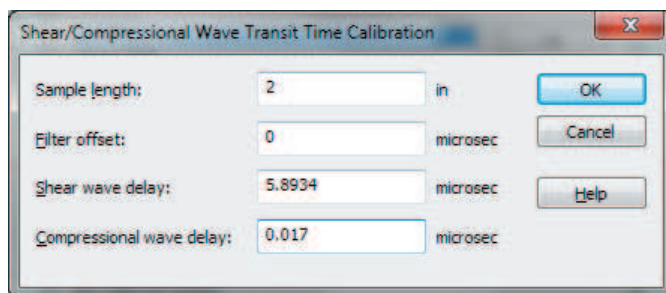
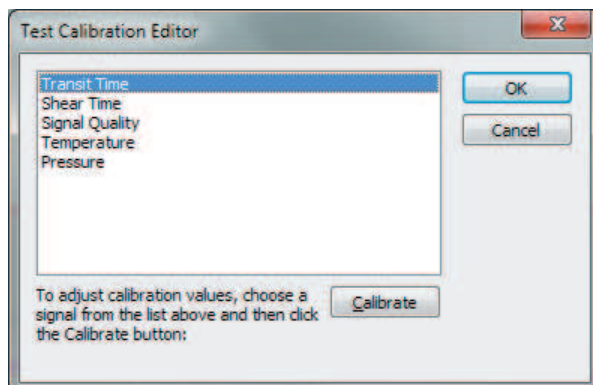
12. The shape of the compressional waveform must be comparable to the illustration.
13. The amplitude of the compressional wave must exceed a value of 100 with water in the vessel at stable temperature and pressure. If this can not be achieved, check the cables and connections to the transducers. If the problem persists, the transducers need to be re-worked. Contact Chandler Engineering for details.
14. Open the Excel Worksheet 348-2070-REVx provided by Chandler Engineering. Save the file as SNxxx-CAL.XLS.
15. Enter the instrument serial number water temperature and pressure, measured RAW transit time into the "blue" fields as illustrated below.

TITLE: Procedure, Field Calibration, Vessel

REF. NEXT ASSY: Model 6265 Mechanical Properties Tester (MPRO)

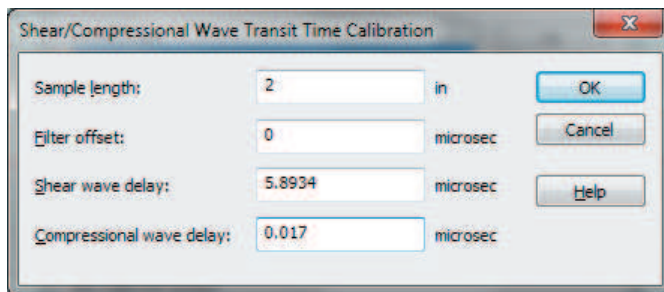
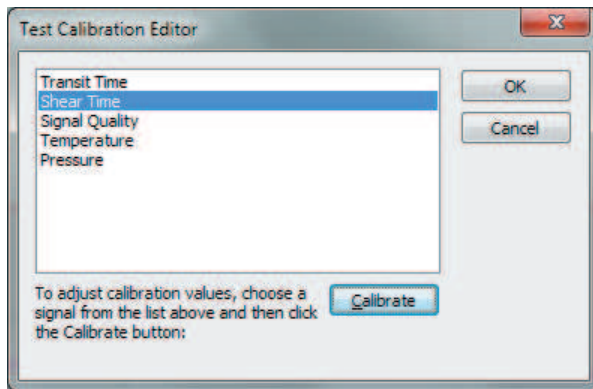
	A	B	C	D
1	<p style="text-align: center;">Worksheet used to Determine the Compressional Wave and Shear Wave Time Offsets for a MPRO Pressure Vessel Assembly - <b>FIELD CALIBRATION</b>  348-2070-REV 3</p>			
2				
3				
4				
5				
6				
7				
8				
9				
10				
11	<b>Vessel Assembly Information</b>			
12	Vessel & Instrument Serial Number			
13	Vessel Internal Length, inches:	2.000		Internal distance between xducer tips
14				
15	<b>Water Temperature and Pressure</b>			
16	Water Pressure, psig:	2981		Enter the water pressure
17	Water Temperature, degF:	77.0		Enter the water temperature
18				
19	<b>Water Velocity Result</b>			
20	Actual velocity, inch/sec:	60278.244		Calculated using REFPROP
21	Actual transit time, microsec/inch:	33.179		Calculated
22				
23	<b>Compressional Time Measurement</b>			
24	Measured transit time, microsec/inch:	33.196		Enter raw transit time from water test
25				
26	<b>Final Results</b>			
27	Compressional time offset, microsec:	0.017		Calculated
28				
29				
30				

16. The resulting "compressional time offset" value is used to update the instrument calibration in the 5270 field "Compressional wave delay", as shown below. The remaining 5270 fields "sample length", "filter offset" and "shear wave delay" must not change from the pre-configured values.



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### **Procedure for installing and configuring REFPROP:**

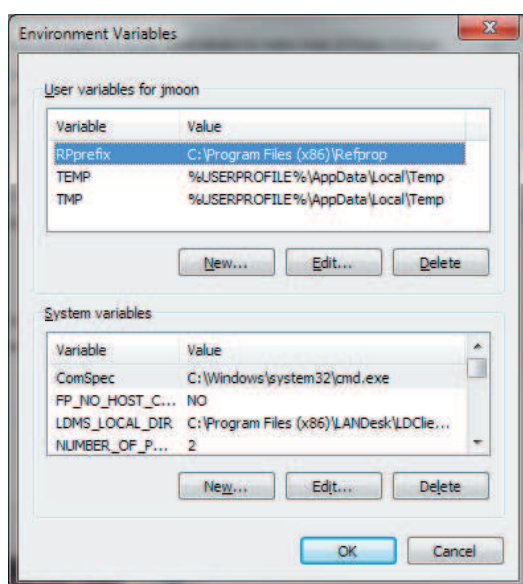
The worksheet requires a license of REFPROP software from NIST. It is also known as "NIST Standard Reference Database 23". <http://www.nist.gov/srd/nist23.cfm>

Before the worksheet can be used, four steps are required:

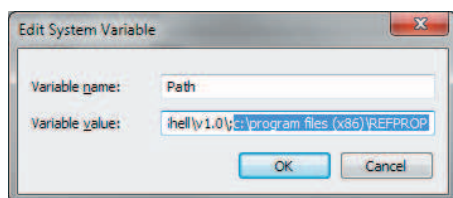
1. An environment variable can be set to specify the location of the fluid files. This new variable should be called RPPrefix and be given the value of "C:\Program Files\REFPROP".

**Note 1:** Environment variables are set under Start/Settings/Control Panel/System/Advanced/Environment Variables, under the "User variables" option.

**Note 2:** In Windows 7, Environment variables are set under Start/Control Panel/System And Security/System/Change settings/Advanced/Environment variables.



2. 'Add a second environment variable named "path" (under "User variables") that contains the text "C:\Program Files\REFPROP". If the path statement already exists, it can be modified by adding ";C:\Program Files\REFPROP" to the end so that the file REFPROP.DLL can be found from any location.



3. Using Excel, open the file REFPROP.XLS that is installed with the program. Select "File/Save As..." option in Excel and select "Microsoft Office Excel Add-In" under the "Save as type" section. This will change the extension to .XLA and save it in a default dir.
4. Restart Excel. Under the Tools/Addins option, select the REFPROP add-in. The macros will now be available for use in any empty or existing worksheet.



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