

Automated Permeability Plugging Apparatus Model 389AP and Automated Receiver Model 389 MC Manual



Manual 102196683, Revision D

Model 389 AP Instrument No. 101967987

Model 389 MC Instrument No. 102484770

**Combined Instrument Model 389 AP/MC No.
102557625**

fann[®]
Fann Instrument Company

APPA AP, MC Manual

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1 Introduction

The Automated Permeability Plugging Apparatus Model 389AP (APPA) is a high pressure, high temperature instrument designed to perform permeability plugging tests. The 5000 PSIG rated APPA is ideal for predicting how a drilling fluid can form a permeable filter cake to seal off depleted or under pressure intervals.

The Automated Permeability Plugging Apparatus, Model 389AP is a high temperature, high pressure instrument that has a maximum operating temperature of 500°F (260°C) and a maximum operating pressure of 5000 PSI (34,473 kPa).

Built into the system is a heating chamber, a hydraulic pump, and an air pump. The control panel has an LCD with keypad, nitrogen pressure regulator, and an oil pressure regulator.

The LCD with keypad is used to operate the APPA. A computer (not included) is also required to operate the pump and setup the temperature and pressure profiles.

The APPA also comes with the following items:

- 5000 PSI stainless steel APPA cell
- Backpressure receiver
- Software
- Accessory kit
- Tool kit

The standard 5000 PSI APPA cell, end cap, and retainer ring are made of Type 17-4 stainless steel and the floating piston is made of Type 303 stainless steel.

The Measurement and Control (MC) system includes a digital backpressure receiver made from 316 stainless steel, measurement interface, and valve box to facilitate automated and continuous filtrate measurement during testing.

1.1 Document Conventions

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



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



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



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



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



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



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



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

2 Safety

This section explains the safety measures for heating, pressurization, electrical operation, handling the APPA.

Safe laboratory practices and procedures should also be observed while operating and maintaining the APPA.

Please review standard safety practices for handling high pressure, high temperature equipment and test cells.

2.1 Safe Pressurization

Follow these instructions for the hydraulic pressurization system and the backpressure receiver.

1. Hydraulic Pressurization System

Make sure that the hydraulic pressure has been released and that the pressure gauge reads zero before performing these actions:

- Disconnecting the hose from the cell at quick connector
- Removing the cell from the heating chamber
- Moving the APPA
- Refilling the oil reservoir with hydraulic fluid
- Performing any maintenance

When refilling or repairing the hydraulic system, wipe spilled oil. Oil on the floor is a fall hazard. Spilled oil attracts dirt and can be a fire hazard.

When assembling the cell, make sure that the O-rings in the end caps are properly seated and the retainer ring is properly tightened.

2. Back Pressure Receiver

For temperatures greater than the boiling point of the sample fluid, the backpressure receiver must be pressurized to prevent vaporization of the filtrate.

3. Gases

- Use either nitrogen or carbon dioxide to pressurize the backpressure receiver.
- For the APPA, nitrogen pressurizes the backpressure receiver.
- Nitrogen must be supplied in an approved nitrogen gas cylinder or laboratory supply system. Nitrogen cylinders must be secured to meet safety standards.
- Carbon dioxide is usually supplied in small cartridges, which contain approximately 900 PSI (6206 kPa) pressure. Carbon dioxide can also be supplied in cylinders.



WARNING! Do NOT allow carbon dioxide cartridges to be heated or exposed to fire. They can explode if overheated.

4. Pressure Regulators

- Maintain pressure regulators in good condition.
- Never use oil on pressure regulators.
- Leaking pressurization systems, hydraulic or pneumatic, should be repaired or replaced.
- Regularly inspect gauges, fittings, and hoses. Check for leaks.
- Periodically test the safety relief valve on the pressurization manifold to verify it will relieve if excessive pressure should occur. Never plug or bypass this safety valve.
- When pressurizing the backpressure assembly, always open the supply pressure first, and then adjust the regulator.
- Do not attempt to pressurize higher than the equipment is rated for or above the relief valve settings.
- When de-pressurizing, shut off the supply pressure, bleed the system of pressure, and then back out the regulator T-screw.

2.2 Safe Heating

Caution should be exercised by all personnel working with the APPA or working in the area where the APPA is in operation to avoid accidental injury caused by touching the heating chamber or cell assembly when they are hot. The heating chamber can operate at a temperature that will cause burns if touched. Safeguard

the equipment after the test ends long enough for it to cool. It can still cause burns even after it has been turned off.

Removing the cell before it has cooled and placing it in water is very dangerous. This practice is not recommended because the user could be severely burned by the steam. Also, the user could be burned if the cell is touched or accidentally dropped.

Be careful when handling a hot cell. Wear thermally insulated gloves. The recommended procedure is to let the cell cool in the heating chamber before removing it.

A cell removal tool (P/N 209497) is available for handling the cell assembly and removing it from the heating chamber. Its use will reduce the chances of accidentally dropping a cell or being burned by a hot cell.

2.3 Safe Electrical Operation

Make sure the electrical source is fused and grounded.

Verify that the power cord is in good condition and has the proper ground connection.

Electrical problems in the wiring or heaters may not be obvious by looking at the equipment. If a fuse blows, circuit breakers trip, the heating time seems too long or the thermostat control does not respond, electrical repair may be required.

Always test the heating chamber for proper operation after repair or part replacement.



Always disconnect the power cable before attempting any repair.

2.4 Safe Test Cell Maintenance



These instructions are for use only with a 5000 PSI (34,473 kPa) working pressure cell. Do not pressurize cells above their stamped ratings.

The APPA cell assembly is a pressure vessel. These safety precautions should be followed to assure safe operation:

- Cell material should be compatible with the test sample.
- Cell bodies that show stress cracking, severe pitting, or have damaged set screw holes must not be used.
- Cell caps with pulled or deformed set screw seats must not be used.
- Cells, cell caps, or retainer rings that have damaged threads must not be used.

The 5000 PSI test cell features a 6150 PSI rupture disc in the bottom end cap and a 999 PSI rupture disc in the floating piston. These devices will relieve the pressure to atmosphere if the pressure exceeds the limits.
102196683

3 Features and Specifications

- Realistic and accurate downhole simulation
- Automatic pressure control
- Pressure applied from bottom, preventing solids settling that contributes to filter cake
- Designed for high pressure, high temperature (HPHT) testing
- Allows use of filter media in various pore sizes
- Built-in heating chamber, hydraulic pump, and air pump
- Built-in resistance temperature detectors (RTDs)
- Nitrogen pressure regulator and oil pressure regulator on control panel
- Real-time data in graph
- Capability to store test data

Table 3-1 Model 389 AP Specifications

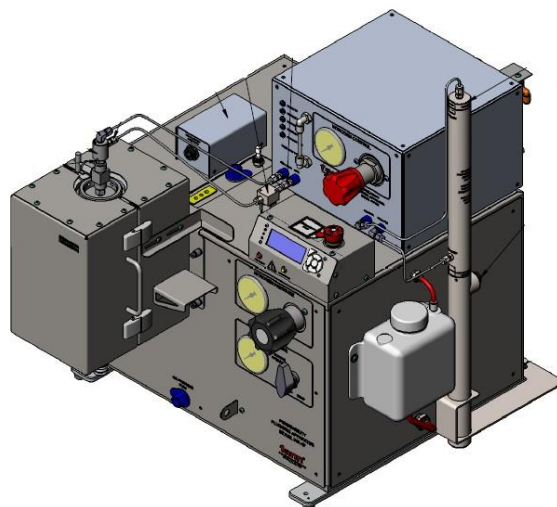
Category	Specification
Bottom Side Pressure Range	5000 PSI (34,473 kPa)
Maximum Differential Pressure	750 PSI (5170 kPa)
Operating Temperature Range	Ambient to 500°F (260°C)
Compressed Air Supply	80 PSI (551 kPa) Minimum
Nitrogen Supply	1000 PSI (6895 kPa) Maximum
Power Supply	115/230V, 50/60 Hz, 1000 Watts
Dimensions (Width x Depth x Height)	29.7 x 29.9 x 26.2 inches 75.4 x 75.9 x 66.5 centimeters
Weight	175 lb (79.4 kg)

Table 3-2 Model 389 MC Specification

Category	Specification
Maximum Differential Pressure	750 PSI (5170 kPa)
Nitrogen Supply	1000 PSI (6895 kPa) Maximum
Purge Fluid	Clean Distilled Water
Dimensions (Width x Depth x Height)	17 x 14 x 30 inches 43.1 x 35.5 x 76.2 centimeters
Weight	45 lb (20.4 kg)

Table 3-3 Model 389 AP/MC Specifications

Category	Specification
Dimensions (Width x Depth x Height)	29.7 x 29.9 x 30 inches 75.4 x 75.9 x 76.2 centimeters
Weight	220 lb (100 kg)


Figure 3-1 APPA AP/MC Assembly

4 Installation

Place the APPA in a location where the unit can operate with minimum disturbance, has suitable electrical power, and is near the computer. Consideration should be given to the location where samples are prepared and the cells are cleaned following test completion. The type of pressurizing system may also dictate installation specific requirements, such as having a large compressed gas cylinder secured nearby.

There should be sufficient storage area nearby for commonly used tools, as well as consumables, such as ceramic filter discs and pressurizing cartridges

4.1 Model 389 AP Setup

1. Remove APPA 389 AP from packaging and place in desired location.
2. Connect the power supply, being sure to make the correct selection on the voltage selector switch, then connect the Ethernet port to the computer or the network via the RJ45 port.



Figure 4-1 Electrical and Computer Connections



WARNING! Do NOT turn on the power switch yet

3. Connect the nitrogen and air supplies on the back of the Model 389 AP, as well as the drain via the 1/4" FNPT connections on the back panel.



Figure 4-2 Connection Ports on the Back Panel

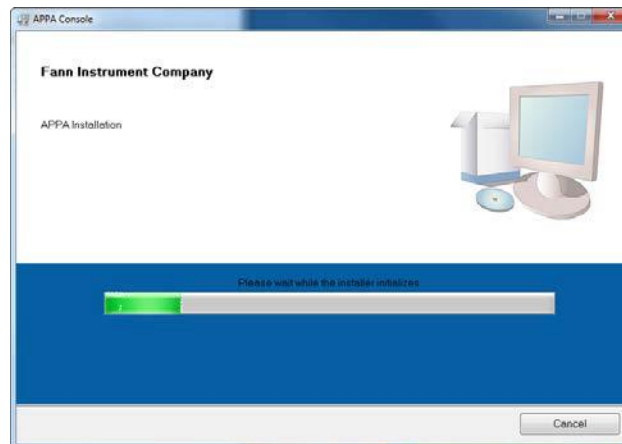
4. Place the heater assembly on the front of the 389 AP and secure in place with the captive screws.
5. Attach the heater power on the left side of the heater assembly.
6. Hook up the oil pressure line on the front of the unit
7. Hook up the nitrogen line for the backpressure receiver on the top of the unit.

4.2 Software Installation

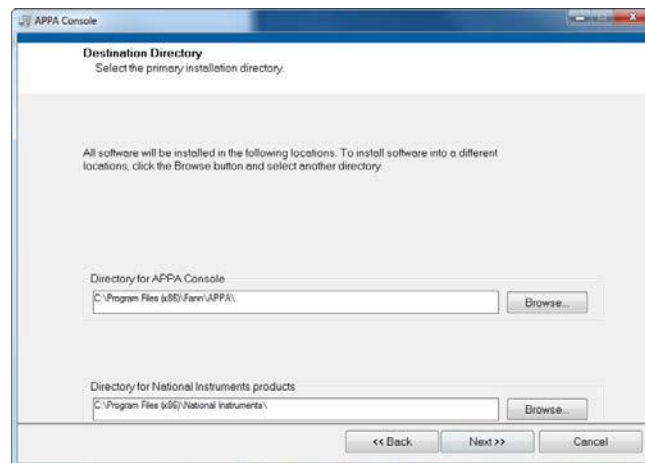
A computer that operates on Windows® 7 is required. The APPA does not include a computer and monitor.

1. Connect one end of the cable to the Ethernet port on the APPA.
2. Insert the software USB flash drive (included).
3. If the installation process does not automatically begin, click Start, and then Run. Browse to find the setup program. Select the setup program, and then click to open.
4. When the setup program appears in the Run dialog box, select OK.

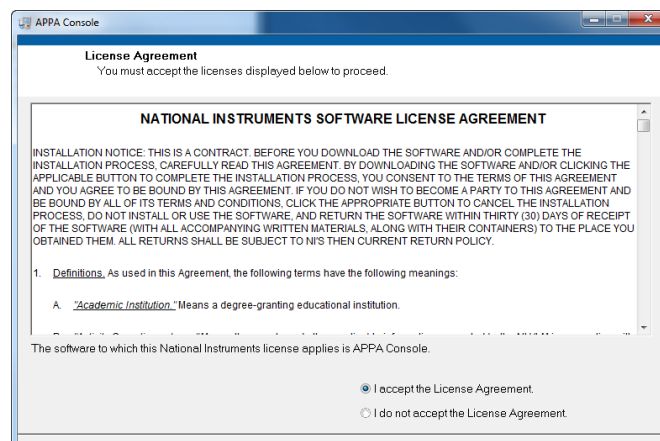
5. Wait for the software to install.

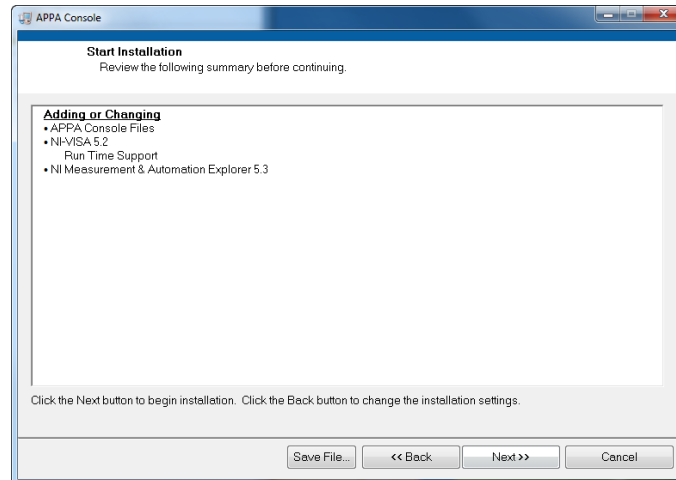


6. Select the desired software location.

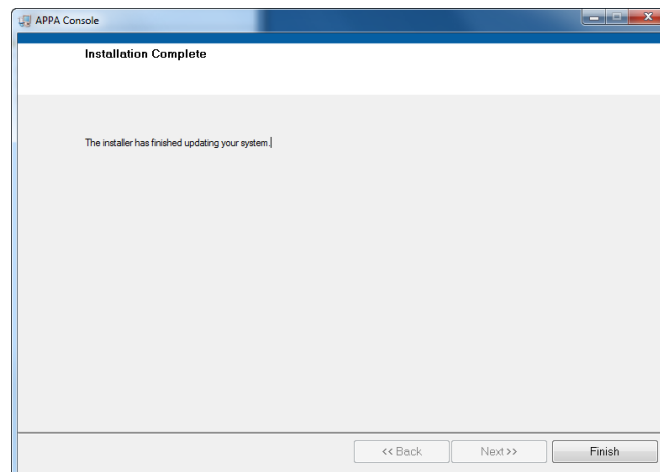


7. Continue with the installation process, following the prompts, and clicking **Next** when required.



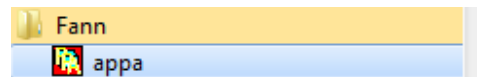


8. When the software installation is complete, click **Finish**.

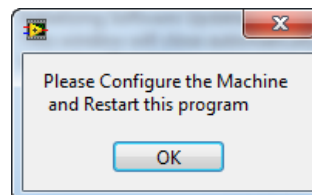
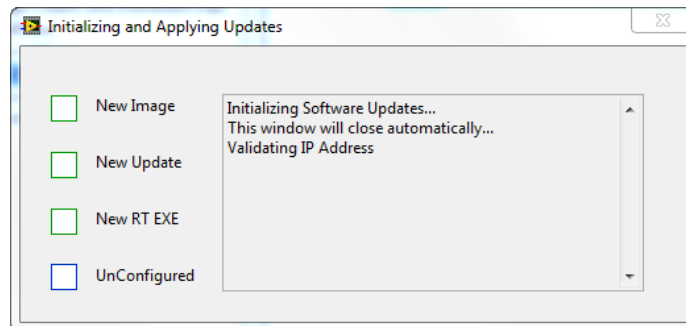
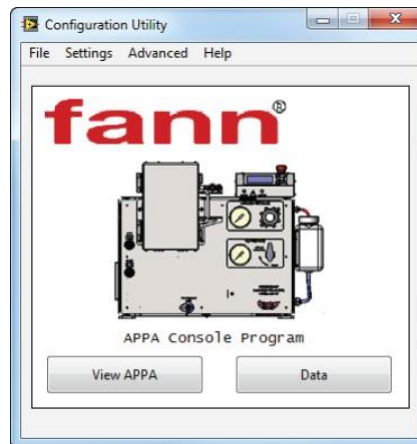


4.3 Machine Configuration

1. Browse to find Fann folder on user computer. Click on the APPA icon.



2. Wait for the following images to appear on the desktop.



3. Click **OK** on the message request to configure the machine and restart.
4. Wait for the Configuration screen to appear.

Configuration

Step 1: Serial Number <-- Enter/Verify S/N

Step 2: Find Hardware

Step 3: ☒ Use DHCP OR ☐ IP Address Subnet Mask
DNS IP Address Gateway IP Address

Step 4: Machine Name Enter new name here Rename
Web Address http://appa.html

Target Information

MAC Address IP Address
Status Model
Machine Name Firmware/Safe Mode 0
Subnet Mask Gateway
DNS Server Serial Number 0
Model Code
☐ Locked
☐ Use DHCP
☐ Halt If TCP/IP Fails
☐ Pwd Protected

Reboot OK Cancel

5. Complete the following fields on the Configuration screen:
 - a. Step 1 – Enter the APPA serial number.
 - b. Step 2 – Click on **Find Hardware**.
6. Wait for the configuration to complete. The **Target Information** fields will be automatically filled and the **Web Address** field will contain the IP address. Copy the IP address for records.

Configuration

Step 1: Serial Number 00E71539 <-- Enter/Verify S/N

Step 2: Find Hardware

Step 3: ☒ Use DHCP OR ☐ IP Address Subnet Mask
DNS IP Address Gateway IP Address

Step 4: Machine Name II E24 Rename
Web Address http://34.52.21.68/appa.html

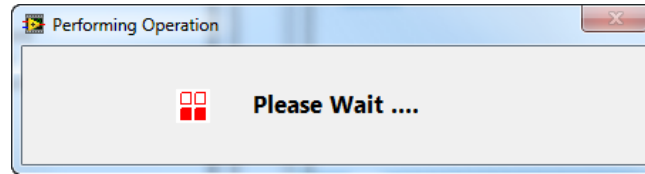
Target Information

MAC Address 0080 2F0A B0AF IP Address 34.52.21.68
Status Running Model cRIO-9012
Machine Name II E24 Firmware/Safe Mode 0
Subnet Mask 255.255.252.0 Gateway 34.52.23.254
DNS Server 34.52.248.10 Serial Number E71539
Model Code 718F
☐ Locked
☒ Use DHCP
☒ Halt If TCP/IP Fails
☐ Pwd Protected

Reboot OK Cancel

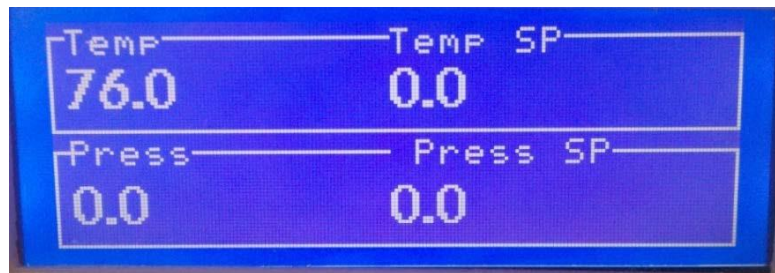
7. Make sure that **Use DHCP** is checked (if not previously checked).
8. Enter a machine name or click Rename to change the machine name. This step is optional.
9. Click OK on the Configuration screen.

10. Wait for the initialization process to complete.



4.5 Model 389 AP Setup

1. Turn power switch to the ON position (main switch on back of APPA). Wait for the default screen on the LCD that shows the temperature and pressure.



2. Open the air supply line and the nitrogen supply line.

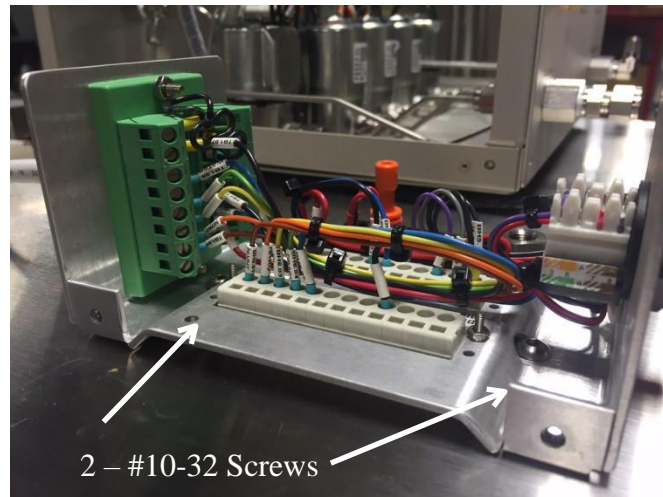


NOTE. Air supplies pressure to the pump. Nitrogen supplies pressure to the backpressure receiver.

3. Make sure that the oil reservoir is full of hydraulic fluid.
4. Turn on the computer. Click on the APPA icon (located on the desktop).

4.6 Model 389 MC Setup (if applicable)

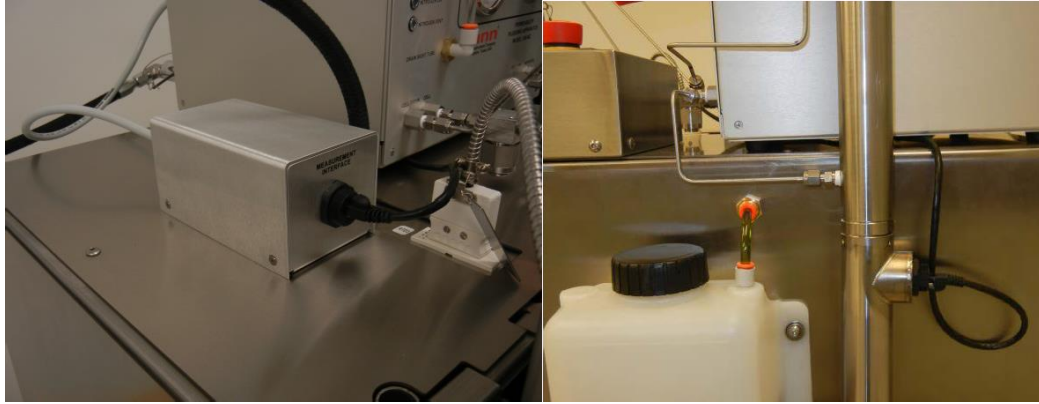
1. Remove the small cover plate from the top of the APPA.
2. Find the measurement module and remove the four screws from the corners.
3. Using the screws removed from the cover plate attach the measurement module to the top of the APPA via the bulkhead connectors and two button head screws used to attach the cover plate to the top of the APPA
 - a) Replace the four screws on the measurement module.



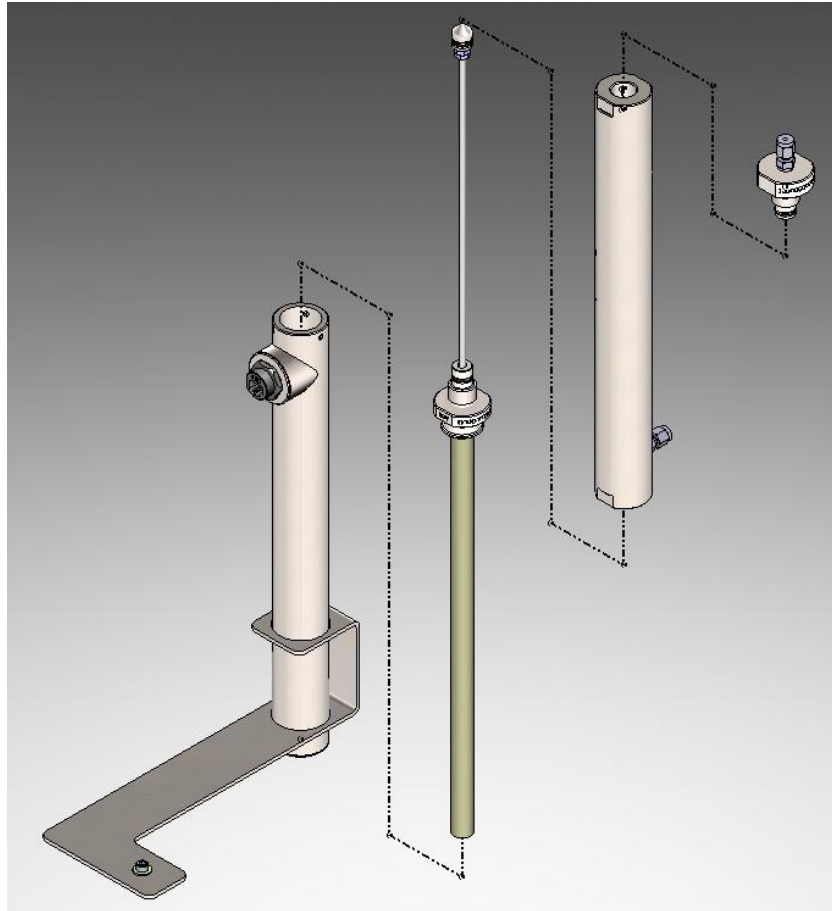
Mounting the measurement module

4. Find the valve box assembly and place it on the top of the APPA.
5. Connect 1/4" tubing from the left side of the filter to a container of distilled water and from the drain port to an empty container for the filtrate to drain into.
6. Find the receiver bracket and using the included hardware attach it to the right side rear foot as shown.



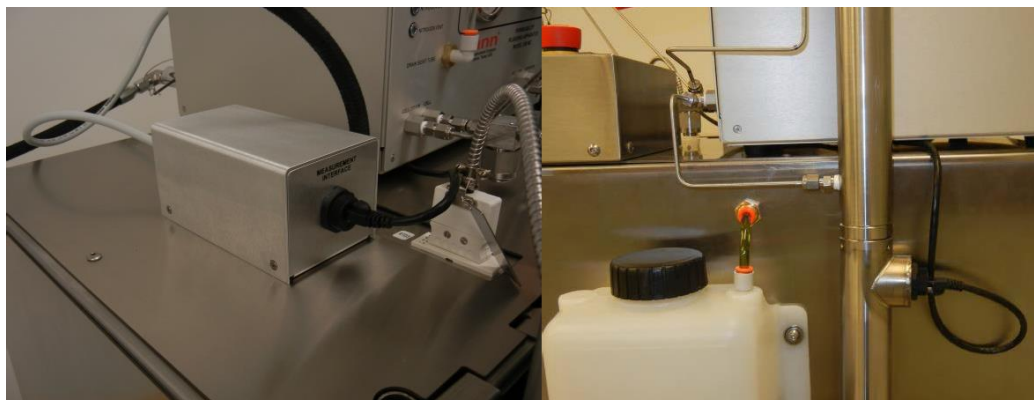


7. Find the two halves of the receiver, and after greasing the O-rings, carefully insert the half with the shaft and the piston into the other half of the receiver. Tighten the threads **hand tight only** until it stops turning.
 - a) Orient the two halves so that the half with the Ethernet port and the half with the tube fitting face opposite directions.
 - b) Place the receiver assembly flat side down in the bracket with the tube fitting facing forward.
 - c) Tighten the three set screws on the cell assembly evenly, if necessary
 - d) The receiver support bracket secures to the rear foot of the Model 389AP.

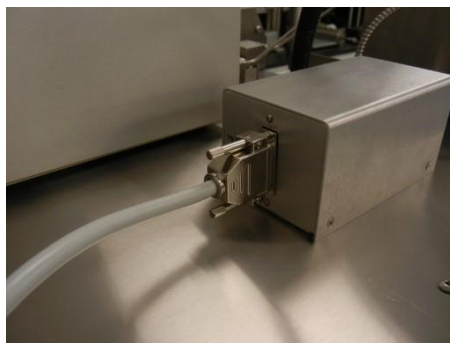


Receiver Assembly

8. Connect the provided Ethernet cable to the front of the measurement module and then to the rear of the receiver.



9. Connect the high density D-sub cable to the rear of the measurement module and then to the rear of the valve box.



10. Connect the backpressure receiver hose from the APPA to the connection on the rear of the 389 MC. Insert the locking pin.
11. Using the provided diagram, connect the included tubing to the various parts of the system. It is helpful to insert a PPA cell into the heater assembly on which to mount the receiver block before starting assembly of the tubing components. Once the tubing is connected tightly the hardware setup is complete. Connect the APPA to the network with the computer via an Ethernet cable or connect it directly to the computer.

4.7 Software Installation

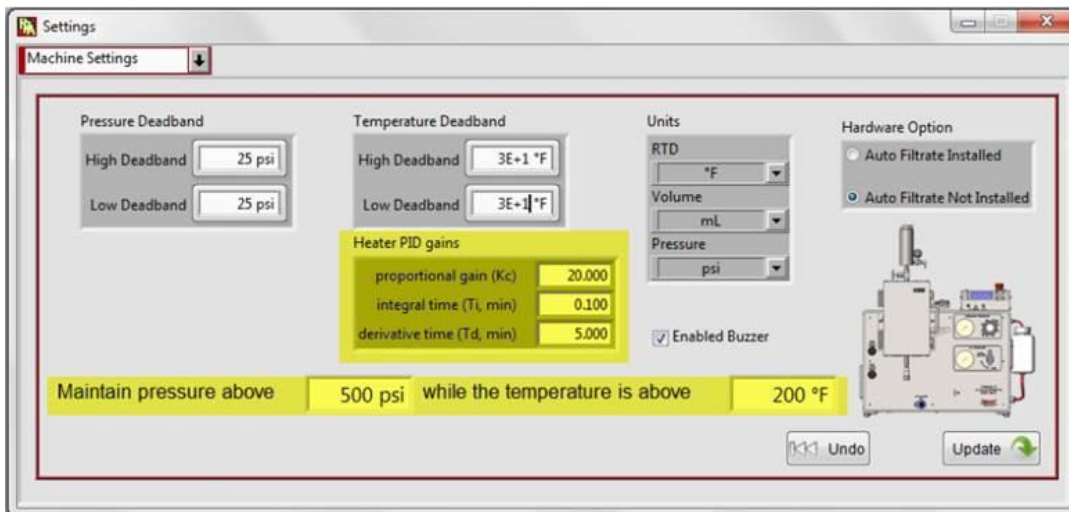
See section 5 for additional information on software.

1. Check the USB flash drive that was sent with the unit. The version number should be 2.0 or higher. If it is not, please contact the local Fann service representative for an updated copy of the APPA software.
2. Plug in the USB flash drive to the designated computer that will be operating the APPA. Move the installation files from the flash drive to the computer. Run the Setup.exe file and follow the installation instructions.
3. Once the software has installed, start the APPA.exe program. Follow the machine setup prompts, by entering the serial number and finding the APPA, locally, or on the network.
4. If having difficulty connecting to the APPA, it may be necessary to enter computer's firewall settings, and allow the APPA software through the firewall.
5. When the software connects to the machine, the application home screen/dashboard will be visible.
6. Click the gear, located in the lower left hand corner, and click on 'machine settings'. If the automated filtrate collection system is installed, the Model 389 MC, then select the option in the machine settings.





PID settings that have resulted in good performance are $P=20$, $I=0.1$, and $D=5$.



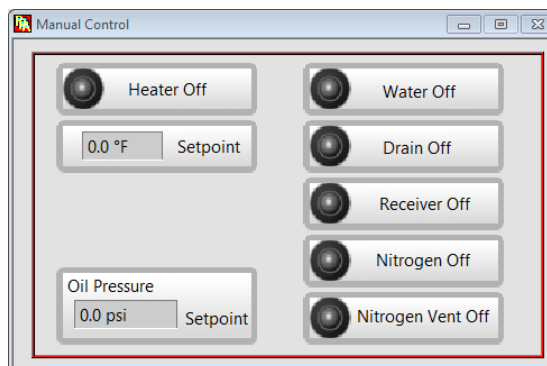
4.8 Using the Automated Filtrate Collection System for the First Time

User should familiarize themselves with section 5 to understand the software operation before using the system for the first time.

1. To prevent damage to the receiver and components, it is critical to follow these procedures when first setting up the automatic filtrate collection.

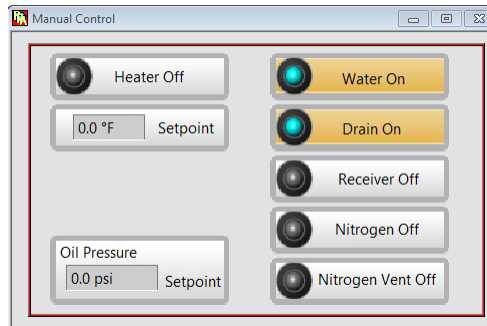


2. Open “Manual Control.”

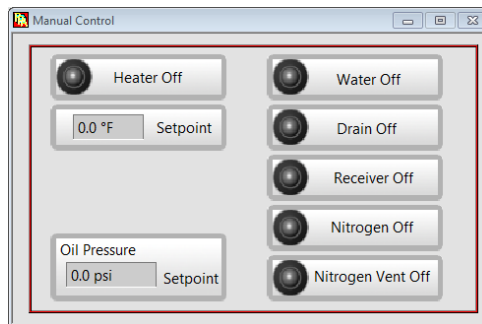


NOTE. If valve options do not appear, go to ‘settings’ and choose automatic filtration system installed’ and save the configuration using the settings menu icon.

3. Select the 'Water' and 'Drain' valves.



4. The pump should turn on, and water will begin to flow through the system. Bubbles will flow through the drain sight tube as water exits to the drain. Click on the buttons again to close the valves.



5. Turn regulator on 389 MC (red regulator) to 200 PSI. If pressure does not increase, check the pressure on the APPA and adjust the regulator on the APPA to 700 PSI (maximum pressure) before setting the red regulator on the Model 389 MC.
6. Run the 'Flush' sequence 3 times or until air no longer flows through the sight drain tube.



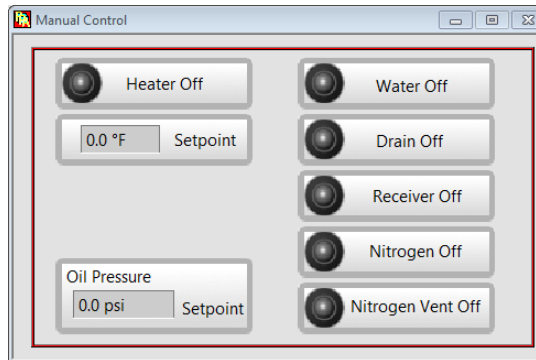
7. When the flush sequence is complete, Run the 'Fill' sequence.



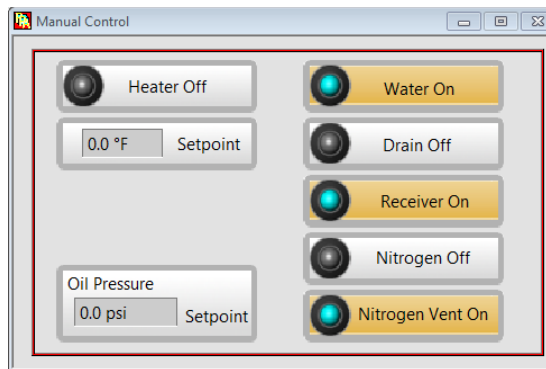
8. Verify that the volume in the receiver is less than 5 mL but greater than 0 mL after the 'Fill' sequence is complete.

Receiver Volume 2.30 ml

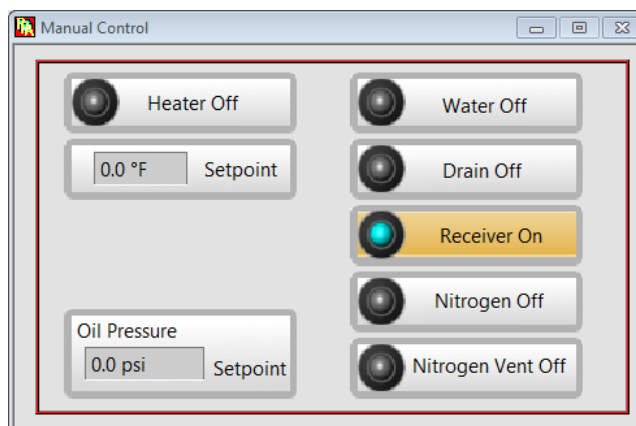
9. Close all of the valves.



10. Open the 'Water', 'Receiver,' and 'Nitrogen Vent' valves.

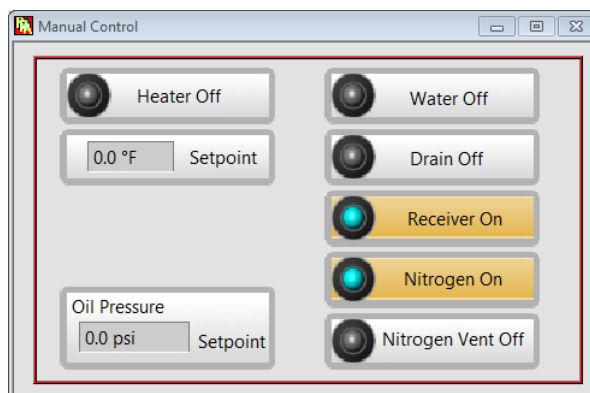


11. Let water fill the receiver until the indicated volume is greater than 20 mL, then close the 'Water' and 'Nitrogen Vent' Valves.

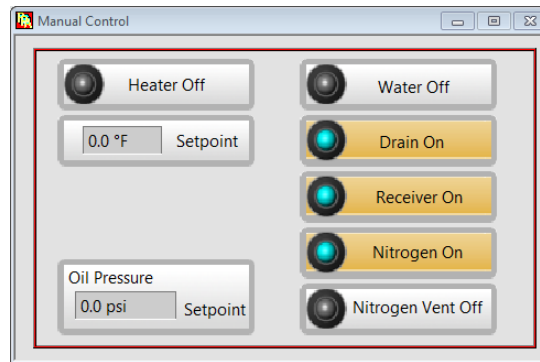


12. Check that the nitrogen supply is set to 700 PSI minimum, as well as the regulator on the APPA itself. Once verified, open the regulator on the 389 MC until the pressure gauge reads 700 PSI. Open the Nitrogen

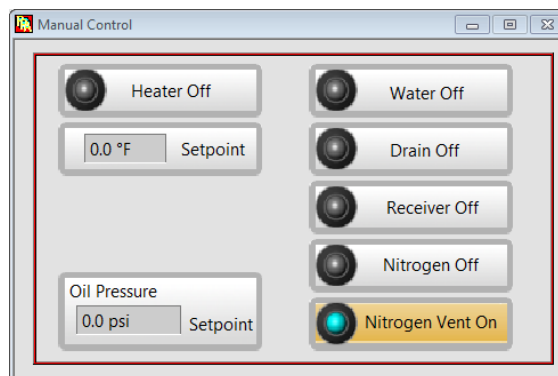
valve.



13. Check for immediate leaks and tighten if necessary. A decreasing receiver volume is an indicator that a leak is present in the system. If no leaks are visible and the volume in the receiver is still decreasing, empty the receiver by opening the drain valve, then close all of the valves when it is empty. Depressurize using the nitrogen vent before disassembling.
14. If no leaks are present in the system and the receiver volume is stable, take note of the volume and allow the unit to sit under pressure (Step 20) for 30 minutes.
15. At the conclusion of 30 minutes, if the receiver volume is unchanged, the unit passes the pressure test. If the volume of the receiver decreases during the test, check for leaks, tighten any fittings if necessary, and repeat.
16. Once the unit has passed the pressure test, reduce the regulator pressure to 200 PSI. Open the drain valve. This will evacuate any fluid from the receiver.



17. Once empty, close all of the valves and open the nitrogen vent valve to remove excess nitrogen pressure from the system.



18. Reduce all regulators to zero, close the valve on the nitrogen supply tank, bleed pressure from the lines and disassemble as required.

5 Software

This section describes opening and operating the APPA software in Windows®. A computer is required for operating the instrument's software. The computer allows the user to perform these actions:

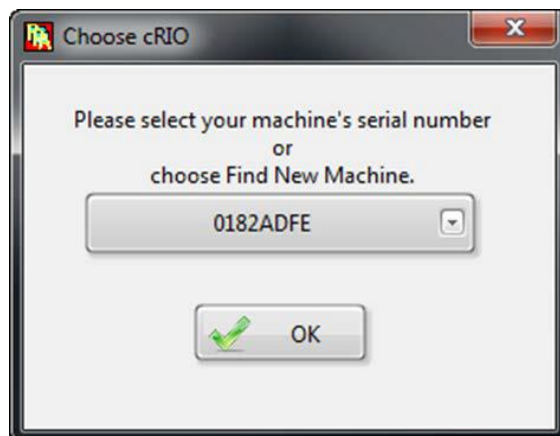
- Start a test
- Stop a test
- Operate manual controls, temperature setpoint, pressure setpoint, the heater, and prime function
- Create, select, and review test profiles, temperature setpoint, pressure setpoint, heater activation, and prime function. (Machine Function and Machine Settings)
- View real-time data in a graph
- Store test data

The following actions are also possible with the APPA keypad:

- Start a test
- Stop a test
- Prime the cell
- Select preprogrammed Test Profile
- Adjust Pressure or Temperature

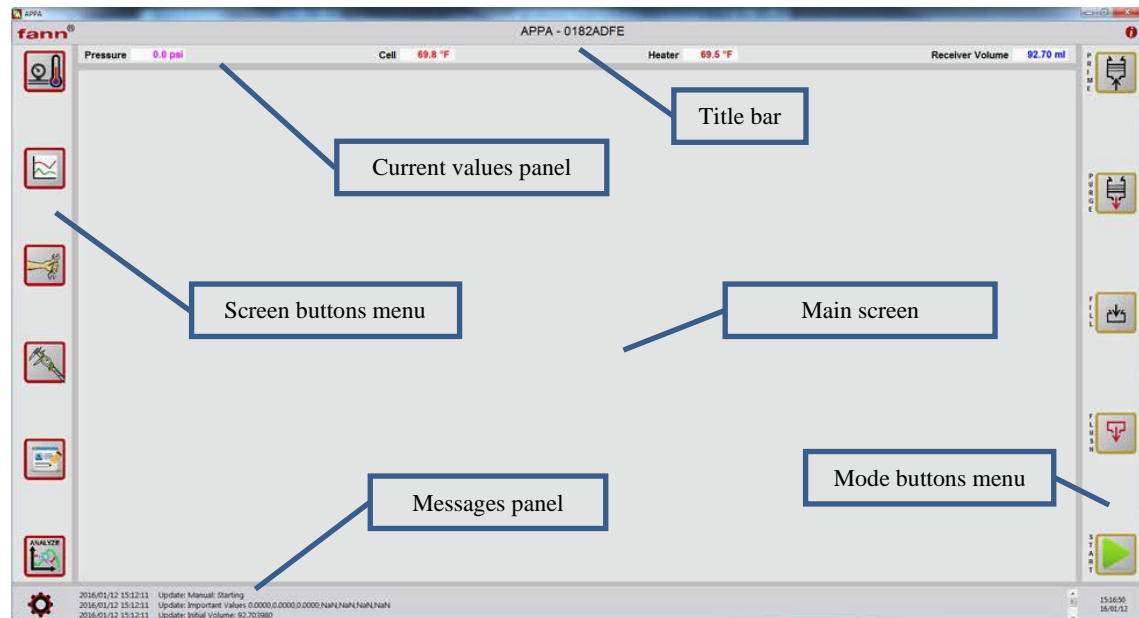
5.1 Starting Up

1. Use drop down below to select the machine to connect to. If the software was configured before, that machine will be in the drop down menu. If not, select "Find new machine".



2. After selection is made, press OK to continue.


3. The title screen has the following components:

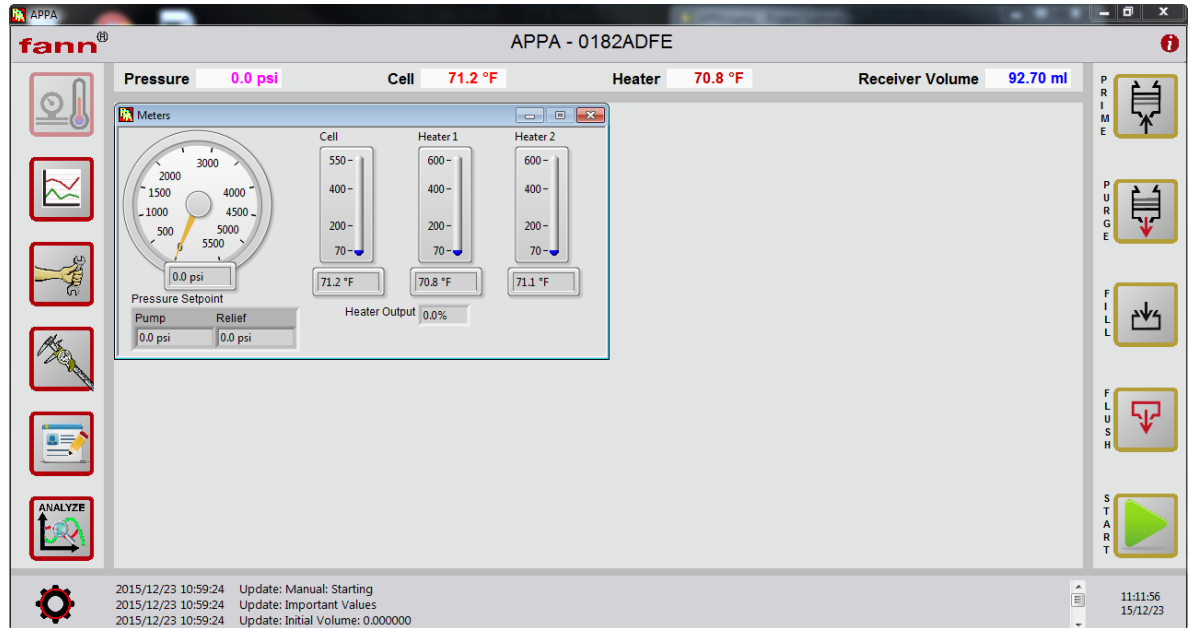


- Title bar: has the Fann logo with a link to the www.fann.com, the machine name/serial number, and the About button.
- Current values panel: updates once a second with most recent values.
- Screen buttons: choices for screen mode displays.
- Messages panel: messages from the APPA, with a configuration button on the left and a time button on the right.
- Mode buttons menu: choices for APPA actions to be performed.
- Main screen: display area.

5.2 Screen Buttons Menu

1. Meter Screen


Pressing  opens the screen below:

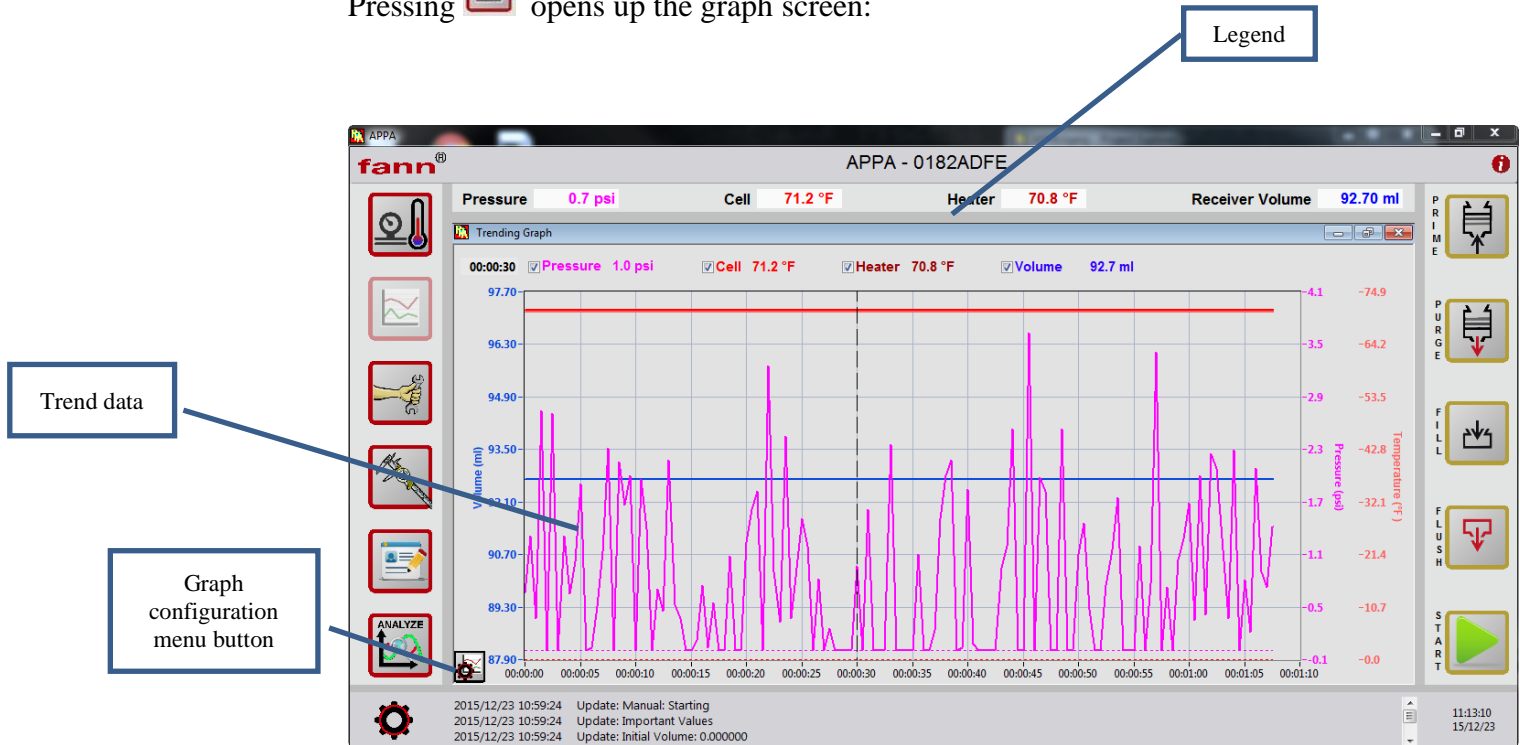


Dial shows the current pressure values. The numbers below indicate the pump setpoint and the relief setpoint. If the pressure is below the pump value the machine will pump until the pressure is above the pump value. If the pressure is above the relief setpoint, the machine will relieve pressure until it falls below the relief setpoint. The user can set this deadband range (range between the pump and relief) in the settings page shown later in this document.

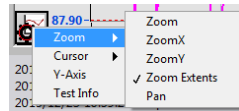
Thermometers show current temperature values. The heater output is the current percentage the heater is on.

2. Graph Screen

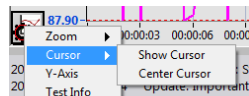
Pressing  opens up the graph screen:



- Trend data: shown up to 4 hours, updates every 0.5 seconds.
- Graph continuation menu button options:



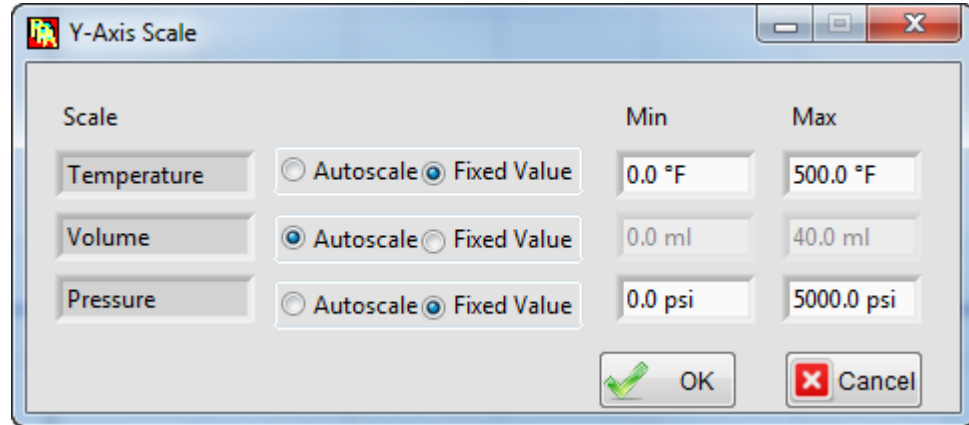
- Zoom options allow the user to zoom in on a section of the graph. ZoomX allows to zoom in along the X axis. ZoomY zooms in along the Y axis. Pressing zoom extents will show the entire graph again. Pressing Pan allows the user to move the graph. When the user clicks on zoom that option will be checked and the cursor will change to a magnifying glass. To change the cursor back to its default icon, click the selected option again. This will uncheck it but not change what is shown on the graph.



- Cursor options will show the cursor allowing the user to see values in the past. The cursor is shown in the image above. When first

selecting show cursor, the cursor will appear in the middle of the graph. Select Center Cursor to place the cursor at the center of the viewing area. Show Cursor option will become Hide Cursor when cursor is shown. Selecting Hide Cursor will hide the cursor and the past values and time indicators.

- Selecting Y-Axis gives this UI below allowing the user to auto-scale the various y-axes

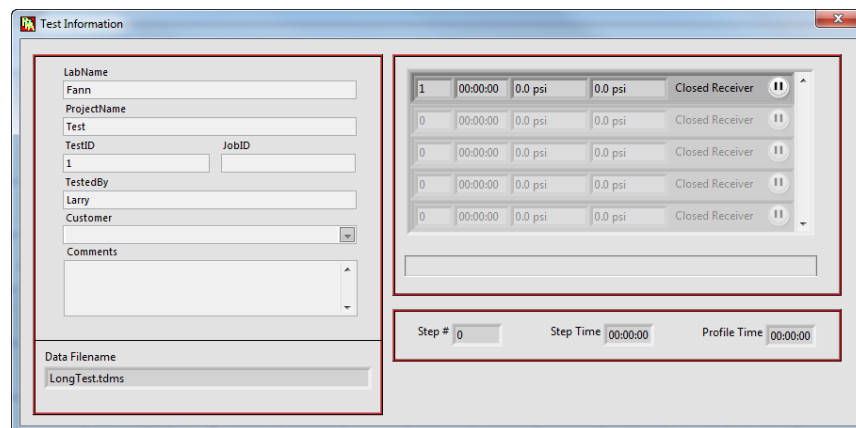


The Y-Axis Scale dialog box allows users to configure the scale for Temperature, Volume, and Pressure. Each parameter has a radio button for Autoscale or Fixed Value, and corresponding Min/Max value fields.

Scale	Autoscale	Fixed Value	Min	Max
Temperature	<input type="radio"/>	<input checked="" type="radio"/>	0.0 °F	500.0 °F
Volume	<input checked="" type="radio"/>	<input type="radio"/>	0.0 ml	40.0 ml
Pressure	<input type="radio"/>	<input checked="" type="radio"/>	0.0 psi	5000.0 psi

Buttons: OK, Cancel

- Selecting Test Information shows the UI below which would show the last or current test that is running.



The Test Information dialog box displays test details and a table of test steps.

LabName: Fann
 ProjectName:
 Test:
 TestID: 1 JobID:
 TestedBy: Larry
 Customer:
 Comments:
 Data Filename: LongTest.tdms

Step	Time	Pressure	Volume	Status	Control
1	00:00:00	0.0 psi	0.0 psi	Closed Receiver	II
0	00:00:00	0.0 psi	0.0 psi	Closed Receiver	II
0	00:00:00	0.0 psi	0.0 psi	Closed Receiver	II
0	00:00:00	0.0 psi	0.0 psi	Closed Receiver	II
0	00:00:00	0.0 psi	0.0 psi	Closed Receiver	II

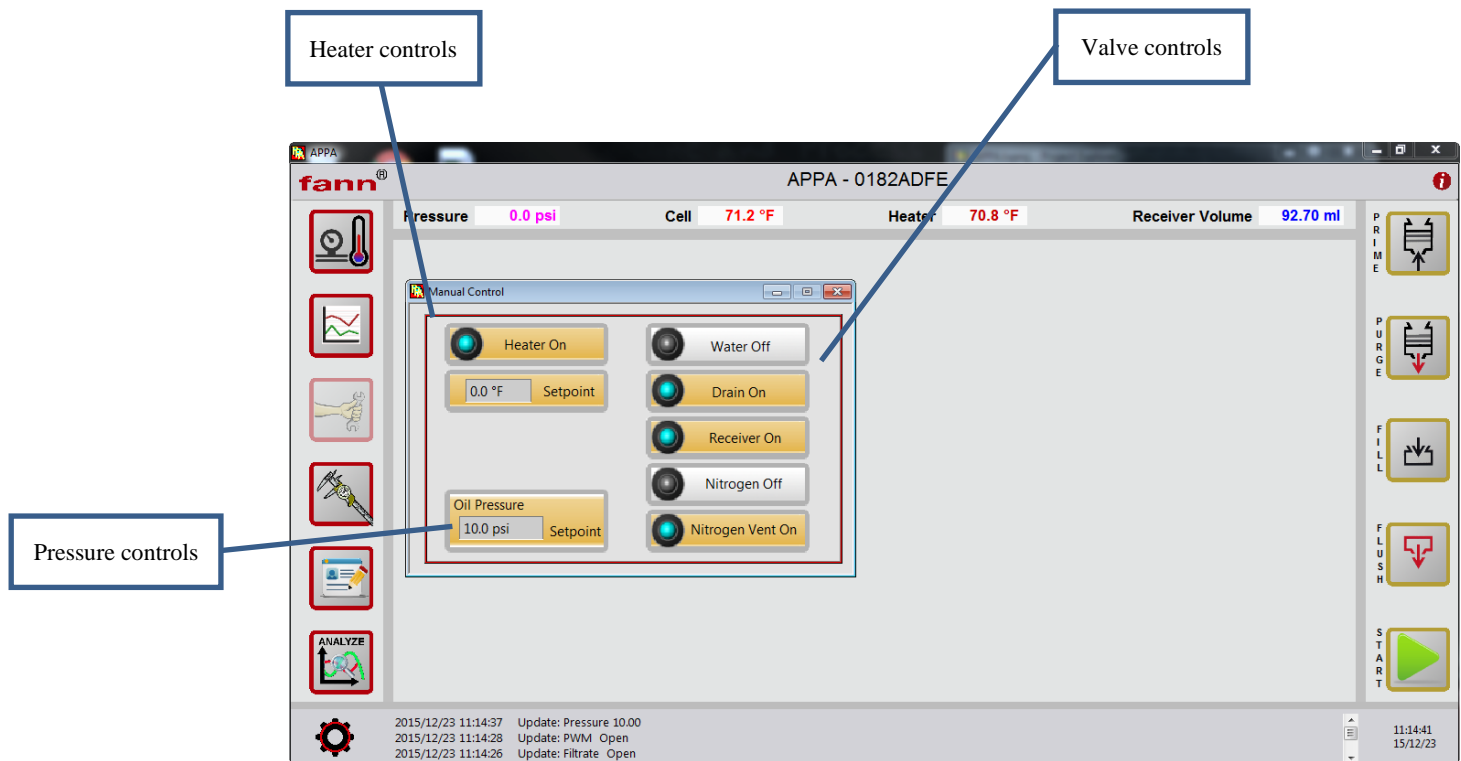
Step #: 0 Step Time: 00:00:00 Profile Time: 00:00:00

- Legend shows which color lines refer to which variable. When cursor is on this will also show the past values and time the cursor is on.

3. Manual Control Screen




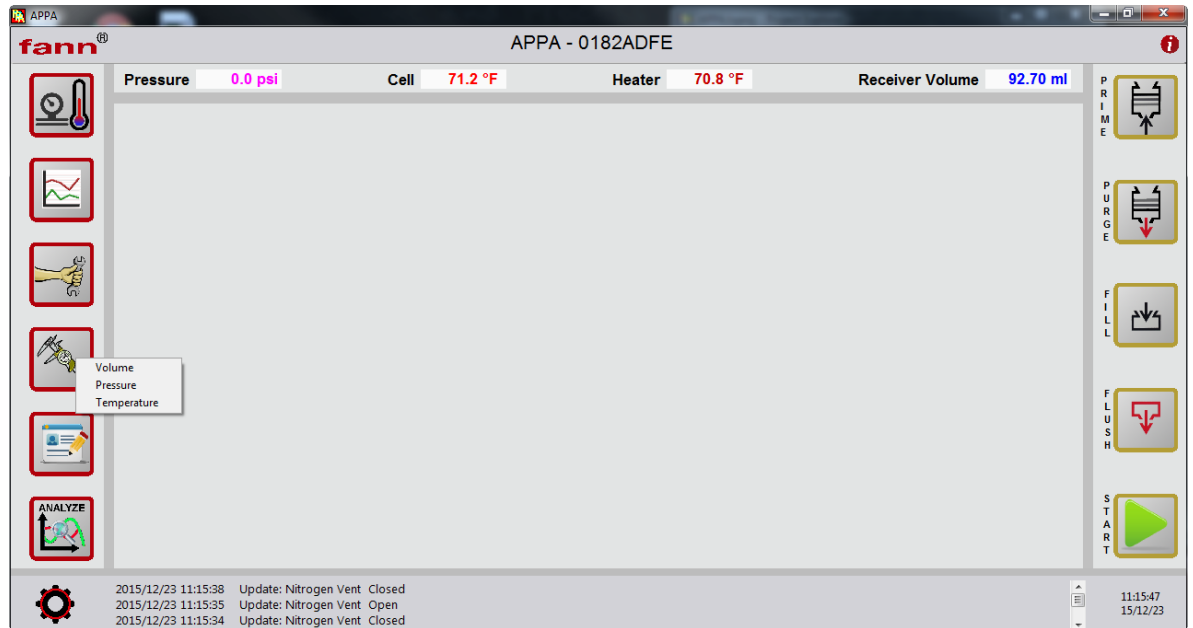
Pressing the Manual Control icon pop ups the manual control UI. This allows the user to control the system when a test is not running. When a test is running, this will show the current setpoints for the system.



- Valve control buttons: open or close the various valves in the system. When orange and the LED is blue, the valve is open
- Heater control buttons: type in what value to heat the system to in the bottom control. If the Heater On button is not pressed, the system will not start heating.
- Pressure buttons: these set the value to pump the pressure up to desired

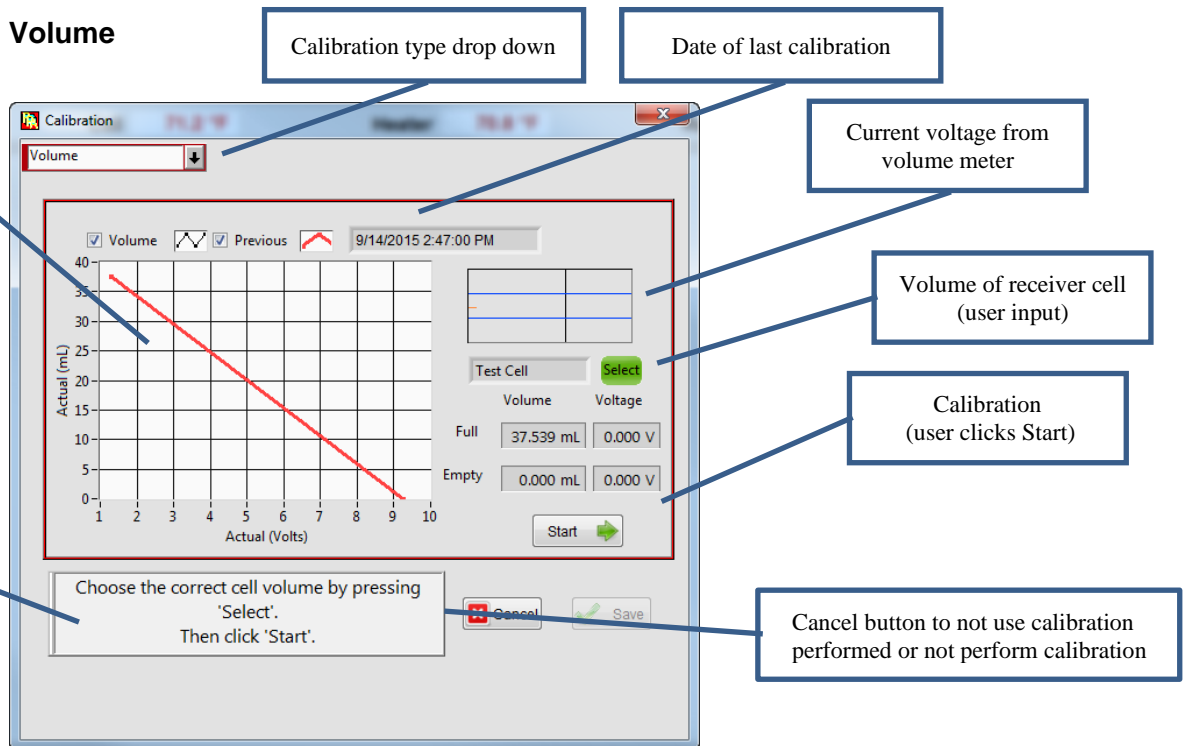
4. Calibration Screen

Pressing  will show the options for calibrations. This button will be disabled when a test is running.



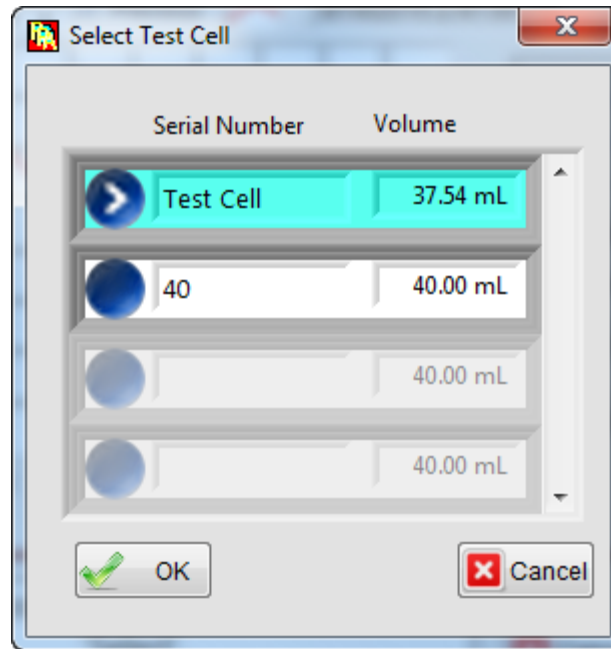
Select a feature in the calibration menu to calibrate as follows:

5. Volume



- After selecting the calibration type, the user can still change the calibration by using the drop down menu
- Before the calibration starts, the graph will show the previous calibration
- Shows current voltage from the volume meter. The user can see the voltage increase and decrease as the calibration progresses

- The only value the user needs to input is the volume of the receiver cell. Press this button and the user can then input cell volumes for multiple receiver cells.
- Type in the serial number of the receiver cell or a name for the cell, and then input the total volume of that cell indicated on its side. Note: these volumes are calculated in serialized sets and the components may not be interchanged. When done click OK. This will save the volume. Press the arrow to select that cell.



- The calibration will occur automatically when the user clicks Start. As the cell is filling or emptying, the corresponding indicators will show the changing voltages.
- Start button, when ready press start to start the calibration. The calibration will then begin automatically
- Instructions on how to perform a calibration
- Cancel/Start – press start when ready to begin a calibration. Press cancel to not use the calibration performed or to not perform a calibration.

6. Pressure

Calibration type drop down

Date of previous calibration

Graph of current or previous calibration

Table of voltages/pressures

Back, Start/Next

Cancel or Save

Instructions for how to perform calibration

Press 'Start' to begin

Pump (V)	Reg (V)	Press (V)	Enter Actual Press (PSI)
0	5	1.9	0
1	5	3.4	950
2	5	4.9	2000
3	5	6.5	3100
4	5	7.9	4000
5	5	9.4	5000
0	4	8.0	4050
0	3	6.5	3100
0	2	5.1	2100
0	1	3.6	1100
0	0	1.9	0

- Use the drop down to switch between calibration types
- Table that shows the voltages applied to the pump/regulator will be set to during the calibration (Pump (V) and Reg (V) respectively). Press (V) is the voltage from the pressure sensor. Enter Actual Press is where the user inputs what the actual pressure at these Voltages is. The user will only be able to input on the correct step.
- Back / Next (Start). This button shows start to start the calibration, thus it shows start before the calibration begins. During the calibration, the user can click next to move to the next step in the calibration or back to move to the previous step in the calibration.
- Cancel / Save – press cancel to cancel the calibration, press save to save the calibration and use it in the system.



Ensure a pressure calibration exists before attempting to pressurize the unit. If a calibration file does not exist, it may result in equipment damage.

Temperature

Calibration type drop down

Date of previous calibration

User input

Graph of current or previous calibration

Back, Start/Next


Instructions for how to perform calibration

Cancel or Save

Setpoint	Raw	Input
50.0	50.0	50.0
100.0	100.0	100.0
150.0	150.0	150.0
200.0	200.0	200.0
250.0	250.0	250.0
300.0	300.0	300.0
350.0	350.0	350.0
400.0	400.0	400.0
450.0	450.0	450.0

- Use the drop down to switch between calibrations
- Press 'Last Cal' to load previous calibration
- Setpoint and Raw is the setpoint the user should set the RTD to. Raw is the non- calibrated value the meter is reading. Input is where the user sets the what the actual value is. The user can only input values on the current step
- Back / Next (Start) – Start button is visible before a calibration begins. It is used to start a calibration. Next is pressed to move to the next step in the calibration. Back is pressed to move backwards in the calibration.
- Cancel / Save – used to cancel the calibration or save when all the steps have been stepped through to save and use that calibration

7. Profile Editor Screen

Pressing  starts the profile editor. This is where the user can create or edit a profile. When a test is running, this will also allow the user to modify the running profile.

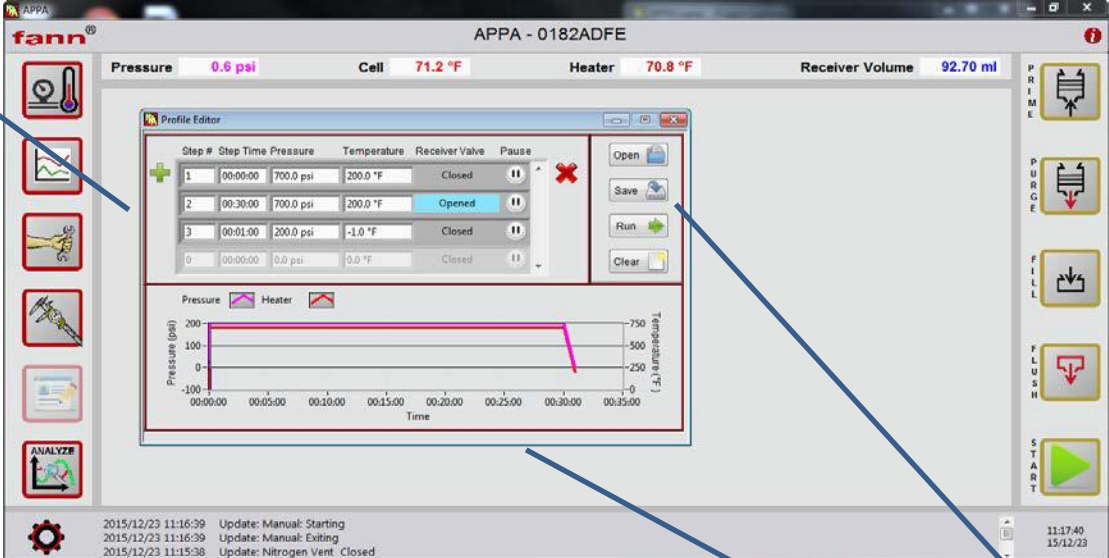


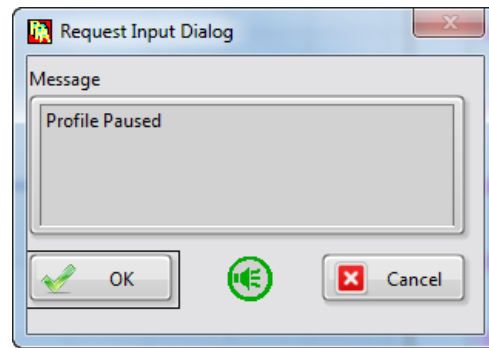
Table to input the profile

Graph of profile created

User action buttons

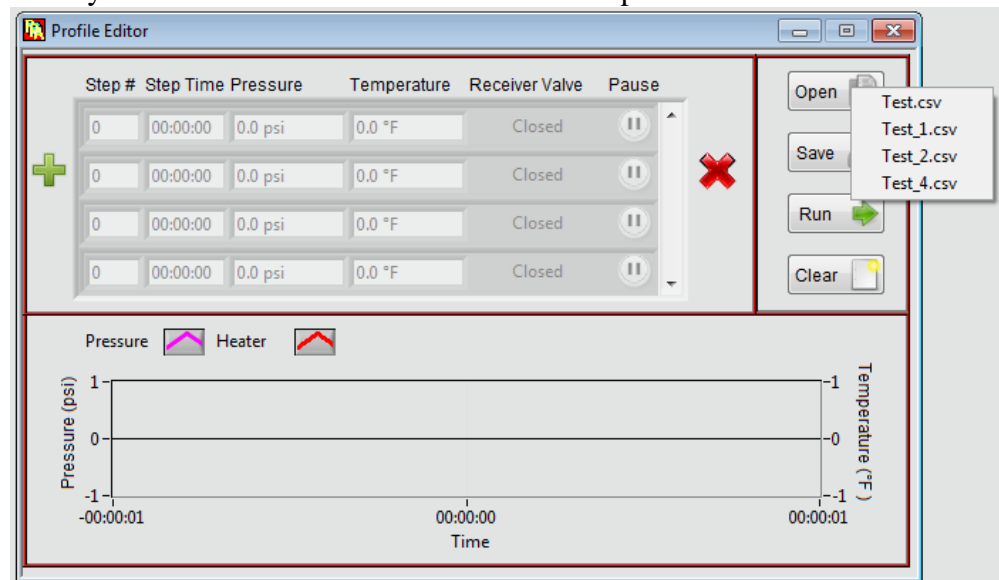
8. Profile Input Table

- Starting on the left, Step # indicates what step number of the profile each row is. This cannot be edited.
- The minimum time the step should take to complete. It is formatted as hh:mm:ss.
- Pressure is the pressure set point the system will reach at the end of the step. Pressure will ramp to the set point over the course of the Time of the step.
- Temperature is the temperature set point the system will reach at the end of the step. Temperature will ramp to the set point over the course of the Time of the step.
- Receiver Valve will determine if the receiver valve is open or closed.
- Selecting pause will prevent the next step from starting automatically. When pause is selected, when that step finishes a buzzer will sound and a UI will appear (as seen below) allowing the user to move to the next step or cancel the test. There is also a button allowing the user to silence the buzzer.

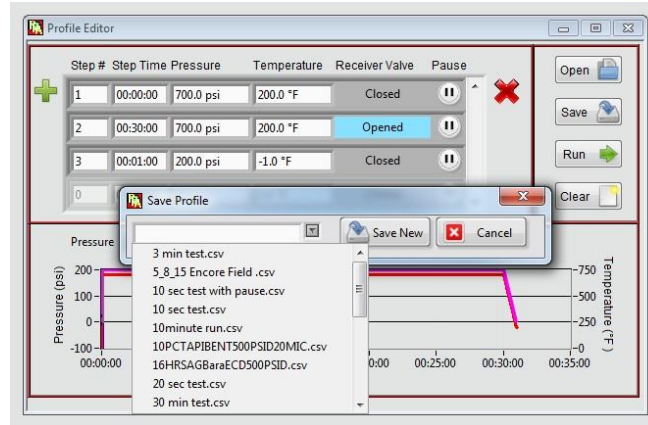


9. Action Buttons

- Open as seen below will show a drop down menu with the profiles already saved to the APPA. These files are in alphabetical order.



- Save allows the user to save the profile they just created. The user will *have* to save the profile in order to run it. Pressing saves opens up a UI to allow the user to overwrite an existing profile, save it as a new profile or cancel from saving it. If the user uses the drop down menu to select an existing profile the Save New button will change to an overwrite button indicating they are overwriting an existing profile.




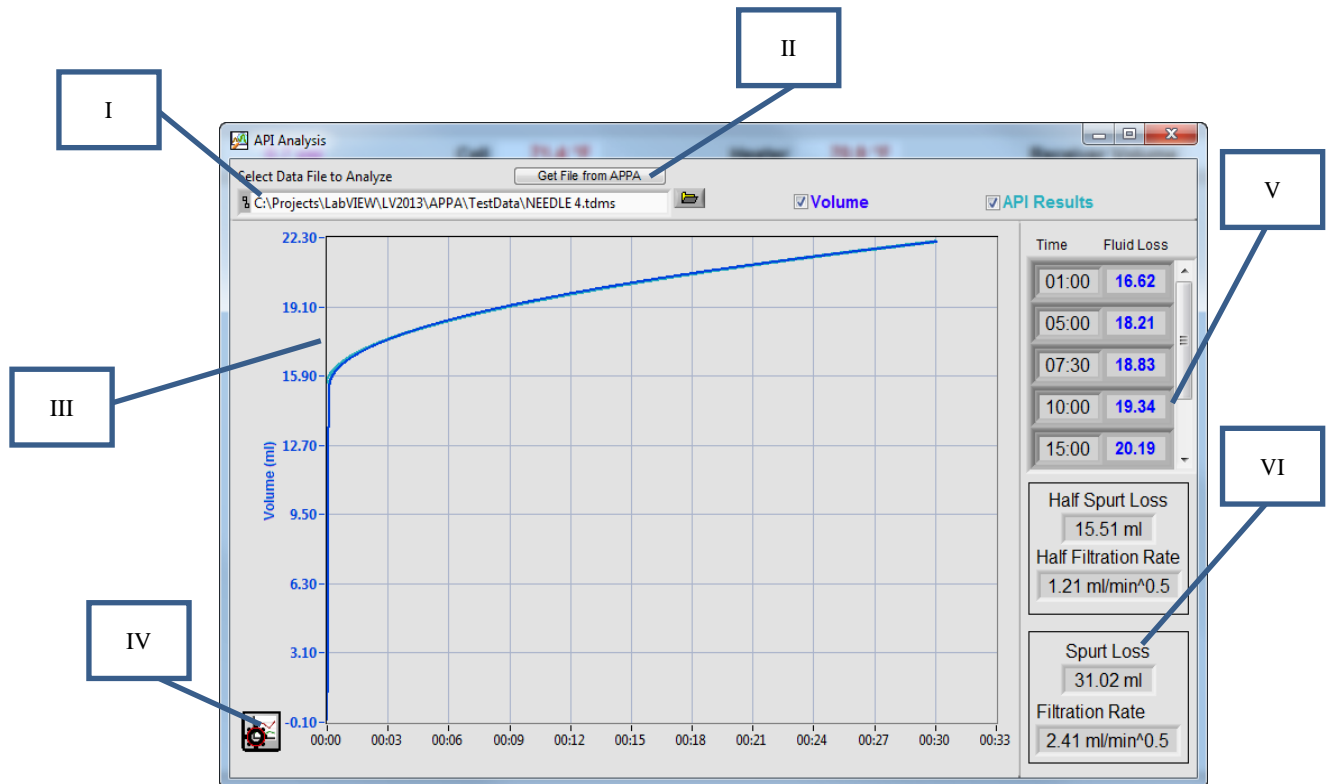
- Run button will automatically take the profile in this UI and open up the profile wizard with this profile loaded. If this profile is not saved it will ask the user to save it first and then open up the profile wizard.
- Clear will clear the profile in the table.

10. Graph of the Profile Created.

When the user moves the mouse over the step that particular step will be highlighted in the graph.

11. Analysis

- Pressing  will open up the analysis executable. This is not a UI inside the APPA software. This is a standalone executable that can be started from outside the APPA software if desired. Multiple windows of this executable can also be opened. Analysis will also open up automatically after a test finishes.



I.

- i. If the user opened this manually this control will be blank. The user will then choose which test data file to load.
- ii. If analysis is opened automatically after a test, this will already have the test data created from that test loaded. Notice that the test file is on the user's computer. It is copied from the machine and placed on the user's computer to be loaded in this analysis software. The machine still has a copy of the test data.

II. Get File from APPA will open up the same UI as transferring test data from the APPA. This allows the user to pull data from the APPA.

III. Graph shows the data from the APPA (in dark blue) and the API recommended best fit formula. No data is plotted when the receiver is not open. Data is zeroed so the volume loss before the valve is opened is zero.

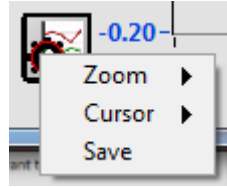
i. API Best Fit

1. Specified in API specifications.
2. For better accuracy this best fit line uses all data 1 minute after receiver valve is opened.
3. The best fit curve is calculated by finding the least squares best fit line of the data vs the square root of

time.

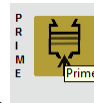
4. This best fit line is then used to calculate the half and full spurt loss and filtration rate.


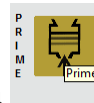
IV. Graph settings



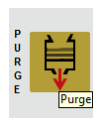
- i. Zoom has the same options as the zoom features in the graph in the main APPA software
 - ii. Cursor has the same features as the cursor in the graph in the main APPA software. Showing the cursor will allow the user to see values along the two curves
 - iii. Save allows the user to save this zeroed data and the API best fit curve to a tdms file.
- V. Events – by default the software will highlight the test data at 1 minute, 5 minutes, 7.5 minutes, 10 minutes, 15 minutes, 20 minutes, and 30 minutes. When the user ran their test they could have changed these options by selecting different time or volume events. This is shown in the Start Wizard section.
- VI. Half Spurt Loss/Half Filtration Rate and Spurt Loss/Filtration Rate are calculated from the API best fit data. These values are equivalent to a traditional collected volume from a half-area HPHT filtration test before the result is doubled to compute the whole-whole area spurt loss and filtration rate. The half spurt loss is the y-intercept of the best fit curve, and the half filtration rate is the slope of that best fit curve vs square root of time. The spurt loss and filtration rate are double the half spurt loss and half filtration rate respectively.


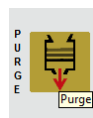
12. Prime



- Press and hold  (being held down ) to prime the system.
- Prime pushes hydraulic fluid into the cell at a very slow rate. The prime is used to push the cylinder up so that the fluid will be at its highest position when the user places the cell cap on the cell.


13. Purge

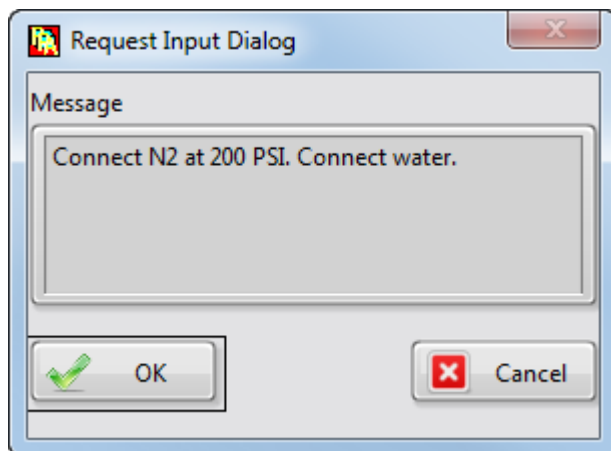


- Press and hold  (being held down ) to purge the system.
- Purge removes hydraulic fluid from the cell

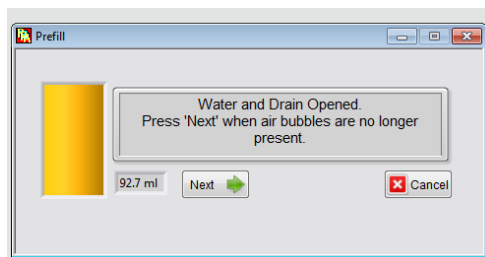
14. Fill



- Press  to fill the system before a test.
1. Before a test starts, all of the tubing in the system must be purged with water. The filtrate loss during the test will displace the water in the lines which then is measured in the receiver cell. To ensure accurate measurement, the piston is not allowed to bottom out, with the 'Fill' volume ending less than 5 ml. This is precautionary to prevent errors due to compression of fluid in the system. When the test starts the receiver cell indicator will show 'Fluid Loss' instead of 'Volume' and is zeroed.
 2. When first clicking Fill, a message informs the user to connect water and nitrogen at 200 PSI. Drain should also be connected. Click OK to continue the fill or cancel to stop.



3. After hitting OK, a UI will appear which shows the volume in the receiver cell and messages to the user. During fill, the user will have to click Next to move to the next step when instructed to do so.




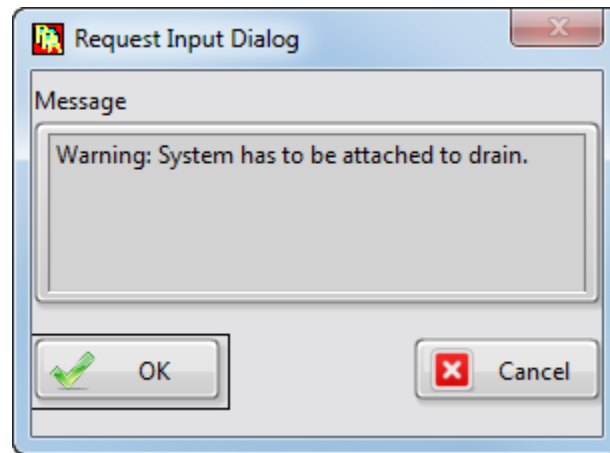
4. Fill will completely fill the receiver valve. Then it will open water and drain to remove all air bubbles. This step requires user intervention to move on. After clicking Next, fill will empty the receiver cell until the

cell has less than 5 mL of water left.

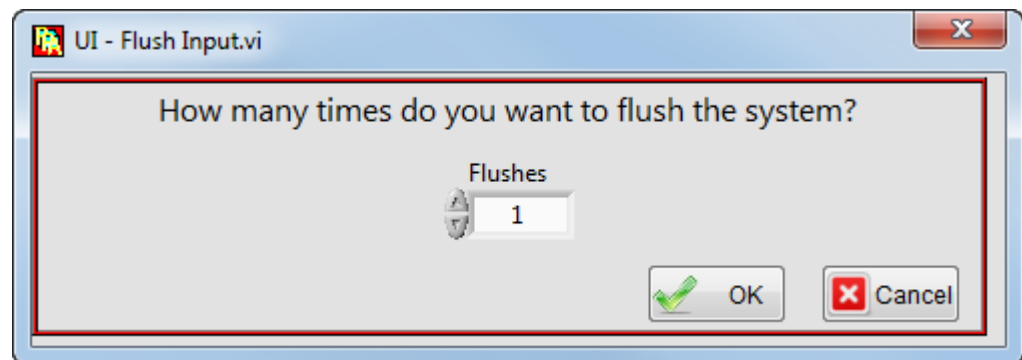
15. Flush



- Press  to flush the system.
 - I. After a test is completed the user will want to flush the system of the filtrate. This can be done automatically using 'Flush.'
 - II. When first clicking flush, the user is given a message to make sure the system is attached to the drain. OK continues the flush routine while cancel will stop it.
 - III. If using oil based fluids, Barakleen may be used in place of the water reservoir to enhance the cleaning cycle. Soapy water is NOT advised for use during the 'Flush' cycle as it produces large amounts of foam in the system.

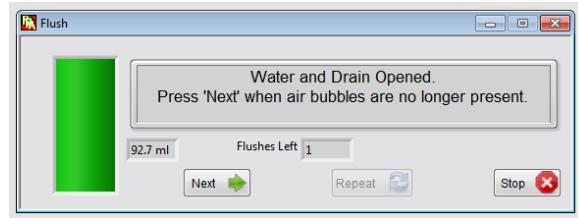


- IV. After pressing OK, the user can then select how many times they would like to flush the system. OK continues while cancel stops.



- i. Unlike fill this routine does not require user intervention. This was done intentionally so the user can select to flush the system multiple times in a row without having to be present at the system.


- V. After that the user is shown a UI with the volume of the receiver and messages regarding the flush routine. There will be steps the user can skip through. Unlike fill though there is a maximum time the system will stay in this step. If the user is not present at the machine the flush cycle will continue without them.

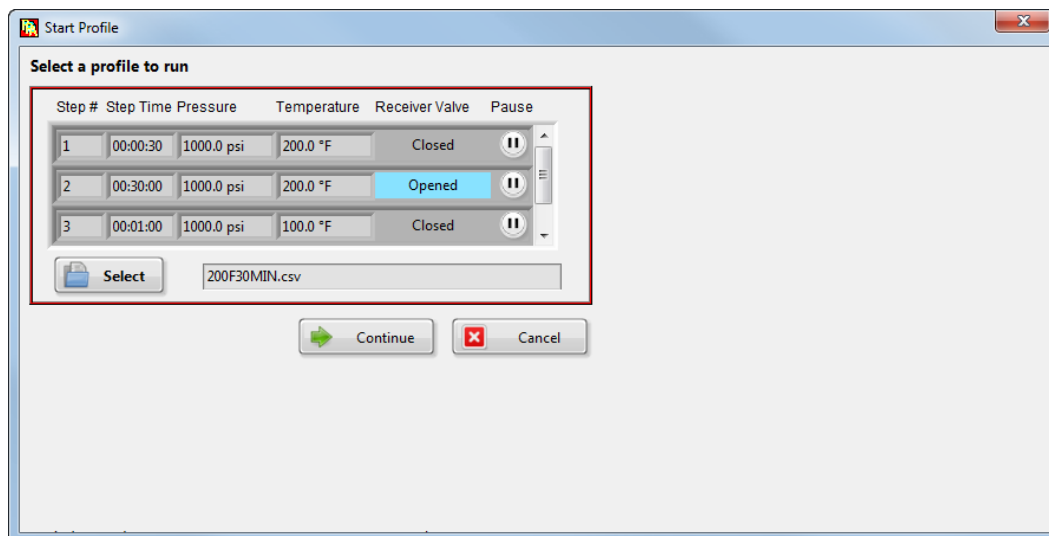


- VI. At first the system will completely fill the receiver.
- VII. Then the system will open the water and drain to flow water through the system.
- The user can either press next when satisfied or the system will continue after a maximum time.
- VIII. The system will then drain completely unlike the fill routine which drains the system, but stops above 0 mL.
- IX. When the flush routine ends, if there are still flushes left in the repetition the flush routine will restart. If this was the last flush, the user can still repeat it by pressing the repeat button.
- X. At any point the user can click stop and stop the flush routine. This will stop the routine where it is. It won't finish a step or drain the system.

16. Start Test

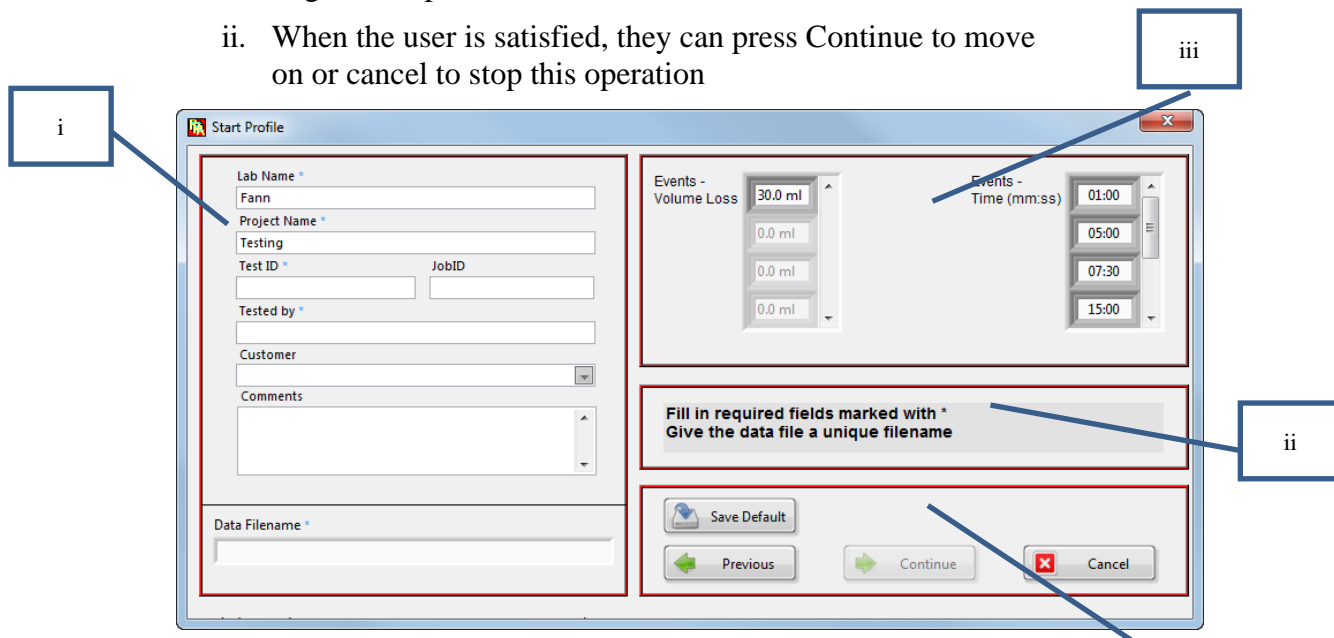


- Press  to open up start wizard and start a test. The user may also start the start wizard/test from the profile editor by pressing the Run button.



- I. The first screen seen after starting the start wizard is this below. If the user opened this screen from the Start Button, they will have to select a profile by pressing the select button and then choose from a profile from the list. If the user opened this screen from the profile editor, the profile will already be loaded.

- i. The user cannot edit the profile from this screen. They will have to go to the profile editor to do that.
- ii. When the user is satisfied, they can press Continue to move on or cancel to stop this operation



- II. After pressing Continue, the user will see this screen

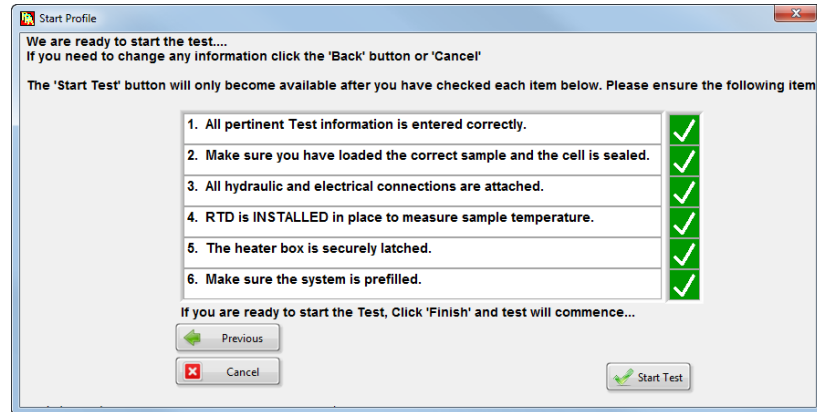
- i. The test information is saved with test data in the tdms file.
 1. Any field marked with an asterisk has to be filled in.

The software will not let the user continue (see that it is greyed out here) until all required fields are filled in.

- ii. If the continue button is greyed out, it is because something is missing. This direction box shows what is needed in order to continue. See below for a completed example. Notice the directions are crossed off. They will cross off as the user completes them.

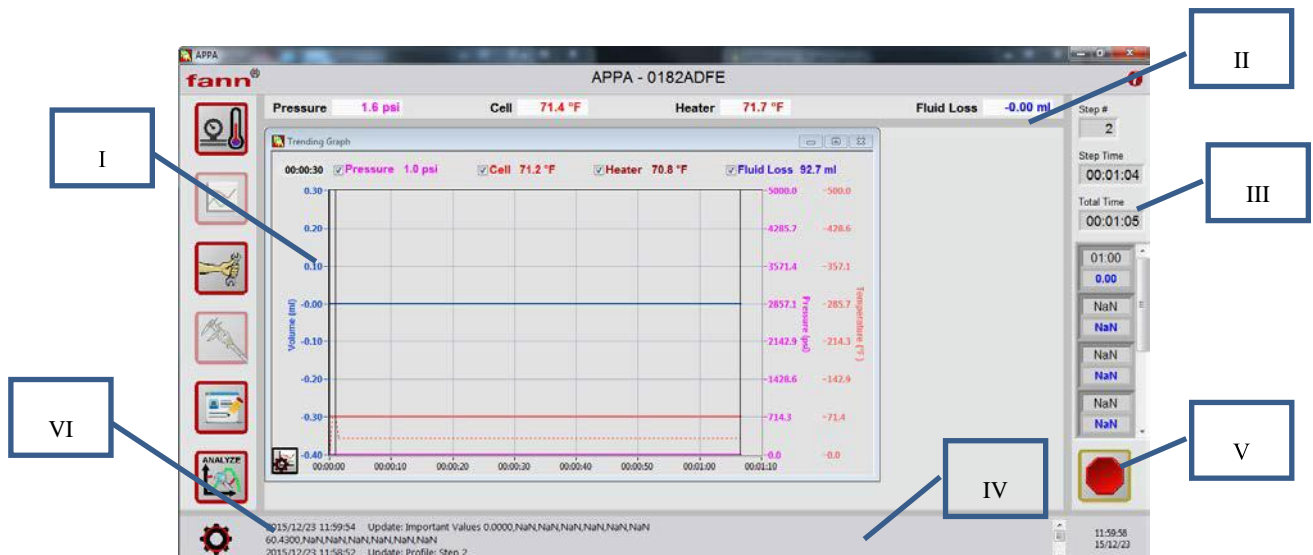
- iii. Events – during a test the software will mark important times and values. The user can choose which times or values are marked here using the events option.
 1. Changing these events will also change what important values are shown in the analysis software
- iv. Action buttons
 1. Save Default will save the test information so the next time the user starts the wizard the fields will be preloaded
 2. Previous/Continue move forward or backward in the start test process
 3. Cancel stops this process

- III. The final screen will ask the user to confirm they are going to safely and correctly run the test.
- i. When the setup is correctly completed, the screen will look like this:



17. Running a Test

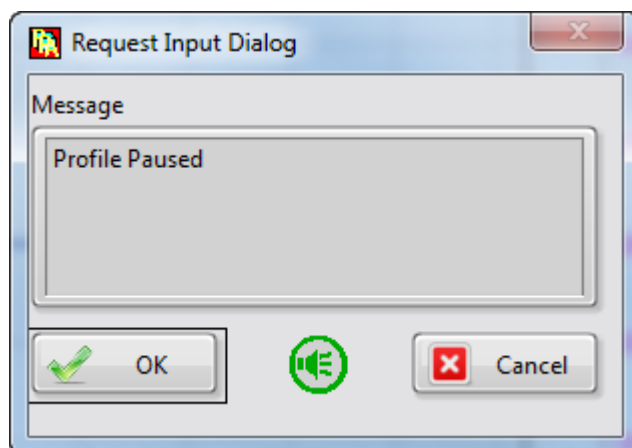
- When a test starts, the screen will automatically open the trending graph, and the screen will appear as shown. When the test is completed the analysis software will automatically open.



- I. The trending graph will automatically open and thus start when a test begins.
- II. Notice the indicator does not say 'Receiver Volume' but 'Fluid Loss.' This is because it is zeroed after the fill
- III. Step and Time information for the test can be seen here
- IV. Events specified in the start wizard will appear here as they occur.
- V. Stop the test by pressing this button
- VI. Notice that some functions are disabled when a test is running


including calibration.

- i. If the user opens the manual screen now, it will show the setpoints as they change with the test. The user will *not* be able to change these setpoints.
2. If the test has a pause in it, the user will see this screen.

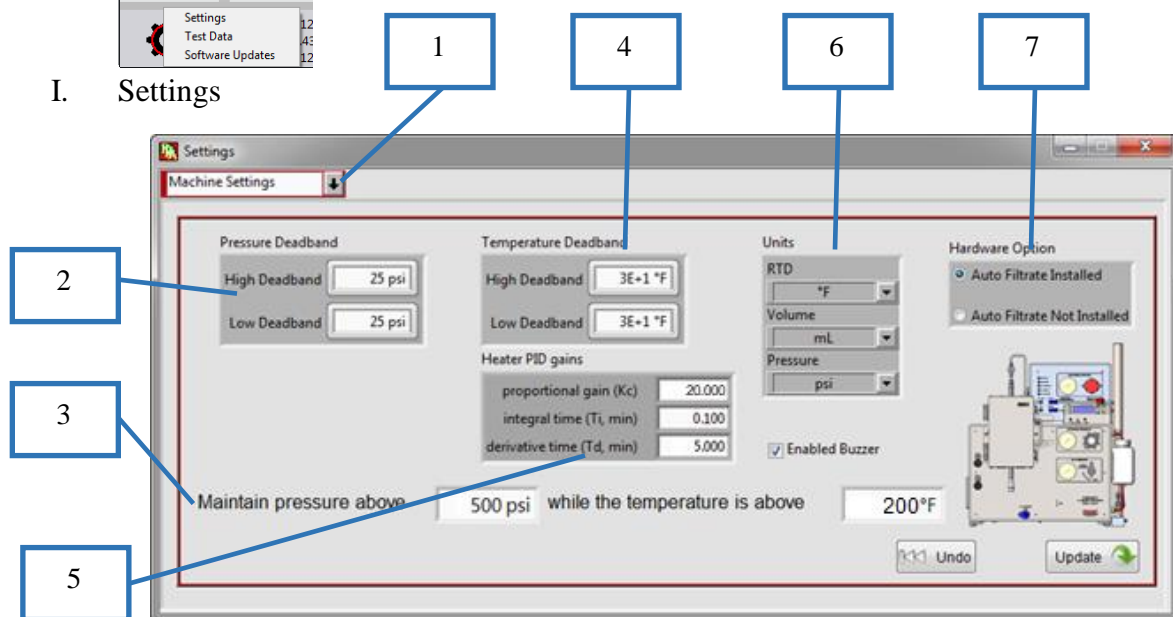


- I. Press OK to continue the test
- II. Press buzzer button to silence the buzzer
- III. Press Cancel to stop the test

18. Settings

- Press  button to see the configuration options

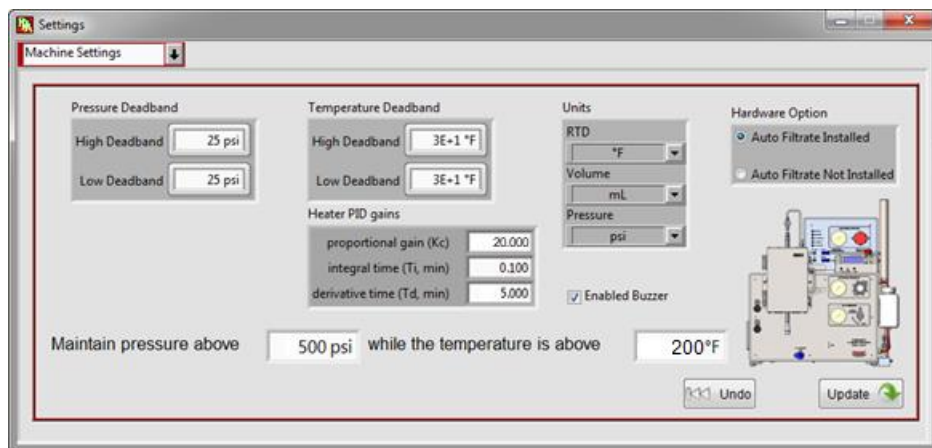
I. Settings



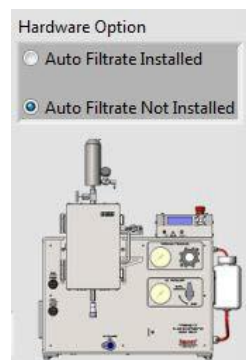
- i. When the user presses the settings page, it will automatically

open to Machine Settings.

1. Use the drop down menu to switch between Machine Settings and Configuration
2. Pressure Deadband
 - a. High is the pressure amount added to the setpoint to set the relief value
 - b. Low is the pressure amount subtracted from the setpoint to set the pump value
3. This safety statement is used to prevent a high temperature substance dropping pressure too quickly. When this is set correctly, the system will not be able to drop the pressure unless the temperature is low enough.
 - a. The default condition should be 185°F and 1000 PSI.
4. Temperature deadband is used during a test. A step will not finish until the pressure and temperature reach the final setpoint of that step. Temperature heats quickly, but we have found it can take a long time to reach that final degree. So we have allowed the customer to set the temperature deadband so the test can proceed when the profile reaches High or Low above or below the setpoint
5. Heater PID are the PID values used to control the temperature.

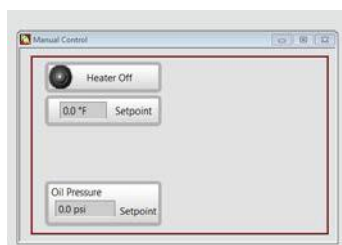


6. Units – change these values to change the units shown in the software.
 - a. Regardless of what values are shown here, the information being saved to the test data will always be °F, PSI, and mL
7. This software can be used with or without the new auto filtrate measurement is installed. If the user does not have it installed click Auto Filtrate Not Installed, the image below will change and look like this



Notice the image does not have the auto filtrate hardware.

- a. When the auto filtrate is not installed, certain functionality will not be available to the user for example
 - i. The manual screen without the auto filtrate installed does not show the valve controls



- ii. Without the auto filtrate installed, the fill and flush are disabled and the calibration options are limited to Pressure and Temperature. Also the receiver volume indicator is greyed out.



- II. Config Hardware – when changing which machine being controlled, or if the software cannot find the hardware, or to change the name of the machine, it would be necessary to come to this settings page.

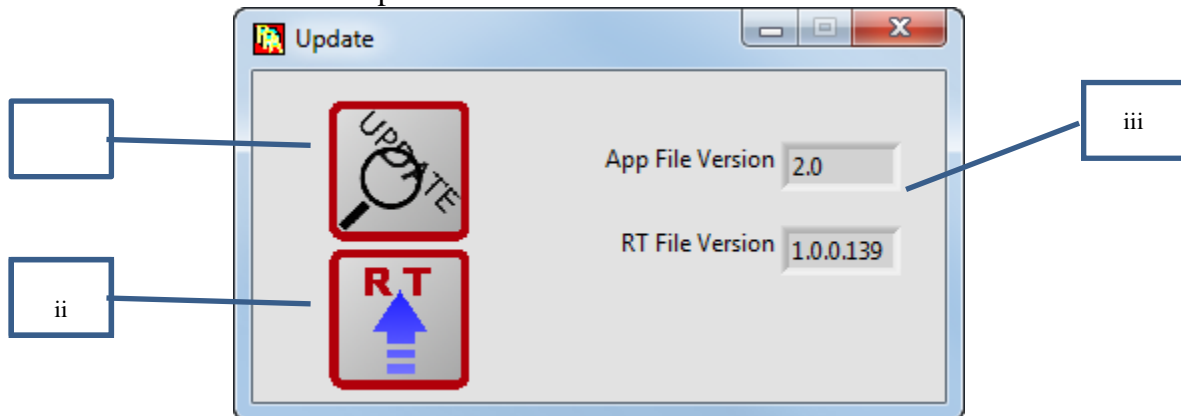
- i. Use the drop down menu to switch between settings options
 - ii. Type in the serial number of the hardware to be controlled
 - iii. Click find hardware. The software will then search for that serial number
 - iv. The user can change the name of the hardware by typing it here, and then clicking rename
 - v. When finished click OK to save the changes or cancel to ignore them.
- III. Test Data – this is used to transfer data files from the hardware to the computer. This process will delete the files after they are transferred

Name	Date	Size
350F500PSIDBaraECDAuto3.tdms	Apr 28 2015	234161
EventTest8.tdms	Jun 8 2015	91308
EventTest9.tdms	Jun 8 2015	90228
PauseTest1.tdms	Jul 16 13:21	14714
TestPause1.tdms	Sep 15 18:52	10228
EncoreFieldBP1.tdms	May 11 2015	306170
...

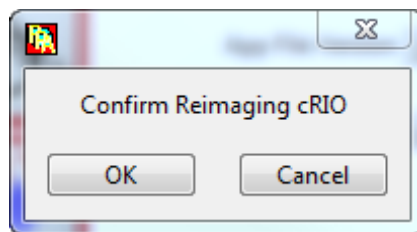
- i. Click the files needing to be transferred. Multiple files can be clicked.
- ii. The rows can be reordered if the column heading is clicked.

- iii. Click transfer to start the transfer

IV. Software Updates



- i. Click update to search for updates for the software
- ii. Click to push an image onto the hardware. There will be a warning before pushing the image as seen below



- iii. These indicators show the File version and the RT File version

6 Operation

Table 6-1 Required Minimum Backpressure

Test Temperature		Vapor Pressure		Minimum Backpressure	
°F	°C	PSI	kPa	PSI	kPa
212	100	14.7	101	100	690
250	121	30	207	100	690
300	149	67	462	100	690
350	177	135	932	160	1104
400	204	247	1704	275	1898
450	232	422	2312	450	3105
500	260	685	4727	710	4900

6.1 Preparing the APPA

1. Turn power switch to the ON position (main switch on back of APPA). Wait for the default screen on the LCD that shows the temperature and pressure.
2. Open the air supply line and the nitrogen supply line.



Air supplies pressure to the pump. Nitrogen supplies pressure to the backpressure receiver.

3. Make sure that the oil reservoir is full of hydraulic fluid.
4. Turn on the computer. Click on the APPA icon (located on the desktop).

6.2 Preparing the APPA Cell

Refer to these figures while performing these steps:

- Figure 6-1, a drawing of the disassembled cell
- Figure 6-2, a drawing that shows the position of the floating piston and hydraulic fluid level in the APPA cell (inverted cell)
- Figure 6-3, a drawing that shows how the APPA cell is arranged (upright cell)



The APPA cell assembly is a pressure vessel. Follow the safety instructions listed in section 2.



Cell material should be compatible with the test sample. The cell body, cell end caps, and retainer ring are made of Type 17-4 stainless steel. The floating piston is made of Type 303 stainless steel.



Cell bodies that have stress cracking or severe pitting, or damaged set screw holes must not be used.

1. Soak the ceramic discs prior before performing a filtration test.



For water-based drilling fluids, the ceramic disc should be soaked for at least 5 minutes in fresh water prior to use.



For oil-based drilling fluids, the ceramic disc should be soaked for 5 to 10 minutes a representative base oil prior to use.



Filter discs should never be re-used.

2. Unscrew the retainer ring and pull the top cap from the cell using the filtrate valve assembly (backpressure nipple, plug needle and cell top nipple) as a handle.



The retainer ring can be left on the top cap.

3. Inspect all O-rings. Replace any damaged or brittle O-rings.



The O-ring supporting the ceramic disc must be replaced after each test.

4. Apply a thin coat of high temperature grease (P/N 204816 or equivalent) completely around all new O-rings installed in the cell assembly and the floating piston.



If the APPA cell is disassembled or if using a new APPA cell, then install the floating piston and bottom end cap. Next, the user will need to fill the area above the piston with hydraulic fluid and remove air from the space between the floating piston and end cap. See Section 6.2.1 for instructions.

5. Place the APPA cell upright onto a cell stand. See Figure 6-3. If placing the APPA cell into the heater chamber, make sure that the cell is secure and the heater chamber latches are closed.



Before adding sample to the cell, check the piston level in the cell. Determine if the piston needs to be raised or lowered to leave enough space for the fluid sample. Steps 6-10 explain how to move the piston.

6. Connect the nitrogen supply line to the cell top cap.
7. Connect the Oil Pressure Port hose to the bottom nipple assembly on the cell bottom.
8. Open the filtrate valve.
9. To raise the piston, use Prime function from the computer or the APPA keypad. Refer to Section 5 for detailed instructions.
10. To lower the piston, apply pressure to the top of the cell. Adjust the nitrogen flow using the knob that controls the nitrogen pressure (located

on front of APPA). This cannot be done with the automated receiver Model 389 MC attached.



The T-bar can also be used to manually move the piston.

11. Disconnect the nitrogen supply hose and the Oil Pressure Port hose.
12. Remove the top cap.
13. Install the O-ring in the groove in the top of the cell.
14. Pour 275 ml of sample fluid into the cell. Do not exceed this amount.
15. Set a presoaked filter disc that has the desired pore size on top of the O-ring.
16. Place the cell upright in the heater chamber. Make sure that the cell is secure and the heater chamber latches are closed.
17. Open the filtrate valve, and then install the top end cap with the filtrate valve assembly into the cell.
18. Make sure that the filtrate assembly is fully assembled and tightened into the top cap. Then close the filtrate valve. It is advisable to use an eye-dropper to fill any dead space in the filtrate valve with base oil or water depending on the test fluid.
19. Connect the backpressure receiver to the filtrate valve assembly. Then install the safety locking pin to secure the connection.
20. Connect the nitrogen supply hose to the backpressure receiver.
21. Connect the drain hose from the drain valve to the graduated cylinder.
22. Place the thermocouple into the small hole in the cell top.

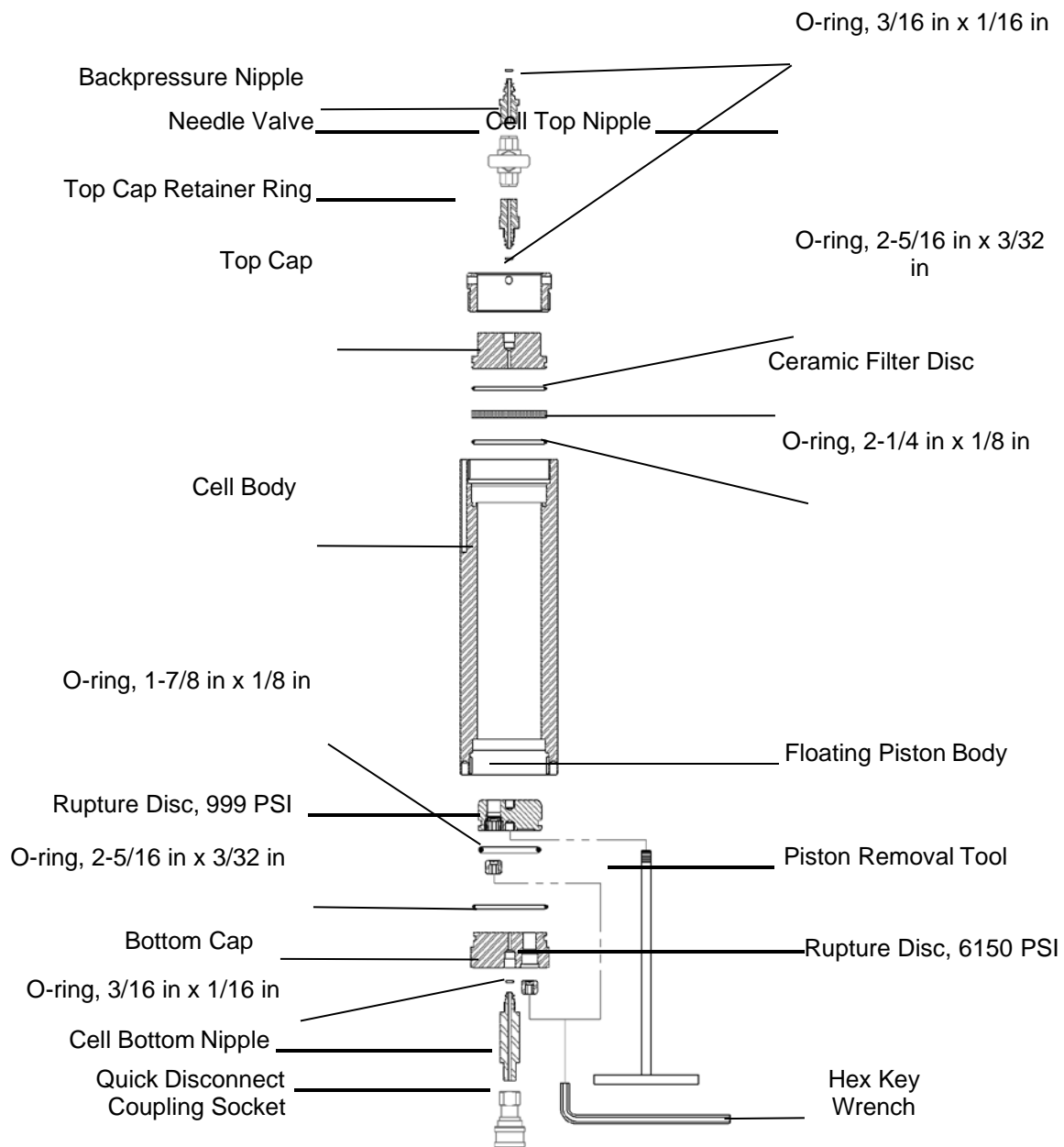


Figure 6-2 Cell Assembly Drawing

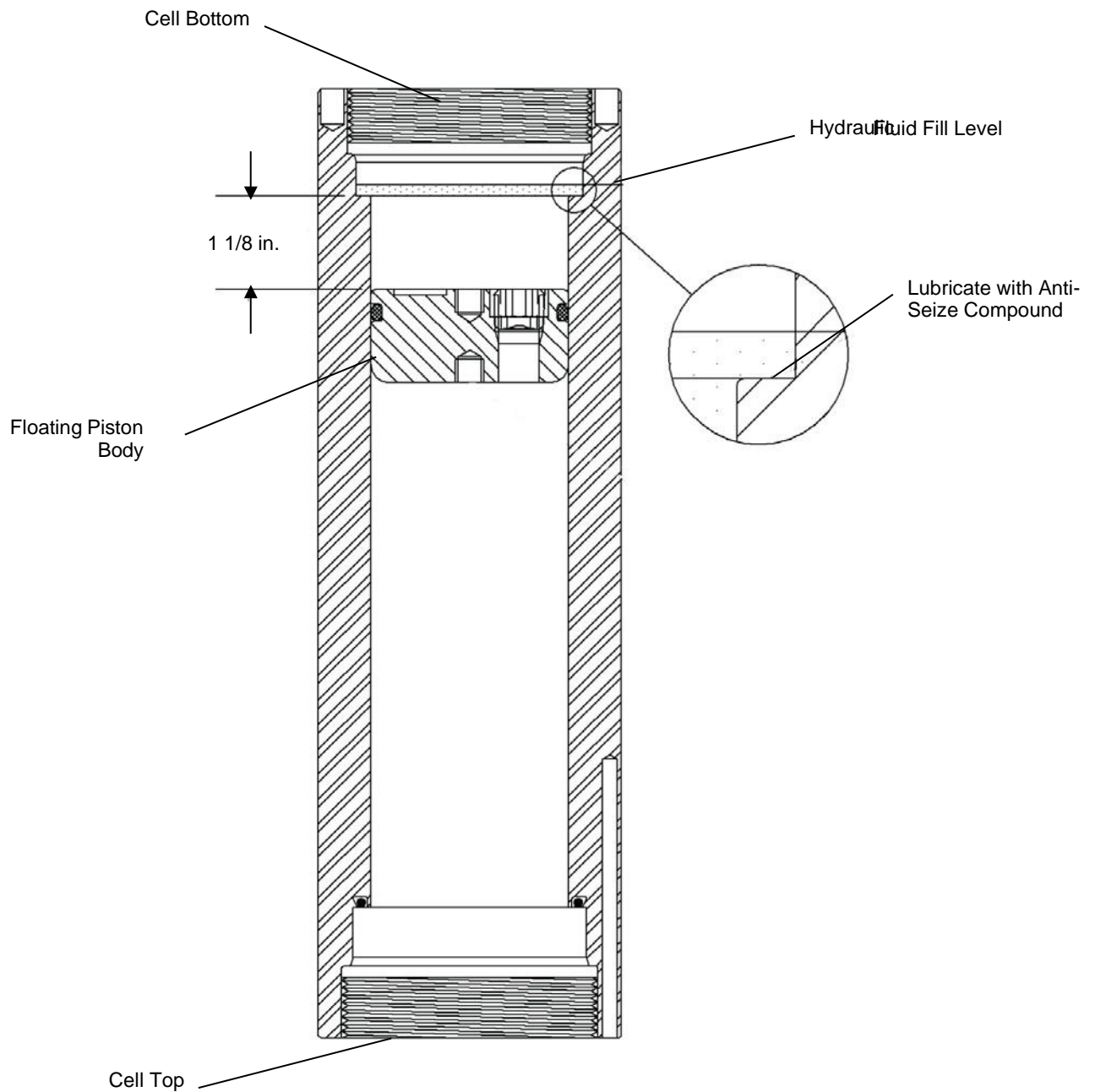


Figure 6-3 Piston Position in APPA Cell

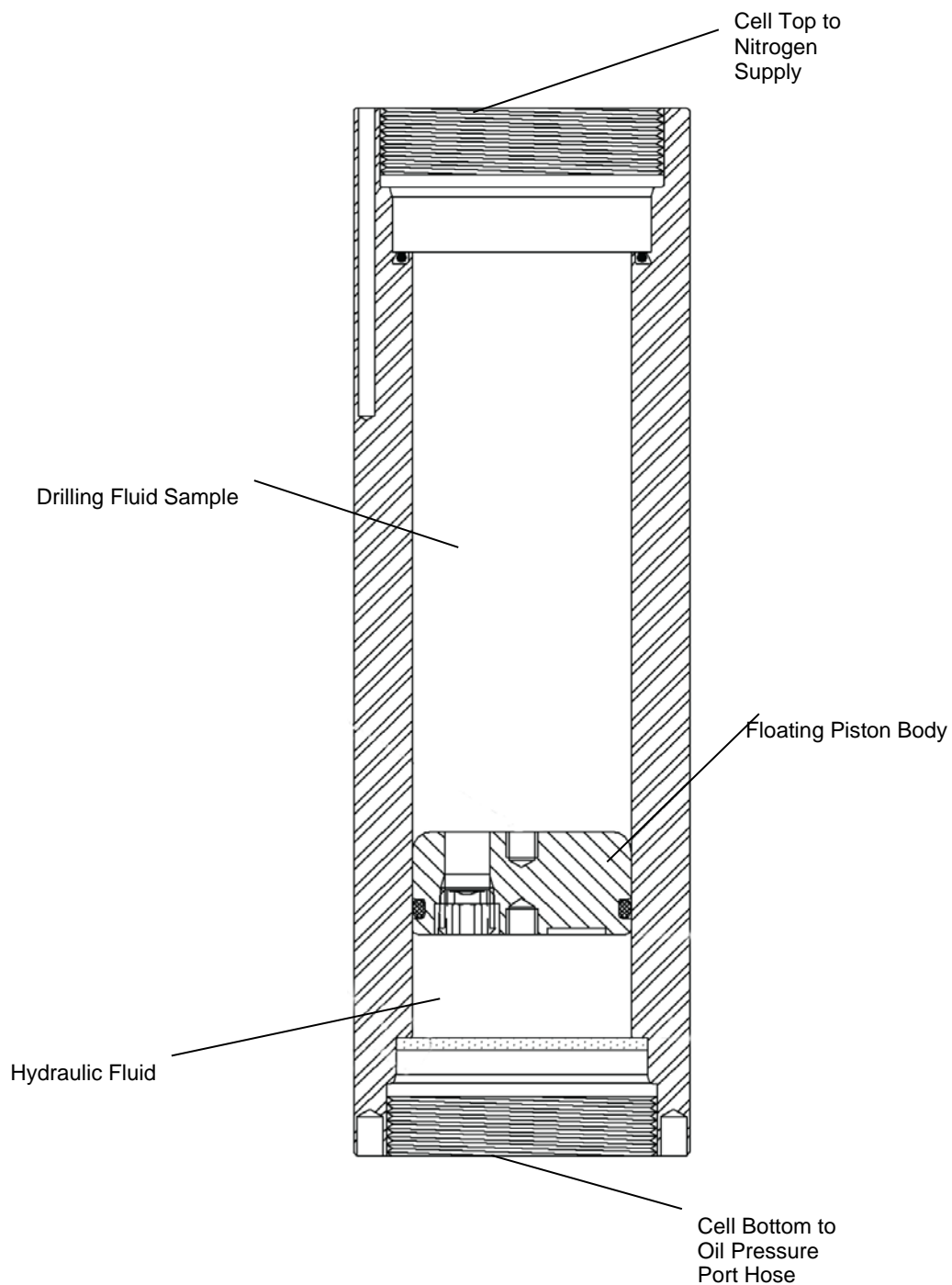


Figure 6-4 Final APPA Cell Arrangement

1. Removing Air from Hydraulic Side of the Cell



If the APPA cell is disassembled or if using a new APPA cell, then install the floating piston and bottom end cap. Next, the user will need to fill the area above the piston with hydraulic fluid and remove air from the space between the floating piston and end cap as described in this section.

1. Install the floating piston and bottom end cap, if necessary.
 - a. Screw the T-bar wrench (piston removal tool) into the O-ring end of the floating piston.
 - b. Install the piston into the bottom of the cell, curved end first. See Figure 6-2.



NOTE. The bottom of the cell is the end that has two locking pin holes.

- c. Place the piston at 1-1/8 inch, and then remove the T-bar wrench.
2. Lubricate the end of the cell bore with high temperature grease as shown in Figure 6-2.
3. Fill the area above the piston with hydraulic oil, covering the area that was lubricated with grease. See Figure 6-2.
4. Lubricate the threads with high temperature grease. Then screw the bottom end cap into the cell. Gently tighten, using the two-pin end of the spanner wrench (P/N 206864). Overtightening will not improve the seal, but will make the bottom end cap more difficult to remove.



Some hydraulic oil will flow from the threaded center hole in the bottom end cap. When the hydraulic oil flows, it is a sign that air is not trapped in the hydraulic end of the cell.

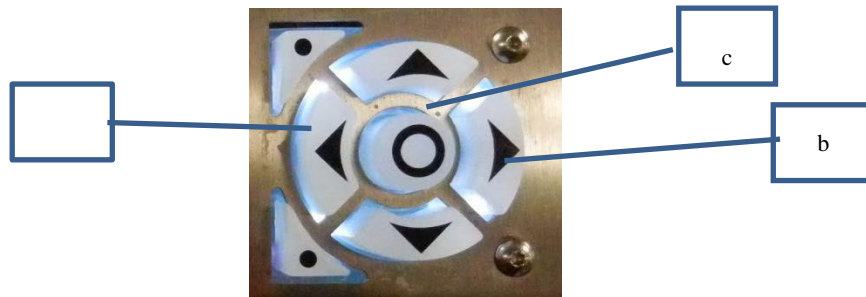
-
5. Connect to the bottom nipple assembly (cell bottom nipple and quick disconnect coupling socket) to the Oil Pressure Port hose.
6. Use the pump to expel all air from the nipple. To activate the pump, use the

Prime function on the computer or APPA keypad

7. Disconnect the Oil Pressure Port hose.
8. Install and tighten the bottom nipple assembly into the bottom end cap.

6.3 LCD

A majority of the functionality can be performed without a computer connected to the hardware. The hardware was designed to be able to run without a computer interacting with it. In fact the computer can be disconnected while a test is in progress without harming the test.



- a. These buttons on the diagonal are used to cycle through LCD screens
- b. The Left/Right/Up/Down buttons are used to move the cursor to select options on the various screens
- c. This center button is used to select the option

2. Current Values / Main Screen



- a. This screen shows the current values from the system and their setpoints

3. Pressure Setpoint



- a. Press left or right button to move the underline below the desired

4. Temperature Setpoint



- a. Press left or right button to move the underline below the desired

5. Error Screen

- a. If no error, the screen will show:



- b. If there is an error it looks like below. Press the center button to clear the error. The red LED will be on if there is an error message available. In the picture below this error occurred because the user tried to fill the system though the system did not have the auto filtrate installed setting selected.



6. The next screen allows the user to choose a control mode from the LCD. Move the cursor to the selection and press the center button to select it. The next screen will give a confirmation of the choice.



- a. Prime
 - i. Prefill – runs a fill routine. Please see below for a description of what a fill routine is.
 1. First screen will give a message to connect nitrogen pressure



2. Most of the screens will give descriptions of what is happening in the fill routine, and a volume measurement of the receiver cell.



3. The next screen requires user intervention. Click next when all the air is removed or cancel to stop the fill routine



ii. Flush

1. First screen for a flush tells the user to connect the drain.



2. Since flush can run automatically the flush screens consist of messages describing the current step
3. When flush ends, it asks the user if they want to repeat the process.



- iii. Profile – this choice allows the user to run a test from the LCD screen. The user cannot create a profile from the LCD screen. They can only choose a profile to run.

1. This screen is used to select the test profile:



2. When the profile is running, there are two screens the user can cycle through.
 - a. A profile current value screen. The difference between this screen and the non running current value screen is that the profile name used to run this test is presented along with the step #



- b. The next screen shows the profile time information. This screen also allows the user to stop the test prematurely.



- iv. The user does not have to hold down a button to prime it on the LCD. The only selection on this screen is to stop priming.



- v. Purge -- The user doesn't have to hold down a button to prime it on the LCD. The only selection on this screen is to stop purging.



- 7. Calibrations cannot be performed from the LCD screen, but if the computer connected to the APPA is running a calibration, the user will see a screen similar to below:



6.4 Starting a Test

Before starting, ensure that the piston in the cell is located AT LEAST 1 inch (2.5 cm) from the bottom of the cell to allow for enough space for thermal expansion and pressure control during test heat-up.



Failure to ensure piston location may result in equipment damage and/or the release of hydraulic oil from the pressure cell.

This can be achieved by removing the bottom cap of the cell and pushing the piston down, or by turning the valve on the front of the APPA to 'Dump' and using the T- handle to push the piston down with the hydraulic hose connected to the bottom of the cell. **This is required with use of the automated receiver.** There won't be a nitrogen supply available to use to push the piston down.

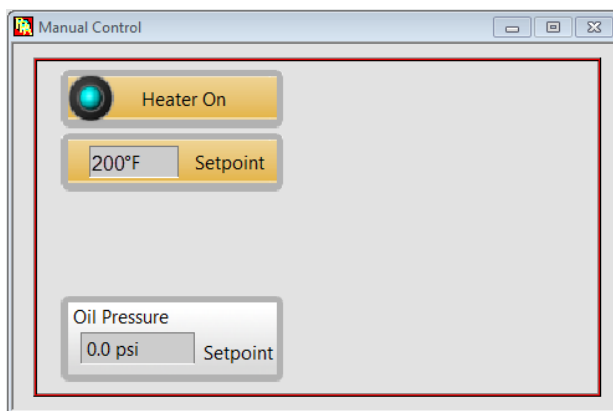
In manual control, go to temperature setpoint and set to desired test temperature. The APPA will begin to heat to the desired temperature.

Load the cell with desired fluid, filling all the way up to the o ring, careful not to get fluid on the seal.

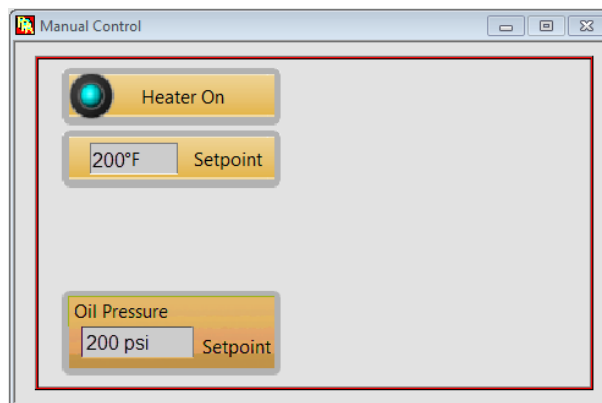
Lubricate the o-ring on the cap and place into the top of the cell Lubricate the threads on the retaining ring and tighten.

Recommended: Once filled, use an eye-dropper to fill the void in the filtrate valve at the top of the cell by dropping fluid on the top of the valve then rotating the valve to the opened and then closed positions.


- Use the software or the controls on the front of the APPA to preheat the heating jacket.



- Once preheated, insert cell into heating jacket, make sure filtrate valve on the top of the cell is closed, connect hydraulic hose to bottom of the pressure cell and apply initial test pressure.

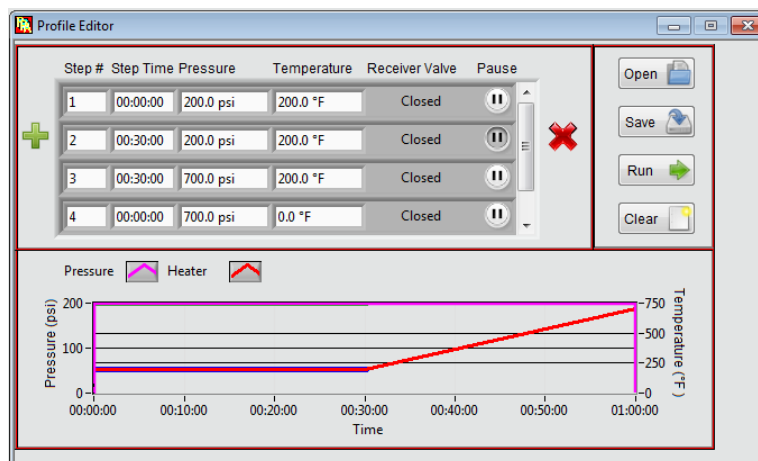


- Attach the filtrate receiver and nitrogen line using the locking pin and use the black regulator to apply the desired amount of nitrogen backpressure to the receiver.

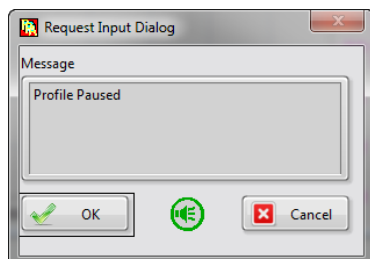
- Start/Open desired test profile 



- If no profiles exists, one may be created. An example is shown below:



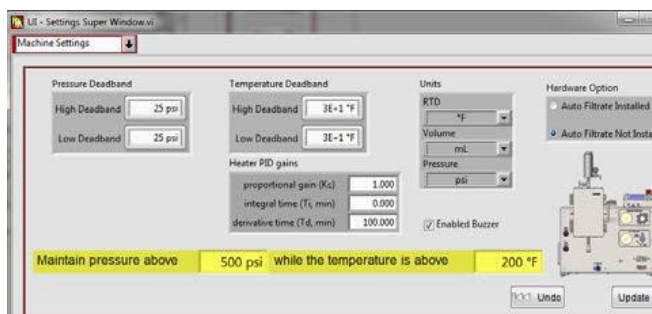
- This test profiles four steps will initiate as follows:
 1. Wait unit pressure and temperature setpoints are both fulfilled at 200 PSI and the cell temperature reaches 200 degrees Fahrenheit.
 2. Hold this test condition for 30 minutes, then pause for user input.



- This pause will signal an alert to let the operator know that the dwell time has elapsed and they may open the filtrate valve between the cell and the receiver so the test may commence.
 - a. Pressing OK will acknowledge the dialog and continue the test profile
 - b. Pressing the center button will silence the alert
 - c. Pressing cancel will abort the test.
- 3. Increase the bottom side (Oil) pressure to 700 PSI and hold this pressure condition for 30 minutes. During this time period, the operator may take intermediate filtrate measurements at any desired intervals.
- 4. Maintain pressure and allow decrease temperature. This is typically the 'end of test' condition.



Do not depressurize the equipment while the cell is heated above 200 degrees F. This can result in rapid expansion of fluid into gas and damage to the equipment and or injury to the user. A safety parameter in the machine settings should permit the user from inadvertently releasing the pressure at an elevated temperature condition



- Enter required fields in the Test Information Section
- Events alarms may be set for volume loss (if using auto filtrate) or by time if desired for accurate filtrate measurement intervals.

Start Profile

Lab Name *
Fann R&D

Project Name *
APPA

Test ID *
APPA123

JobID

Tested by *
AV

Customer

Comments

Data Filename *
APPA123.tdms

Events - Volume Loss
30.0 ml
0.0 ml
0.0 ml
0.0 ml

Events - Time (mm:ss)
01:00
05:00
07:30
15:00

Fill in required fields marked with *
Give the data file a unique filename

Save Default

Previous Continue Cancel

- Click the X's when completed to start the test

Start Profile

We are ready to start the test....
If you need to change any information click the 'Back' button or 'Cancel'

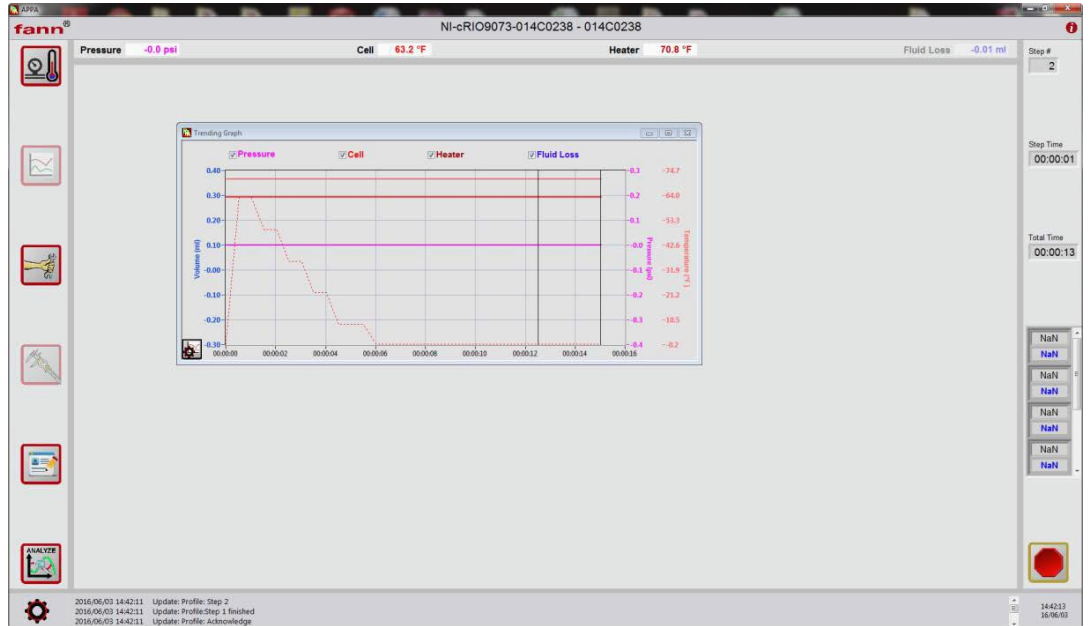
The 'Start Test' button will only become available after you have checked each item below. Please ensure the following item

1. All pertinent Test information is entered correctly.	✓
2. Make sure you have loaded the correct sample and the cell is sealed.	✓
3. All hydraulic and electrical connections are attached.	✓
4. RTD is INSTALLED in place to measure sample temperature.	?
5. The heater box is securely latched.	?
6. Make sure the system is prefilled.	?

If you are ready to start the Test, Click 'Finish' and test will commence...

Previous Cancel Start Test

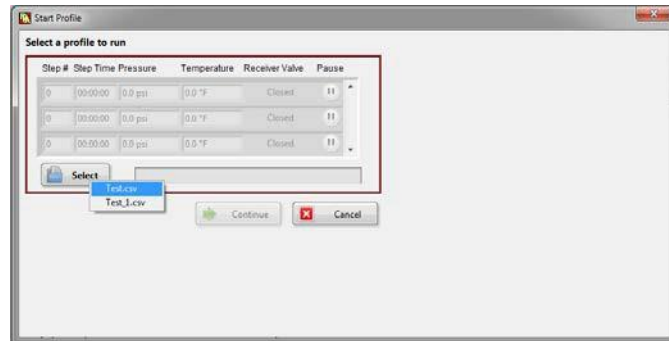
- The Trending Graph screen will automatically open and can be maximized. It will display current values on the right hand panel as well as current filtrate values with the automatic filtrate collection system (Model 389 MC) installed. The stop button located at the bottom right will stop the test at any time.



6.5 Operation with Auto-Filtrate System (Model 389 MC) installed

- Preheat and prepare cell as per instructions without 389 MC. Make sure the black regulator is turned to 700 PSI. (This supplies the 389 MC with nitrogen pressure).
- Once preheated insert the cell into the heating jacket and connect the hydraulic line to the bottom of the cell. Using the manual operation screen apply the amount of pressure EQUAL TO the intended amount of backpressure to be used during the test. This ensures that the system maintains zero differential pressure across the filter disc during the heat up process.
- Connect the top of the filtrate valve on the cell to the Model 389 system via the round receiver block and locking pin, similar to what is done with the manual receiver,
- Slowly turn the red regulator to the desired test backpressure.

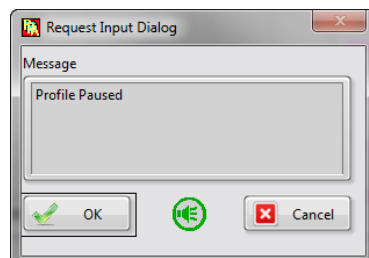
- Start/Open desired test profile



- If no profiles exist, one may be created. An example is shown below, note that it uses the 'Receiver Valve' open and close states to control the flow of filtrate through the filter media:



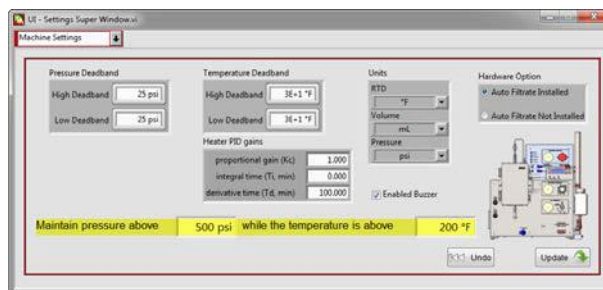
- This test profiles four steps will initiate as follows:
 - Wait unit pressure and temperature setpoints are both fulfilled at 200 PSI and the cell temperature reaches 200 degrees Fahrenheit.
 - Hold this test condition for 30 minutes, then pause for user input.



- This pause will signal an alert to let the operator know that the dwell time has elapsed and they may open the filtrate valve between the cell and the receiver so the test may commence.
 - d. Pressing OK will acknowledge the dialog and continue the test profile
 - e. Pressing the center button will silence the alert
 - f. Pressing cancel will abort the test.
- 3. Increase the bottom side (Oil) pressure to 700 PSI. Open the filtrate valve.
- 4. Hold this temperature, pressure, and filtrate valve state for 30 minutes.
- 5. Close filtrate valve. Maintain pressure and allow decrease temperature. This is typically the 'end of test' condition.



Do not depressurize the equipment while the cell is heated above 200 degrees F. This can result in rapid expansion of fluid into gas and damage to the equipment and or injury to the user. A safety parameter in the machine settings should permit the user from inadvertently releasing the pressure at an elevated temperature condition



- Enter required fields in the Test Information Section

- Events alarms may be set for volume loss (if using auto filtrate) or by time if desired for accurate filtrate measurement intervals.

Start Profile

Lab Name *
Fann R&D

Project Name *
APPA

Test ID *
APPA123

JobID

Tested by *
AV

Customer

Comments

Data Filename *
APPA123.tdms

Events - Volume Loss
30.0 ml
0.0 ml
0.0 ml
0.0 ml

Events - Time (mm:ss)
01:00
05:00
07:30
15:00

Fill in required fields marked with *
Give the data file a unique filename

Save Default

Previous Continue Cancel

- Click the X's when completed to start the test

Start Profile

We are ready to start the test...
If you need to change any information click the 'Back' button or 'Cancel'

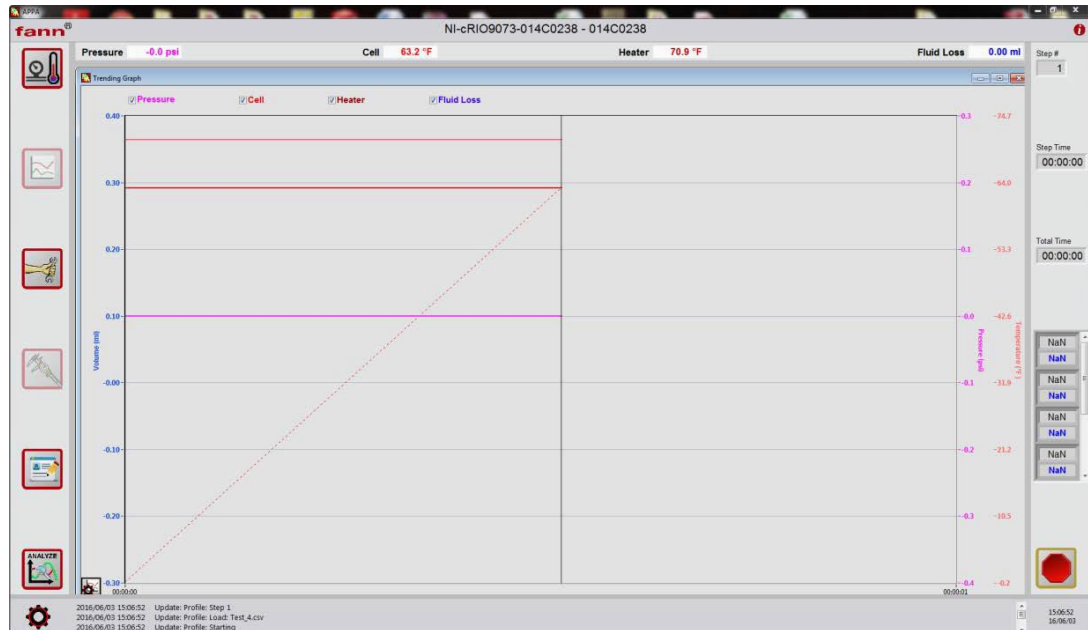
The 'Start Test' button will only become available after you have checked each item below. Please ensure the following item

1. All pertinent Test information is entered correctly.	✓
2. Make sure you have loaded the correct sample and the cell is sealed.	✓
3. All hydraulic and electrical connections are attached.	✓
4. RTD is INSTALLED in place to measure sample temperature.	?
5. The heater box is securely latched.	?
6. Make sure the system is prefilled.	?

If you are ready to start the Test, Click 'Finish' and test will commence...

Previous Cancel Start Test

- The Trending Graph screen will automatically open and can be maximized. It will display current values on the right hand panel as well as current filtrate values with the automatic filtrate collection system (Model 389 MC) installed. The stop button located at the bottom right will stop the test at any time.



6.6 Ending a test

Once the test profile finishes and the temperature decreases below the safety threshold, the filtrate valve on the top of the pressure cell may be closed and the pressure decreased to 0 PSI from the manual control dialog.

The components may now be disconnected.

Upon the completion of the test, the Test Analyzer will automatically open. The details of this portion of the program can be found in section 7.

6.7 Shutting Down

1. APPA

1. Turn the APPA's ON/OFF switch to the **OFF** position.



Do not continue this procedure until the sample temperature in the cell is less than 200°F (93°C).

2. Wait until the cell has cooled.
3. Release the backpressure.
4. Open the valve on the backpressure receiver to release pressure.
5. Remove the locking pins and remove the backpressure receiver assembly.



The system is designed to automatically release pressure from the pump.

6. Open the filtrate valve to bleed any pressure remaining between the cell filter and the backpressure receiver.

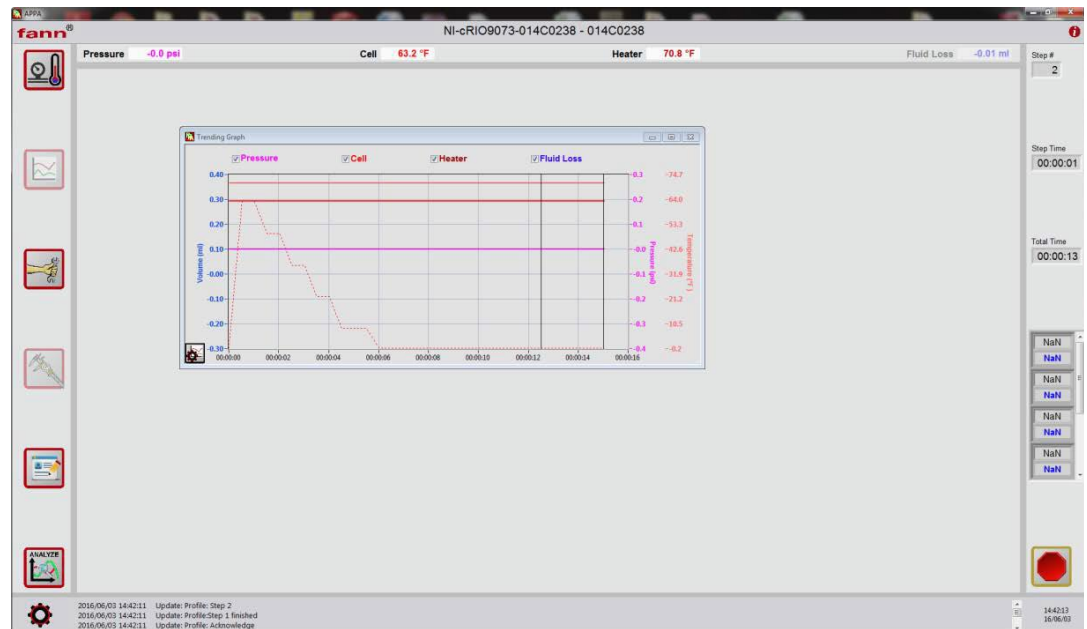
2. Emergency Shutdown

If the APPA needs to be shut down during a test, the user can use the Emergency Stop on the instrument panel. To release the Emergency Stop, twist the red knob counterclockwise.

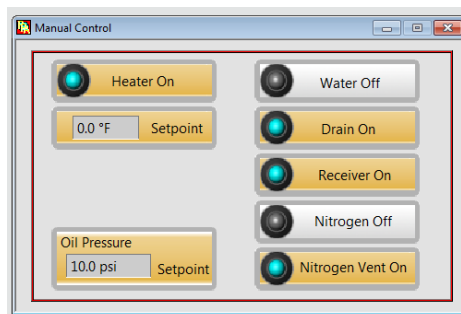
The user can also shut down the system using the computer as follows:

- Manually close the filtrate valve.

- Then, click on **Stop Test**
- Click on **Machine Function** and select **Manual Operations**. Reduce the temperature and pressure.



Real-Time Graph and Data Display (test in progress)



Manual Settings

Cell Disassembly



Make sure that all pressure is released from the cell. If the cell has pressure, then make sure that it is cooled to room temperature before relieving the pressure.



To make sure that pressure is totally released, follow these instructions. Remove the quick-connect assembly from the bottom end cap of the cell. Use a wire or drill bit through the end cap to determine that the floating piston is on the bottom. If the floating piston is not on the bottom, then there is no pressure. If the floating piston is on the bottom, pressure could be present in the cell. Reconnect the hydraulic pump and pump several strokes to move the floating piston. If the cell contains pressure, it will be obvious because force will be required to move the floating piston.



If the cell contains pressure, first make sure that the cell is cooled to room temperature. Then, remove the filtration valve assembly and insert a small drill bit or wire into the cell cap to remove the obstruction. The drill or wire will stop when it contacts the filter disc. Wear gloves and point the opening away from the body when inserting the drill bit or wire.

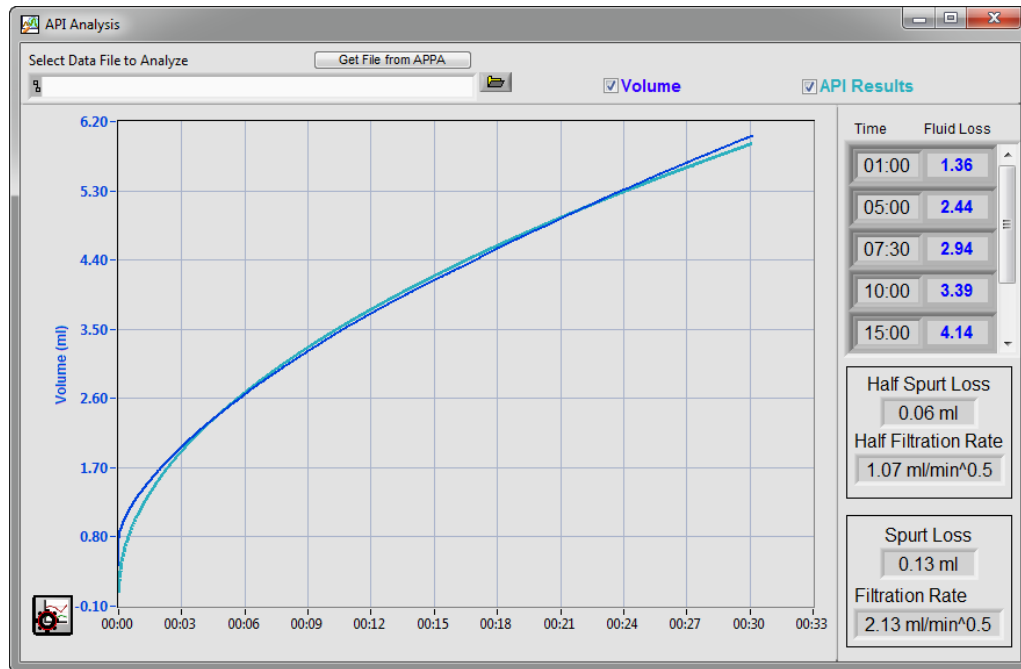
7. Remove the cell assembly. The cell handling tool (P/N 209497) is available to remove the cell. Attach this tool to the backpressure inlet nipple located above the filtrate valve and where the backpressure receiver is usually attached. Use the valve stem locking pin to secure the tool.
8. When the cell cools to room temperature, open the top (filter end) of the cell. Fit the single pin end of the spanner wrench into one of the holes in retainer ring and unscrew the retainer ring. This is a right hand thread. The user may need to tap the wrench to get it to move. If the top is difficult to open, then that means that there is insufficient lubrication, overtightening or insufficient cleaning. It may be necessary to use a suitable holding tool, such as a soft jaw vice, chain wrench, or strap wrench, around the cell near the filter end to prevent the cell rotating. A strap wrench (P/N 206557) is available.
9. Reposition the cell if required so that the filter end is up, and then remove the top cap. If the cap is stuck, use the filtrate valve assembly (screwed into the top cap) to rock and pull the cap upward out of the cell.

10. Remove the filter disc. Use a small knife, small screwdriver, or similar thin blade to pry the edge of the disc up, then remove the disc and filter cake. If required, wash the filter cake lightly with fresh water, or a suitable solvent if the sample is oil based. Then measure and record its thickness and remarks concerning its composition.
11. Empty the cell. Wash the inside of the cell with fresh water, or a suitable solvent if the sample is oil based. Removing the floating piston and the bottom end cap is not necessary unless the last test was run at 425°F (218°C) or higher.
12. If testing was conducted at temperatures above 425°F (218°C), the O-rings on the bottom end cap and the floating piston body must be replaced.
 - a. Remove the bottom end cap.
 - b. Position the cell as described in Steps 1 and 2 except that the cell is held near the bottom end, and the two pin end of the spanner wrench is used.
 - c. Remove the floating piston. Screw the T-bar wrench into the floating piston and push or pull to slide the piston from either end of the cell. The floating piston can be removed through the top end without removal of the bottom end cap.
 - d. Remove hardened or abraded O-rings on the piston and cap.

Clean the parts for re-use. Take care not to damage the rupture discs in the floating piston and the bottom end cap

7 Test Analysis

The Test Analyzer will automatically execute upon the completion of any test, or can be ran whenever the user clicks on the ‘Analyze’ button in the lower left hand corner of the screen. The Test Analyzer is a separate executable that can be ran even if the main user interface is not active. The analyzer will only produce results with the automated filtrate collection system (Model 389 MC).



This UI shows the collected volume versus time. On the right hand side, it shows the volume collected at time intervals specified in the test settings dialog. This UI plots both the actual volume collected (dark blue) as well as a best fit curve for the series of points indicated by API for collection. This shows the user the difference in accuracy in collecting the filtrate automatically versus the traditional manual collection method.

The “Half Spurt Loss” is the actual spurt loss collected by the equipment (since it is a ‘half-area’ filtration test), whereas the “Spurt Loss” on the bottom left is the collected value doubled to display the full area value. The API calculated filtration rates are also displayed.

Graph settings and cursor settings may be manipulated in the lower left hand corner

8 Troubleshooting and Maintenance

Apply standard laboratory procedures when cleaning APPA assemblies and backpressure receivers. After each test, thoroughly clean and dry the cell and backpressure receiver, paying attention to the O-rings and O-ring grooves.

Wipe spilled sample or other debris from the heating chamber and stand. Some sample materials may damage the finish of these parts if allowed to remain on them for a long time.

8.1 Preventive Maintenance

This schedule is recommended for keeping the APPA in good working condition.

Preventative Maintenance Schedule	
Action	Interval
Replace oil	Every 3 months
Replace air filter	Every 3 months
Examine hoses	Monthly
Inspect heater box hinges	Monthly
Inspect heater box latches	Monthly
Inspect heater cables	Monthly
Clean water inlet filter	Every 3 months
Clean filtrate filter (in front)	Every 3 months

8.2 Troubleshooting Tips

Table 8-1 Troubleshooting Guide

Problem	Corrective Action
No power	Make sure that power cord is connected. Check circuit breaker. Check the Main Power Switch.
No heat	Make sure that the heater cable is connected.

No communication	Check the Ethernet cable connection. Check the IP address. See section 4.3 for details. If using another browser, switch to Internet Explorer®.
Pump not working	Perform the priming routine.
APPA is ON, but the system does not pressurize or heat	Release the Emergency Stop by turning the red knob counterclockwise.

8.3 Cell Maintenance

Refer to Figure 6-1.

1. O-rings

While cleaning the O-rings, inspect them for cuts, nicks, hardening or brittleness. If the O-rings have been subjected to temperatures greater than 425°F (218°C), replace them.

Replace all damaged O-rings, including those on the bottom end cap and floating piston.

Lubricate all O-rings before installing them. For most applications, the high temperature grease (thin coating) is sufficient; however, since some O-rings contact the sample, the lubricant must be compatible with the sample and applied sparingly.

O-rings furnished with the instrument are suitable for testing up to 325°F (163°C). They may be used for one test up to 400°F (205°C). Special O-rings are available for repeated testing up to 500°F (260°C). These special O-rings (P/N 204629) are for one-time use only.

2. Cell Top Closure

The cell top closure consists of the top cap, top cap retainer and one O-ring. The O-ring groove and the cylindrical outer surface of the top cap must be kept clean and in good condition. The thread for the nipple should be kept in good condition and lubricated when assembled.

The retainer ring has an external thread which engages a thread in the top of the cell body. Both threads must be kept clean and lubricated when assembled. Use high temperature grease (P/N 204816 or equivalent).

3. Cell Bottom Closure

The bottom end cap is one piece and has an external thread that engages an internal thread in the bottom of the cell body. The cap has a nominal 6150 PSI

(42,400 kPa) rupture disc built into it to prevent accidental overpressure. Both threads must be kept clean, free of burrs, and lubricated when assembled. Use high temperature grease (P/N 204816 or equivalent).

When cleaning, be careful not to damage the rupture disc. The rupture disc, if it should rupture, can be removed by unscrewing it from the bottom end cap using a ¼ inch hex wrench. Replace the rupture disc (P/N 206161). Use high temperature sealant on the threads. Do not damage the disc with the end of the hex wrench.

4. Floating Piston

The floating piston separates the hydraulic oil from the test fluid. It seals the inside of the test cell using one O-ring. It is round edged on the sample side and offset on the oil side. Each side has a blind hole to accept the T-wrench. The floating piston includes a nominal 999 PSI (6900 kPa) rupture disc to limit the differential pressure between the cell hydraulic pressure and the backpressure receiver pressure. This rupture disc prevents cell overpressure if the floating piston sticks or bottoms out at the end of the cell. Do not damage the rupture disc when cleaning the floating piston.

The O-ring groove and the cylindrical outer surface of the piston must be kept clean and free of dings and burrs. Lubricate the O-ring whenever it is replaced with high temperature grease.

If the rupture disc should rupture, use a 1/4-in. hex wrench to remove it. Replace the rupture disc. Use high temperature sealant on the threads. Do not damage the disc with the end of the hex wrench.

5. Filtrate Valve

This is a multi-turn needle valve with all metal seat and high temperature packing. Wash the valve thoroughly to remove sample or other debris and blow dry with air.

Stem leaks can often be stopped by tightening the packing gland. If the valve does not close tightly, replace it. To check for leaks, remove the backpressure receiver (with the valve closed) and put soap solution on nipple end while operating at highest intended temperature and pressure. Bubbles indicate a leak.

6. Cell Corrosion



Corrosion, pitting, or stress cracking can cause the cells to rupture.



The floating piston is composed of Type 303 stainless steel. The cell body, cell end caps, and retainer ring are composed of Type 17-4 stainless steel.

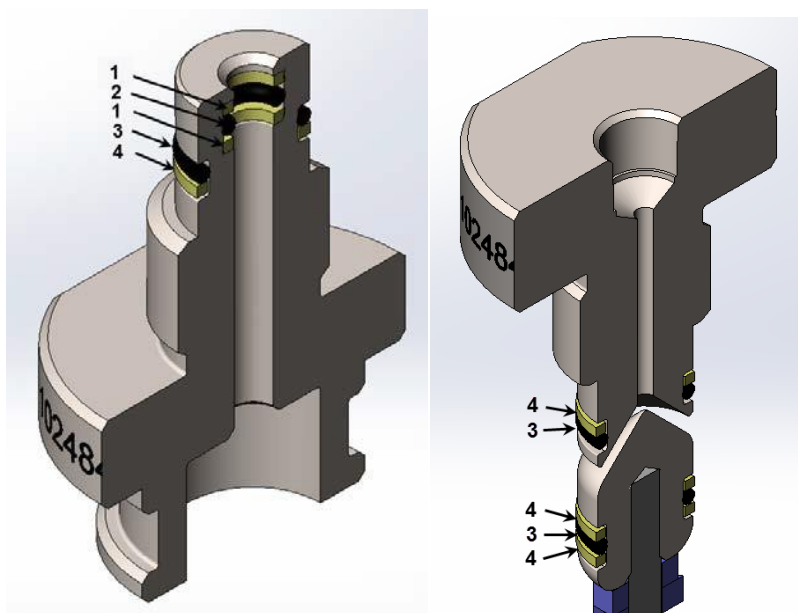
Sample fluids under high-temperature and high-pressure conditions can cause corrosion on the cells and caps.

Periodically inspect the inside of the cell for corrosion. Use 320 grit (or finer) sandpaper, wet or dry, to remove light corrosion. Deep corrosion pitting may be removed by sandblasting the corroded area. If corrosion cracks or pits are evident, then the part must be replaced.

8.4 Automated Filtrate Receiver

1. O-rings

Disassemble and inspect all O-rings and backup rings in the automated filtrate receiver monthly. Take extra caution that all excess pressure is removed when disassembling and that the internal walls of the receiver are not scratched. Grease and replace O-rings. Be careful not to scratch the internal wall of the receiver when separating the piston assembly from the body of the receiver.



O-ring and Backup Ring Configuration in Automated Filtrate Receiver

Item No.	Part No.	Quantity	Description
1	102488773	2	BACKUP RING,SPLIT, 008, DURO D55
2	205649	1	O-RING,008,VITON,0.176 ID X 0.07 W
3	102488775	3	O-RING,013,VITON,0.426 ID X 0.07 W,BR
4	102488774	4	BACKUP RING,SPLIT,013, DURO D55

Seal Part Numbers and Quantities

8.5 Pressurization Systems

Safe operation of pressurized equipment requires properly maintaining the pressurizing systems. Follow these procedures for the safe use of pressure regulators:

- Never expose a regulator to inlet pressure greater than its rated inlet pressure (shown on the regulator).
- Never use the regulator for gases other than those for which it is intended.
- All connections to the regulator must be clean. Remove oil, grease, or other contaminants from external surfaces of the regulator and metal connecting parts.
- Never pressurize a regulator that has loose or damaged parts or is in questionable condition.
- Never loosen or tighten a connection or part until the gas pressure has been relieved. Under pressure, gas can dangerously propel a loose part.
- Periodically, check the regulator and all connections for leaks after installation or after any service in which parts or connections were disconnected and reconnected. Add soapy water to a wash bottle and squirt the soapy water around these fittings. Bubbles indicate a leak.

8.6 Hydraulic Pump

An internal pump pressurizes the APPA cell. Maintenance of this hydraulic system requires keeping the hydraulic oil clean. A high-temperature hydraulic oil (P/N 207805) is provided. This oil will not break down at high temperatures.



A high-temperature hydraulic oil is provided. Do not use standard hydraulic oil.

To drain and flush the reservoir, perform these steps:

1. Remove the filler cap.
2. Drain the hydraulic fluid through the filler hole.
3. Remove the nut from the tie rod.
4. Remove and clean the reservoir and the filter.



Removing the filter from the pump assembly could result in its breakage. Try to clean it as well as possible with it installed.

5. Reassemble the reservoir and fill it with hydraulic fluid.



Drain and flush the reservoir. Drain and clean the hose. Cleaned parts prevent contaminated fluid from entering the pump.

9 Accessories

Table 9-1 102057986 Rev D, APPA Accessory Kit

Item No.	Part No.	Quantity	Description
101	204816	1	GREASE HIGH TEMP 3 OZ.
102	210435	1	HIGH TEMP LUBRICANT,ANTI SEIZE 1 oz Tube
103	207805	2	HYDRAULIC FLUID 1 QUART BOTTLE
104	205868	1	CYLINDER GRADUATED GLASS 25ml TC
105	205622	1	TUBING TYGON 3/16 X 5/16 X 1/16
106	204093	1	QUICK DISCONNECT PLUG 1/8 FNPT SS
201	210537	1	FILTER DISC, API-12, CERAMIC 10/BOX
202	210538	1	FILTER DISC, API-20, CERAMIC 10/BOX
203	210539	1	FILTER DISC, API-40, CERAMIC 10/BOX
204	210540	1	FILTER DISC, API-50, CERAMIC 10/BOX
205	210541	1	FILTER DISC API-55, CERAMIC 10/BOX
206	210542	1	FILTER DISC API-120,CERAMIC 10/BOX
207	210543	1	FILTER DISC CERAMIC 150 MICRON 10/BOX
208	210544	1	FILTER DISC CERAMIC 190 MICRON 10/BOX
301	205649	10	O-RING,008,VITON,0.176 ID X 0.07 W
302	204631	10	O-RING,225,VITON,1.859 ID X 0.139 W
304	102365275	20	O-RING,228,VITON,2.234 ID X 0.139 W
305	204634	10	O-RING,140,VITON,2.237 ID X 0.103 W
306	101730954	10	O-RING,028,VITON, 1.364 ID X 0.07 W

10 Parts Lists

Table 10-1 101967987 Rev E, APPA Assembly, Model 389AP

Item No.	Part No.	Quantity	Description
1	101983936	1	RTD,1/8 DIA,3 WIRE,36 IN LG w/FLEX ARMOR
2	102057813	1	HOSE ASSEMBLY, APPA, MODEL 389 AP
3	205406	1	HOSE,0.25 ID,5000 PSI 5 LG 1/8 MNPT ENDS
4	206850	1	CELL ASSEMBLY PPA 5,000 PSIG 1/4in. DISC
5	209445	1	RECEIVER ASSEMBLY BACK PRES 100ml f/PPA
6	102061744	1	REVERSIBLE TEMP, INDICATORS THERMO
11	204093	1	QUICK DISCONNECT PLUG 1/8 FNPT SS
1000	102054814	1	ELECTRICAL ASSEMBLY,APPA,MODEL 389AP
2000	102054820	1	MECHANICAL ASSEMBLY,APPA,MODEL 389AP
3000	102057760	1	SOFTWARE,APPA,FANN MODEL 389 AP
4000	102057986	1	KIT,ACCESSORY,APPA,MODEL 389AP,5000 PSI
4001	102059452	1	TOOL KIT, APPA, MODEL 389AP
4004	208452	1	CABLE POWER 115V 18 AWG M&F PLUG
4005	208865	1	CABLE POWER 230V 18 AWG M&F PLUG
4006	205533	1	CABLE CAT5 RJ45-RJ45 10FT LG

Table 10-2 102484770 Rev C, Model 389 Measurement and Control

Item No.	Part No.	Quantity	Description
1	102545967	1	ASSEMBLY, VALVE BOX, MODEL 389 MC
2	102488771	1	RECIEVER ASSEMBLY, MODEL 389 MC
3	102500855	1	MEASUREMENT MODULE, MODEL 389 MC
4	102546172	1	RECEIVER BLOCK , MODEL 389 MC
5	102454544	1	1/8-27 NPT to 1/8in TBG ADPTR,Bore THRU,
6	204648	1	PIN COX SAFETY LOCKING
7	102545744	1	TEE-TYPE PARTIFULATE FILTER
8	102497520	1	RJ45,CBL,BLK,3FT,BOOTED
9	102546206	1	CABLE, SHIELDED SET, DB15
10	102551184	1	TUBING KIT, MODEL 389, TOP LEVEL
11	101443952	1	ELBOW 1/8 TUBE X 1/8 MNPT SS

11 Warranty and Returns

11.1 Warranty

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

11.2 Returns

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

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

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