



AIR QUALITY SURVEILLANCE BRANCH

STANDARD OPERATING PROCEDURES

FOR

**Teledyne/Advanced Pollution Instrumentation (API) 701  
Zero Air Module**

AQSB SOP 702

First Edition

MONITORING AND LABORATORY DIVISION

**May 2007**



## TABLE OF CONTENTS

### Teledyne/Advanced Pollution Instrumentation (API) Model 701

	<u>Page(s)</u>	<u>Date</u>
<b>1.0 <u>GENERAL INFORMATION</u></b>	5 – 6	5/07
1.1 Introduction	5	
1.2 Principle of Operation	5	
1.3 Safety Precautions	5 – 6	
1.4 Interferences/Limitations	6	
<b>2.0 <u>INSTALLATION PROCEDURE</u></b>	7	5/07
2.1 Physical Inspection	7	
2.2 Station Installation	7	
<b>3.0 <u>CONFIGURATION</u></b>	8 – 10	5/07
3.1 API 701 Configuration	8	
3.2 Adjust the output, cut-in, and cut-out pressures	8 – 10	
<b>4.0 <u>ROUTINE SERVICE CHECKS</u></b>	11– 12	5/07
4.1 Daily	11	
4.2 Monthly	11	
4.3 Annually	11– 12	
4.4 As Required	12	
<b>5.0 <u>MAINTENANCE PROCEDURES</u></b>	13	5/07
5.1 General Information	13	

**FIGURES**

	14 - 22	5/07
Figure 1 - Pressure gauge elbow attachment (frontal view)	14	5/07
Figure 2 - Mass flow controller (port 1) rear view	15	5/07
Figure 3 - Cut-in and cut-out adjustment location	16	5/07
Figure 4 - Pressure adjustment assembly uncovered	17	5/07
Figure 5 - Front perspective of API 701 uncovered	18	5/07
Figure 6 - Pressure regulator tank	19	5/07
Figure 7 - LED oscillator	20	5/07
Figure 8 – Single headed pump	21	5/07
Figure 9 – Double headed pump	22	5/07

**APPENDIX**

AQSB Monthly Quality Maintenance Check Sheet 702	23
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## 1.0 GENERAL INFORMATION

### 1.1 Introduction:

This Standard Operating Procedure (SOP) documents procedures used by the Air Resources Board's (ARB) Air Quality Surveillance Branch (AQSB) to operate the Teledyne/Advanced Pollution Instrumentation Model 701 Zero Air Module (API 701) used by the AQSB for ambient air monitoring operations. This procedure is designed to supplement the manufacturer's operating manual by describing modifications in the hardware or operating procedures implemented by the AQSB. It is not the intent of this SOP to duplicate the operating manual. All references made to the API 701 operating manual indicate the Teledyne API Model 701 Zero Air Module Instruction Manual, 01671, Rev. E2.

### 1.2 Principle of Operation:

The API 701 is a self contained unit which purifies ambient air by compressing, cooling, and scrubbing filtered ambient air. The API 701 provides on-demand continuous delivery of contaminant-free air at flow rates up to 20 standard liters per minute (SLPM) at a maximum output pressure of 35 pounds per square inch gauge (psig).

To produce zero air, the API 701 uses regenerative scrubbers to remove water from ambient air and produce zero or clean air with a dew point of less than minus 20 degrees Celsius (°C). On instruments with the dew point sensor, a green indicator light on the front of the API 701 indicates that the dew point is less than minus 20 °C. This air is then released on demand through optional specialized scrubbers for SO<sub>2</sub>, NO, NO<sub>2</sub>, O<sub>3</sub>, H<sub>2</sub>S, CO, and Hydrocarbons. The air produced is suitable for use as a zero reference and/or as diluent air for gas calibration systems. A more detailed discussion of the pure air system is contained in the manufacturer's instruction manual.

As it is currently being used by the AQSB, the API 701 provides zero air that is typically used by gas dilution/ozone generator systems.

### 1.3 Safety Precautions:

1. The hydrocarbon scrubber is very hot, exercise caution when opening.
2. The air coming out of the scrubber is at 300°C ( 575°F) and is cooled in the copper exit tubing before it enters the NO scrubber, as a result this coil and casing can be very hot.
3. ***Do not set the delivery pressure on the front higher than 55 psig.*** To do so may cause damage to the 701 and injury to the operator.

4. Dangerous voltages exist on the controller board even when the power switch is turned off.
5. When turning off the instrument for an extended amount of time, power it down and wait one minute. Power it back on allowing moisture to vent, then power off again.
6. Do not run the API 701 for more than three minutes, without any resistance or back pressure.
7. Do not operate the instrument with the cover removed.

#### 1.4 Interferences/Limitations:

The API 701 produces pure air for use in ambient air monitoring operations. If the instrument has a green indicator light on the front and it is not illuminated, it is possible that moisture may be present in the pure air supply. This moisture can in turn affect the results obtained by other instruments, particularly ozone analyzers.

Because moisture can interfere with the ozone reading obtained by this instrument, it is important that the API 701 is allowed to warm up for 30-60 minutes prior to use. This can be confirmed by removing the top of the instrument and viewing the red LED located at DS1 (Figure ) on the circuit board vertical and adjacent to the heater. Once the scrubber has reached 300 °C it will turn off, then on again. This indicates that the operating temperature had been reached and the heater is beginning to cycle in order to maintain operating temperatures. Over time the heater will continue to cycle on and off.

The API 701 has no output restriction by default. If the API 701 is operated without output restriction it will not dry or scrub the air. The API 701 "Air Out" port must be connected to a device which demands zero air flow (e.g. any gas calibrator).

## **2.0 INSTALLATION PROCEDURE**

### **2.1 Physical Inspection:**

1. Verify that there is no shipping damage. If there are signs of damage, immediately advise the shipper, then contact your immediate supervisor or shipping/receiving personnel.
2. Remove the API 701 from its shipping carton, and remove the cover using a Philips screw driver for the side screws and a plain screw driver for the back.
3. Remove the red shipping screws holding the compressor base. These screws are underneath the chassis.
4. Check for damage or parts which may have become loose inside the instrument during transit.

### **2.2 Station Installation:**

As typically used by the AQSB, the API 701 should be rack mounted in a standard 19" instrument rack and located in proximity to the station's auto gas calibrator system. The API 701 should be installed such that there is enough clearance to allow for proper fan operation, proper venting of the instrument and space to perform periodic maintenance on the unit.

### 3.0 CONFIGURATION

#### 3.1 API 701 Configuration:

Prior to initial ambient air monitoring operations, make the following connections on the back of the instrument, connecting each of the following orifices as specified:

1. "AIR IN" (1/4" female pipe thread).
  - a. Screw the inlet filter into the "AIR IN" port. Hand-tight is OK.
2. "WATER DRAIN" (1/4" swage-type bulkhead union).
  - a. Connect 1/4" diameter tubing to the WATER DRAIN to conduct the occasional spurts of water away from the instrument rack. Connect the tubing to a drain or, alternatively, the water may be collected in a tray or jar and dispersed by normal evaporation.
3. "ZERO AIR OUT" (1/4" swage-type bulkhead union).
  - a. Connect the AIR OUT port of the API 701 to a T fitting with an elbow adapter connected to an air pressure gauge (Figure ). This will be used later to adjust the pressure.
  - b. Connect the output of the T fitting to a gas dilution system (typically port 1 of the Environics 9100) using CLEAN 1/4" TFE tubing (Figure 2). The pressure in this line will normally be 30 psig, but may be as high as 80 psig. This line should be no more than 3 meters to prevent pressure drops.
4. Connect the power cord to the proper power source. At 115 VAC, 60 Hz, the 701 draws 3.5 Amps.
5. Turn on the API 701 and let it operate until the green light on the front of the API 701 illuminates. The air may not reach full purity until after 60 minutes of operation.

#### 3.2 Adjust The Output, Cut-in, And Cut-out Pressure:

The API 701 uses an internal pressure tank to hold compressed air for later use by the scrubbing systems. In order to provide a regulated air supply at a constant pressure of 35 PSI  $\pm$  1 PSI, this internal pressure must be kept well above 35

PSI. The pressure inside this tank is therefore maintained between 50 and 70 PSI by a compressor.

To ensure proper operation of the API 701, it is important that the pump cut in, cut out, and output pressures of the API 701 be verified and adjusted if required. Ensure that the output is connected to (in most cases) a mass flow controller as back pressure will be required for proper operation.

## OUTPUT PRESSURE

1. Looking at the gauge installed in the back of the device (see step 3, section 3.1 of the configuration section) and note the pressure. This is the output pressure.
2. Using the pressure regulator knob on the front of the device, adjust it so that the pressure displayed on the back gauge of the device is  $35 \pm 1$  PSI.
3. Record front panel pressure gauge for future reference.

## CUT-IN AND CUTOUT ADJUSTMENT

1. Turn off the API 701.
2. Disconnect the tube fitting to the pressure regulator at the tank (Figure 6 Tube fitting to pressure regulator tank).
3. Replace the tubing you just removed from the tank with T valve and a piece of tubing going to a 100 psig pressure gauge. Leave the connection at the pressure gauge finger tight.
4. Remove the cover from the pressure switch and find the adjustment screws (See Figure and Figure ).
5. Turn on the 701 and allow the pressure to rise until the pressure switch turns off the compressor.
6. Either loosen the connection at the pressure gauge or increase demand to allow the pressure to fall slowly. The compressor should cut-in at 50 psig.
7. If cut-in occurs below this, turn the left-hand (LH) adjustment screw clockwise one turn or counter clockwise until cut-in occurs within the desired range (see Figure ).
8. Repeat steps 5-7 until cut-in occurs at 50 psig.

9. Turn the API 701 on and allow the pressure to rise until cut-out occurs.  
The compressor should cut-out between 70 to 80 psig.
10. If it turns off below this range, turn the right-hand (RH) adjustment screw clockwise one turn (or counterclockwise if cut-out is above this range).
11. Loosen the connection at the pressure gauge and allow the pressure to drop until the compressor cuts in.
12. Repeat the above steps until cut-out occurs in the 70 to 80 psig range.
13. Replace the pressure switch cover.
14. Remove the test pressure gauge and reconnect the pressure regulator.

## 4.0 ROUTINE SERVICE CHECKS

### 4.1 General Information:

Perform the following checks and maintenance at the intervals specified here and in the maintenance check sheet provided. Perform non-routine maintenance as required to assure adequate pressure and purity. Checks may be performed more frequently, but should be performed at least at the prescribed intervals. The Monthly Quality Control Maintenance Check sheet (AQSB QC Form 702) should be completed weekly and forwarded monthly to the person that performs the second level of data review.

### 4.2 Daily:

1. Verify that the red (power) and the green lamps on models with dew point sensors are illuminated on the front panel.

### 4.3 Monthly:

1. Visually inspect the moisture capture flask located in the back of the instrument to ensure that water is being collected. A lack of moisture may indicate a failure of the regenerative scrubbers.
2. Check and adjust the output pressure (reference SOP section 3.2).
3. Complete the monthly maintenance sheet (AQSB QC Form 702) and submit it with monthly data submittals.

### 4.4 Annually:

The hydrocarbon, carbon monoxide, activated charcoal, and regenerative scrubbers may eventually become depleted. Conduct the following checks as needed:

1. Confirm that the carbon monoxide levels on the daily zero values have not increased relative to baseline values. If they have, then you may need to replace the carbon monoxide or charcoal scrubbers using the procedures detailed in the operating manual (Sections 5.6 "Replacing the CO – CO<sub>2</sub> Scrubber and Section 5.7 "Replacing the HC Scrubber").
2. Confirm that the NO levels on the daily zero values have not increased relative to baseline values. If they have, then you may need to replace the Purafil® scrubber using the procedures detailed in the API operating manual (Section 5.5 "Replacing the NO –NO<sub>2</sub> Scrubber").

3. Confirm that the NO<sub>2</sub>, O<sub>3</sub>, SO<sub>2</sub>, and H<sub>2</sub>S levels have not increased relative to baseline values. If they have, then you may need to replace the charcoal scrubber using the procedures detailed in the operating manual (Section 5.4 “Replacing the Charcoal Scrubber”).
  4. At a minimum, the Purafil and charcoal scrubber material should be replaced once a year.
- 4.5 As required:
1. Confirm that the operating temperature of the hydrocarbon scrubber is at or above 300 C by inspecting LED DS1 and ensuring that it is cycling on and off after having warmed up (Figure 8).
  2. Verify the cut-in and cut-out pressures on the API-701 as detailed in section 3.2, “Adjust the output, cut-in, and cut-out pressure” of this document.

## 5.0 MAINTENANCE PROCEDURES

### 5.1 General Information:

The API 701 is a self contained unit and requires little if any maintenance. Typical maintenance may include pump replacement, scrubber cleaning, and pressure adjustment. For any procedures which may not be addressed in this document, refer to the technical procedures detailed in the Teledyne API Model 701 Zero Air Module Instruction Manual, 01671, Rev. E2.

It should be noted, however, that at the time of this writing some API 701's may contain a Thomas pump. If your instrument still has a Thomas Pump (Figure ), contact the Operations Support Sections Instrument Lab to arrange replacement with the new GAST pump (Figure ).

## 6.0 FIGURES

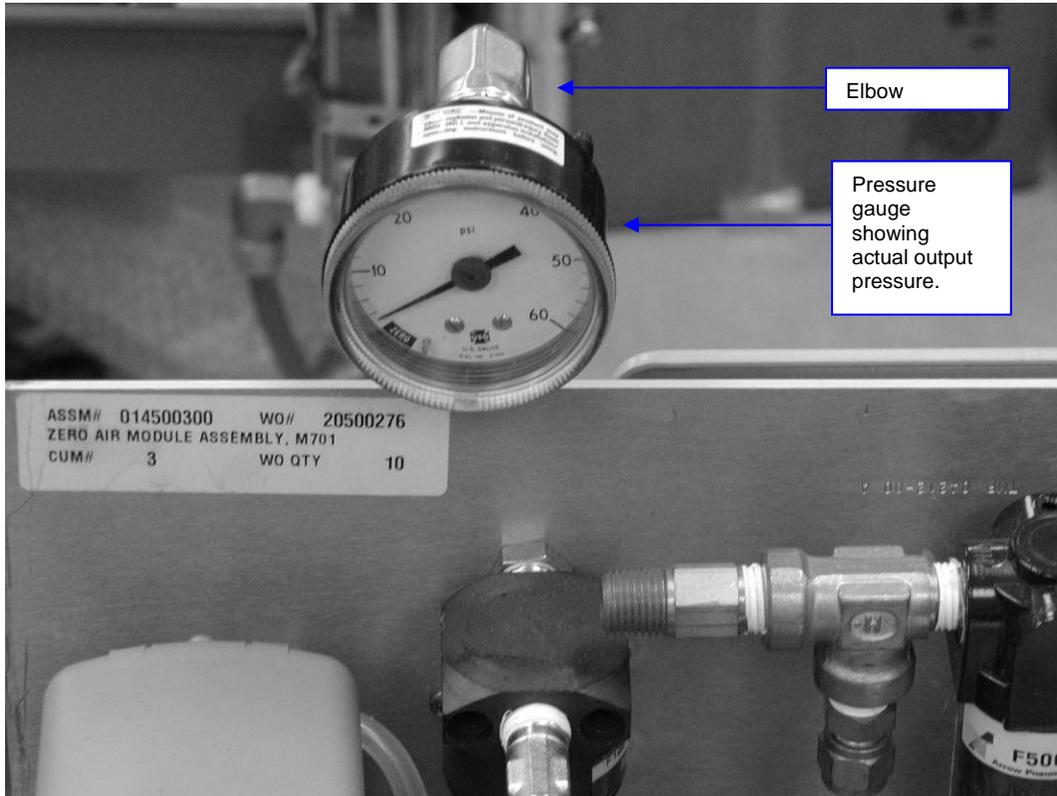
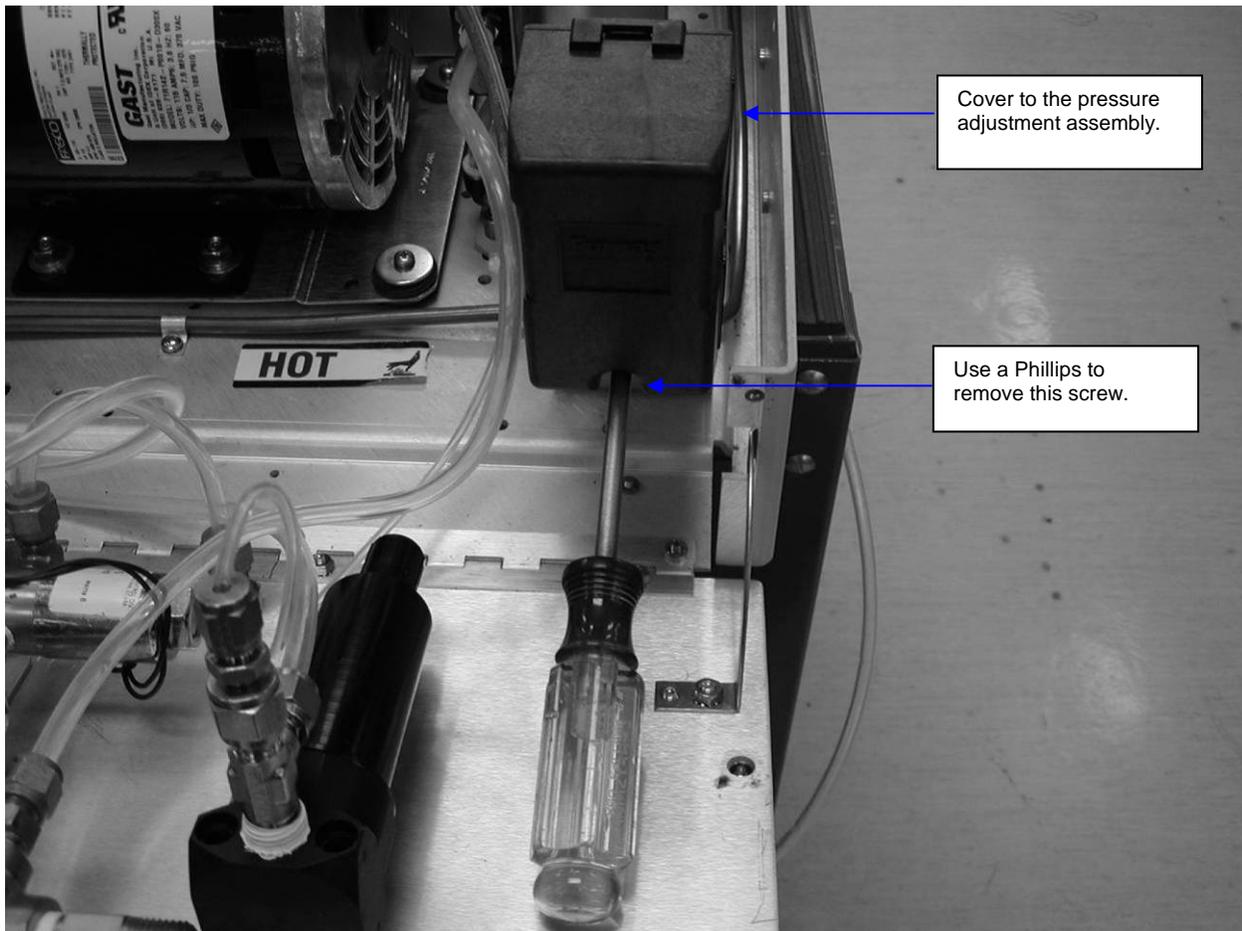


Figure 1 - Pressure gauge elbow attachment (frontal view).

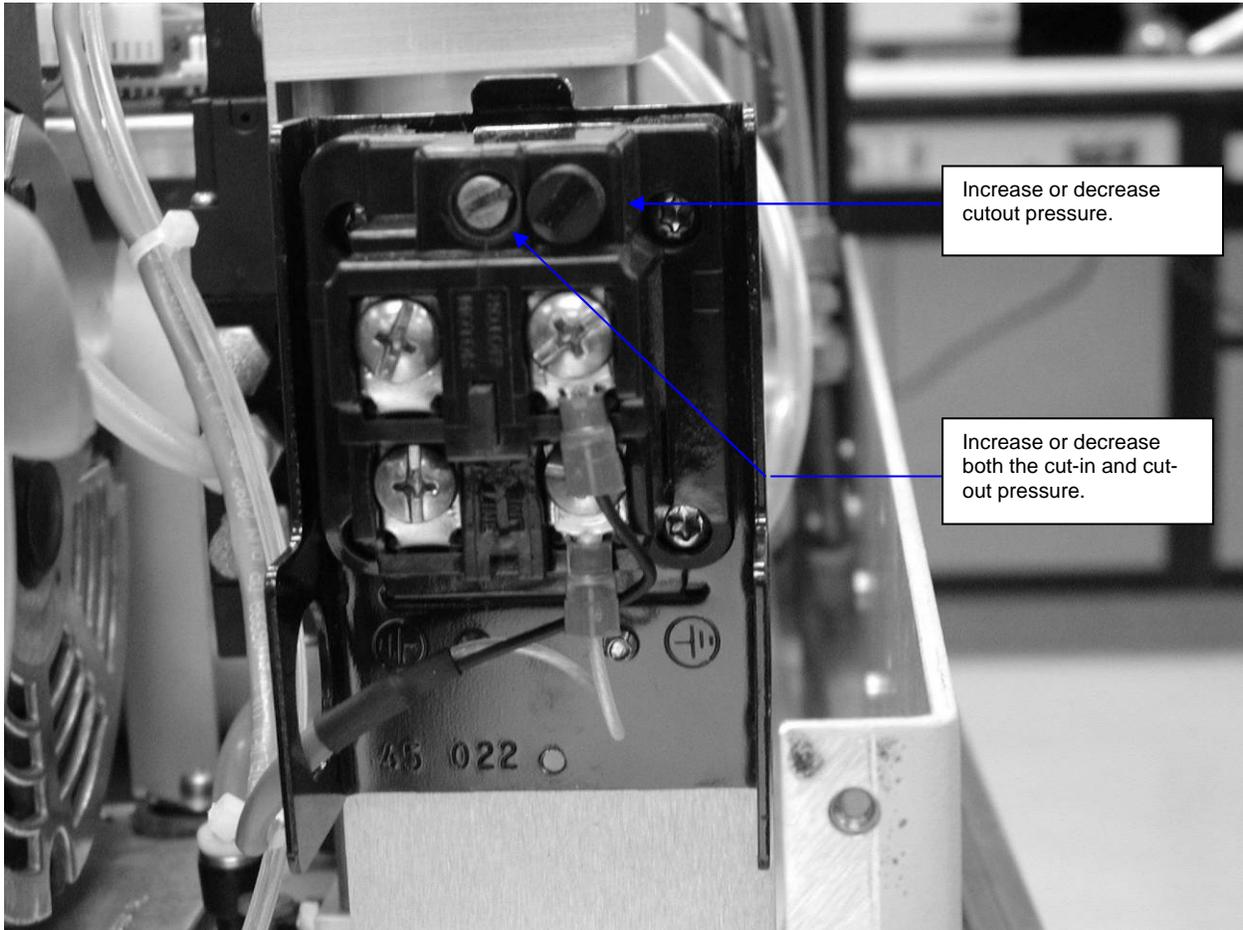


**Figure 2 - Mass flow (port 1) connection rear view**

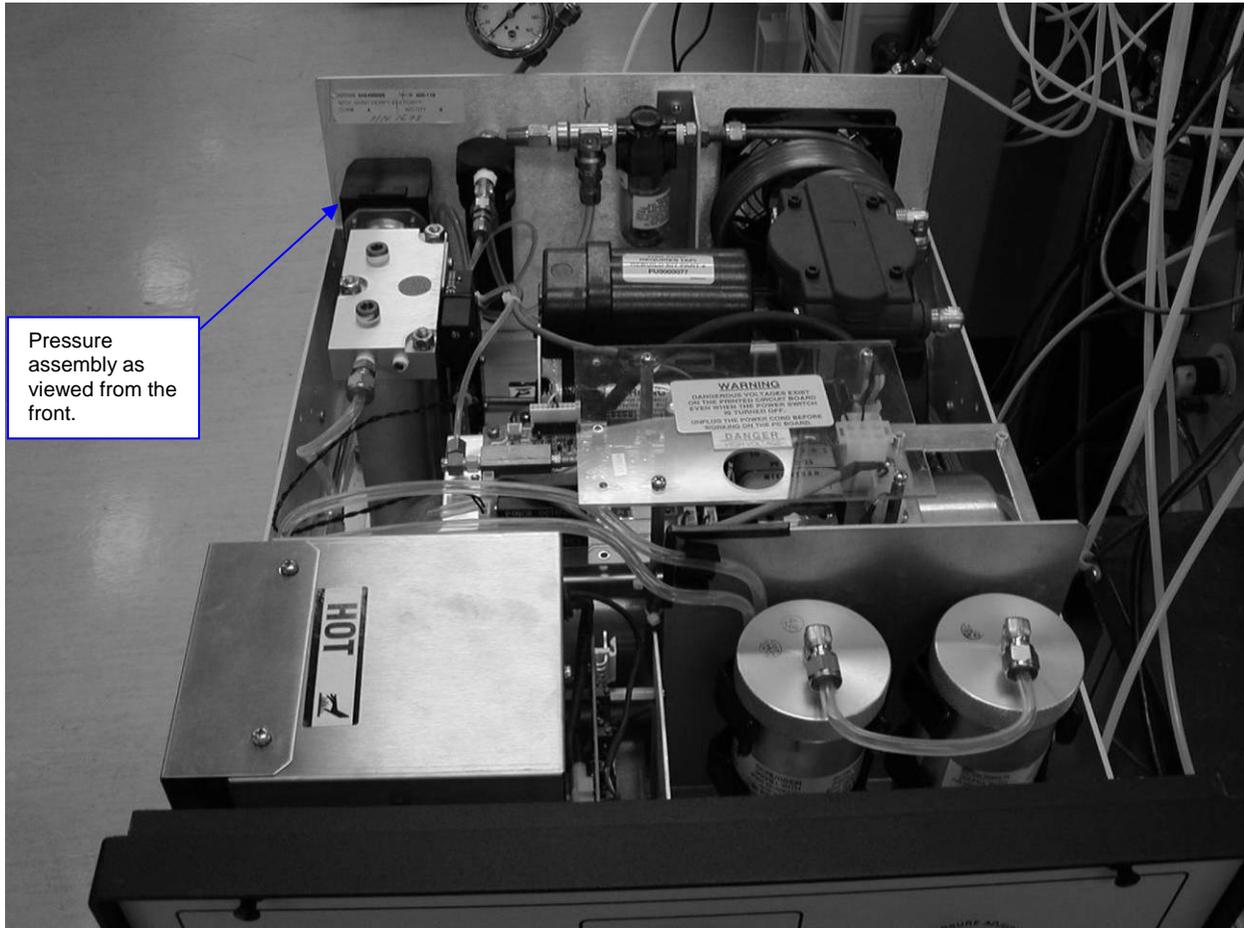
This connection to the API-701H out.



**Figure 3 Cut-in and cut-out adjustment, rear view looking forward. The Phillips screw driver must be used to remove the cover from the pressure adjustment facility. See figure 4 for pictures without the cover.**

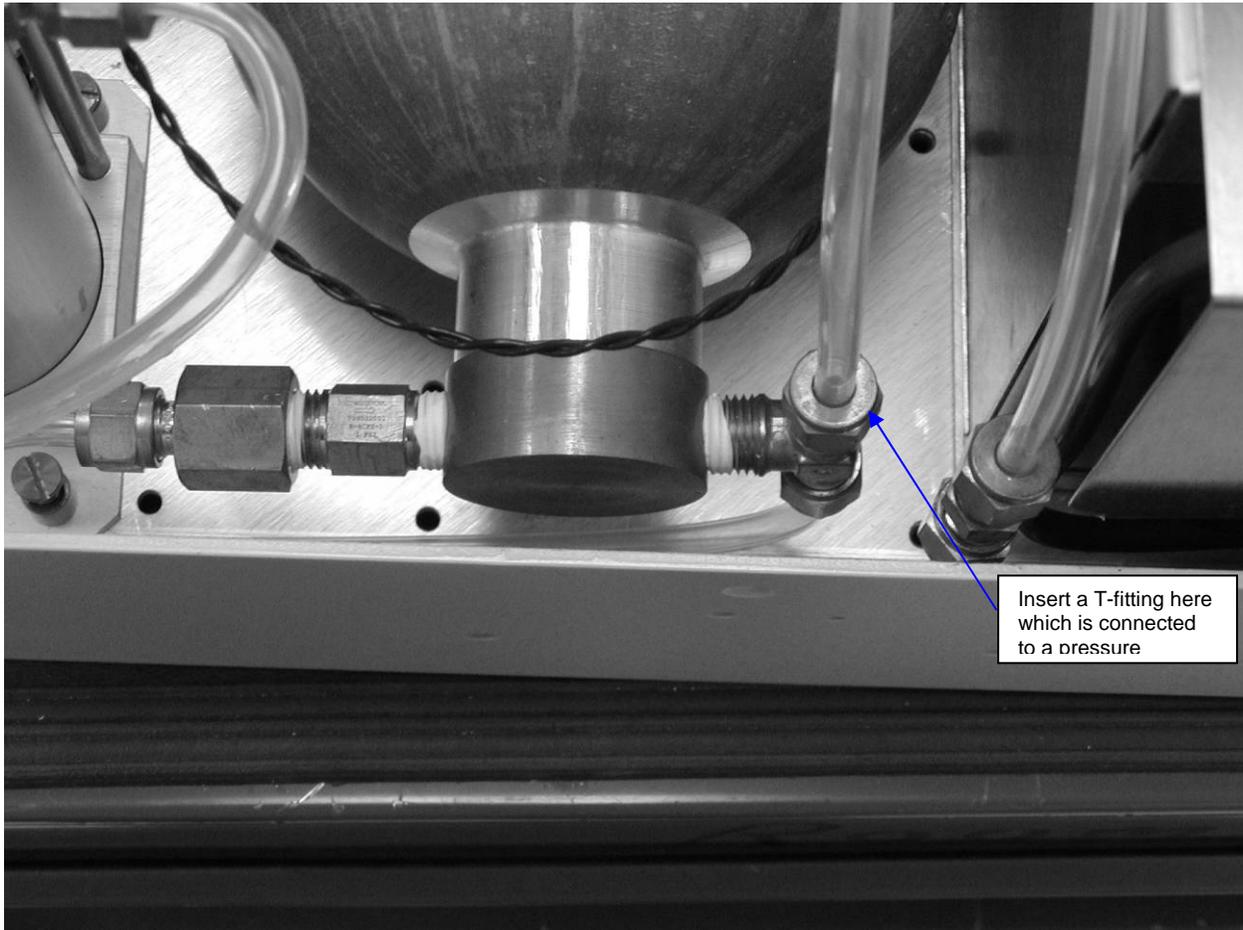


**Figure 4** This view is of the pressure adjustment assembly shown in figure three, with the cover removed. The black, plastic screw on the upper right can be turned clockwise to increase cut-out pressure without effecting cut in pressure. The brass screw adjacent and to the left of the cut-out screw can be turned clockwise to increase both cut-in and cutout.

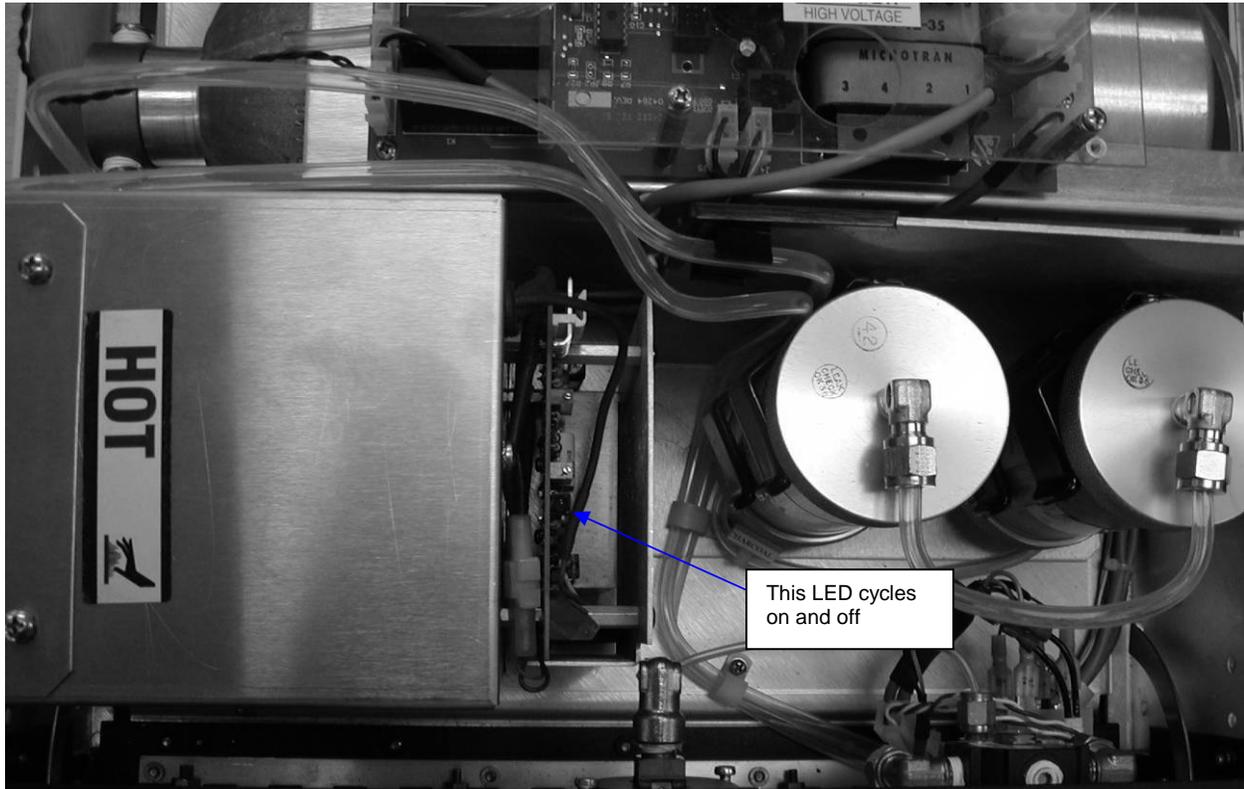


Pressure  
assembly as  
viewed from the  
front.

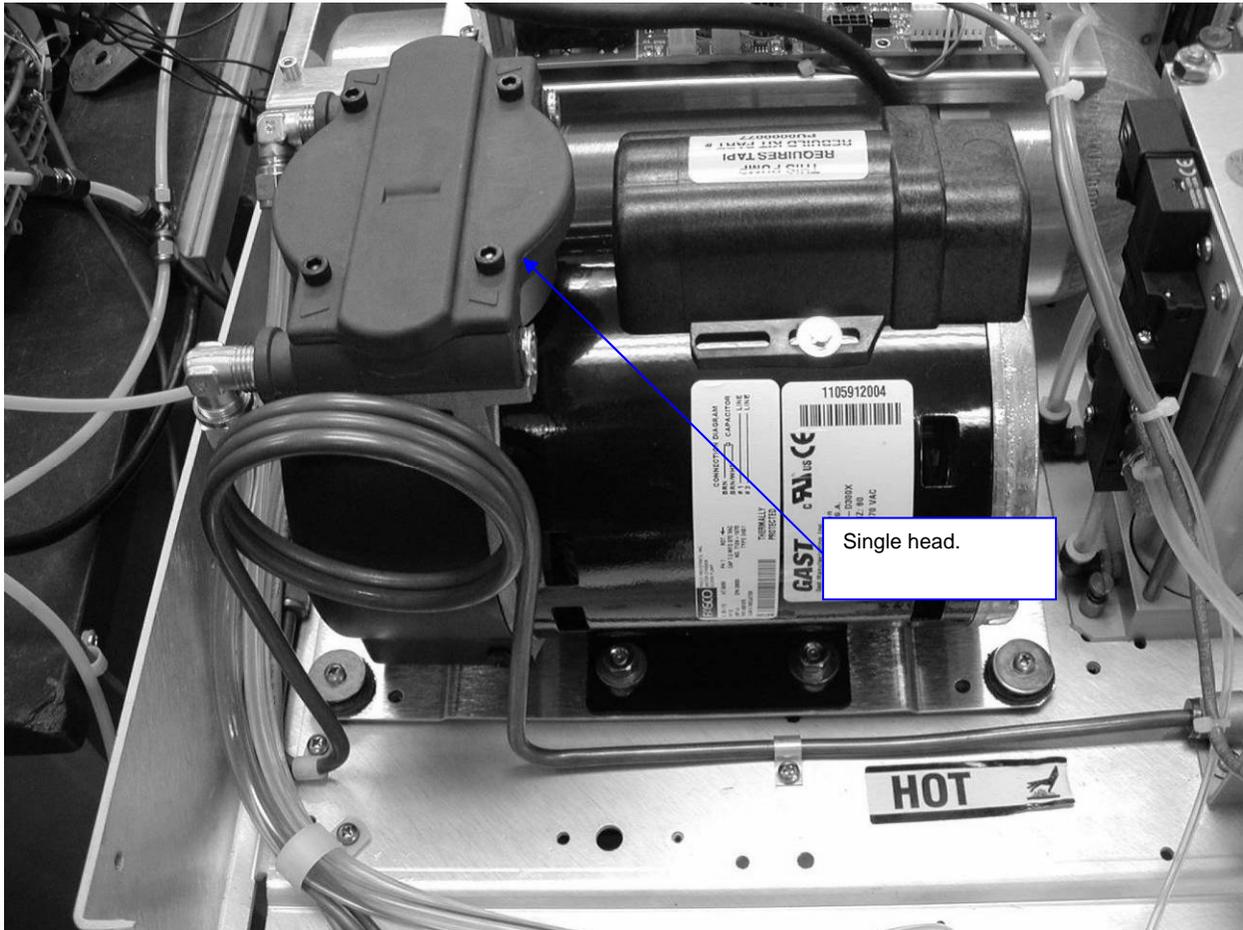
**Figure 5** This picture is taken from the front, looking down at the API 701 with its cover removed.



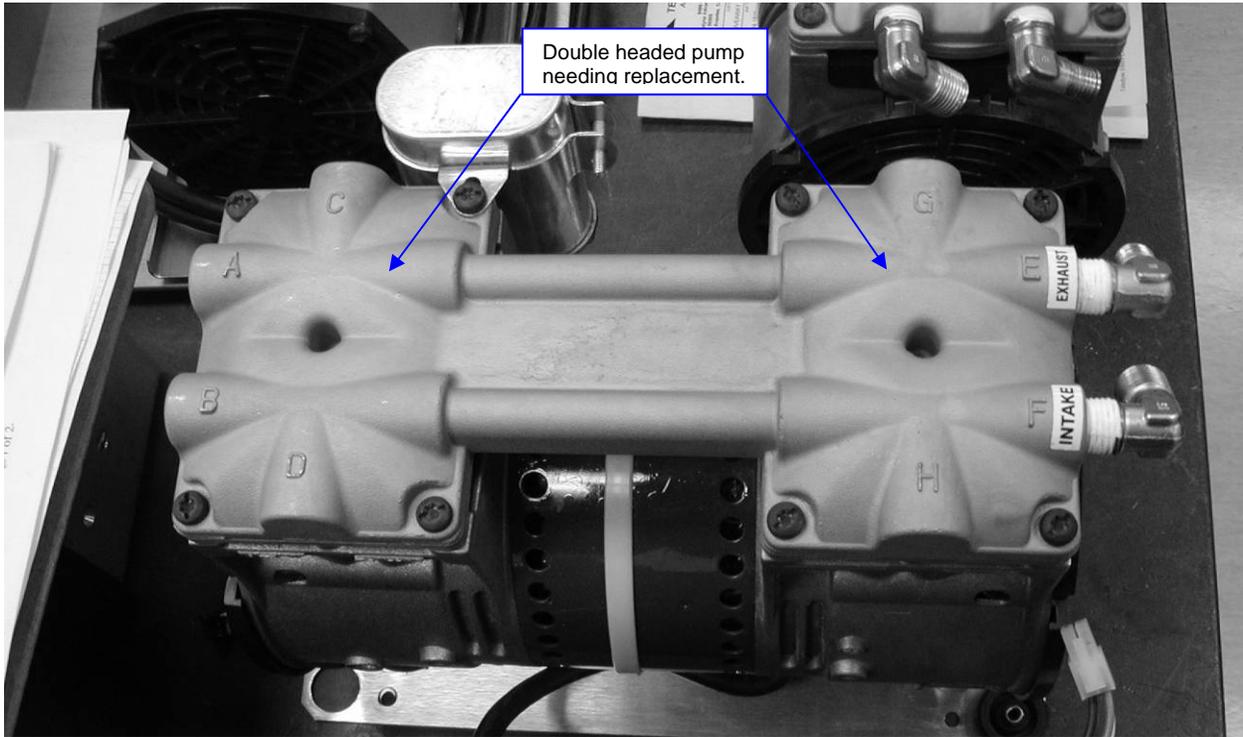
**Figure 6 Tube fitting to pressure regulator tank.**



**Figure 7** This figure shows the red LED which oscillates on and off as the heater cycles. It is located in the middle of the green circuit board which is parallel to the heater.



**Figure 8** This figure shows what the GAST pump looks like. Note the single piston head on the top. If your pump looks like the one depicted in Figure 9 with two heads, you will need to follow procedures to have it replaced. See also Tech Bulletin



**Figure 9 This shows the Thomas pump, with a dual head/piston assembly. If your API-701 contains this, contact OSS to obtain a replacement.**

**CALIFORNIA AIR RESOURCES BOARD  
 MONTHLY QUALITY CONTROL MAINTENANCE CHECK SHEET  
 API Model 701 Zero Air Module**

**Location:** \_\_\_\_\_ **Month/Year:** \_\_\_\_\_  
**Station Number:** \_\_\_\_\_ **Operator:** \_\_\_\_\_  
**Property Number:** \_\_\_\_\_ **Agency:** \_\_\_\_\_

**OPERATOR INSTRUCTIONS:**

**1. Daily checks:**

Check	ON	OFF
Power light (Red).		
Hygrometer light (Green).		

**2. Monthly Checks:**

Check	Recorded	Target
Check and record output pressure.		<b>35 PSI ± 1 PSI</b>
Adjusted pressure (if applicable).		
Confirm the presence of water in the moisture output trap.		

**3. Annual Checks:**

Check	Last Recorded	Current
Change the activated carbon filter as needed or at a minimum of once per year.		
Change the Purafil® filter as needed or at a minimum of once per year.		

**4. As Required Checks:**

Check	Last Recorded	Current
Verify the cut-in and cut-out pressures		
Check operating temperature of the hydrocarbon scrubber		

Date	Comments, Checks, or Maintenance Performed:

Reviewed by: \_\_\_\_\_ Date: \_\_\_\_\_