Instructions for using the A3000 nephelometer at Dome C

Version 1, 2016-12-02

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1. Introduction

The Ecotech Aurora 3000 nephelometer (S/N 13-0683) was modified to keep the air flow constant during the zeroing phase and to keep also the temperature of the zero air as close to the same as the temperature of the sample air. The details of the modification are described in the appendix (A3000 Modification details 2016-12-02.pdf). This instruction describes how to install the zeroing system and how to operate the nephelometer.

Remember to read carefully also the Ecotech's own manual for operating the nephelometer.

2. Installing the external zeroing system

Remove the protective cap from the inlet piece of the nephelometer and screw the zeroing system's Swagelok connector to it. Attach the valve signal cable. Be careful not to break the wiring in the signal cable head. Check that the inlet of the span gas is plugged. It will be opened only during span calibration. Attach the connection for the external pump.

Inlet
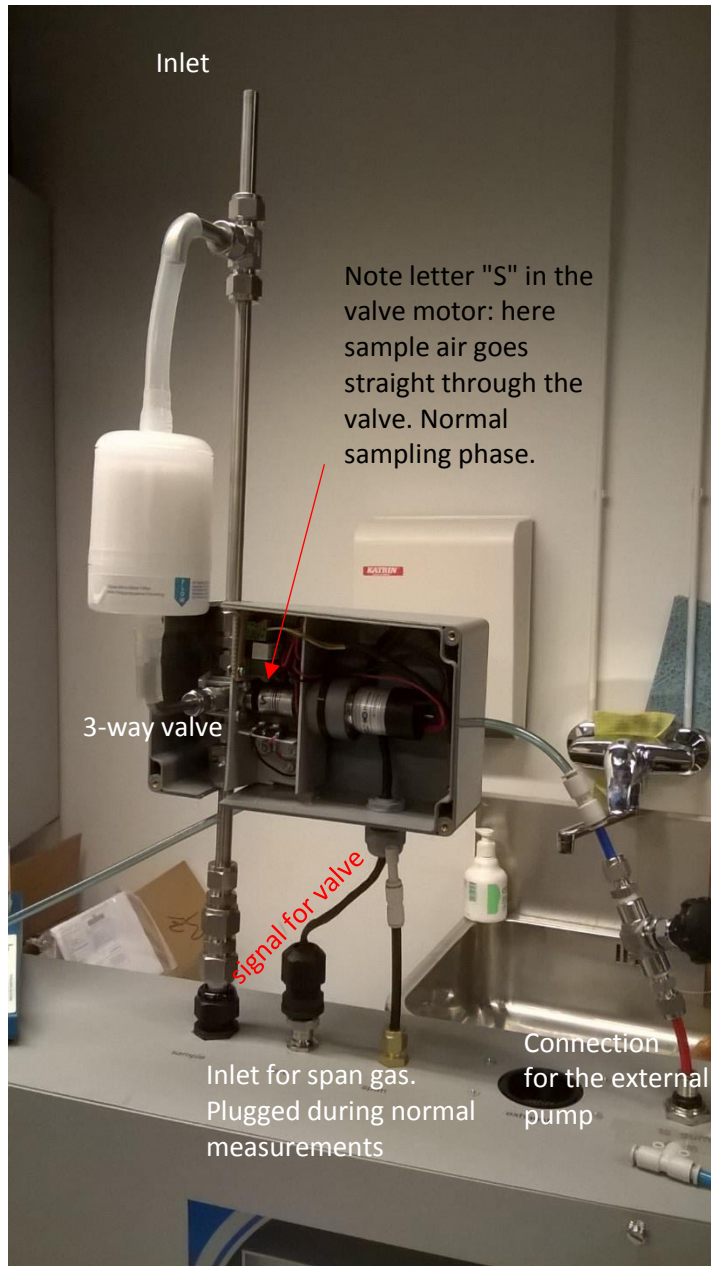
Note letter "Z" in the valve motor: here sample air goes through the HEPA filter. Zeroing phase.

Note letter "S" in the valve motor: here sample air goes straight through the valve. Normal sampling phase.

3-way valve

Signal for valve

Inlet for span gas. Plugged during normal measurements

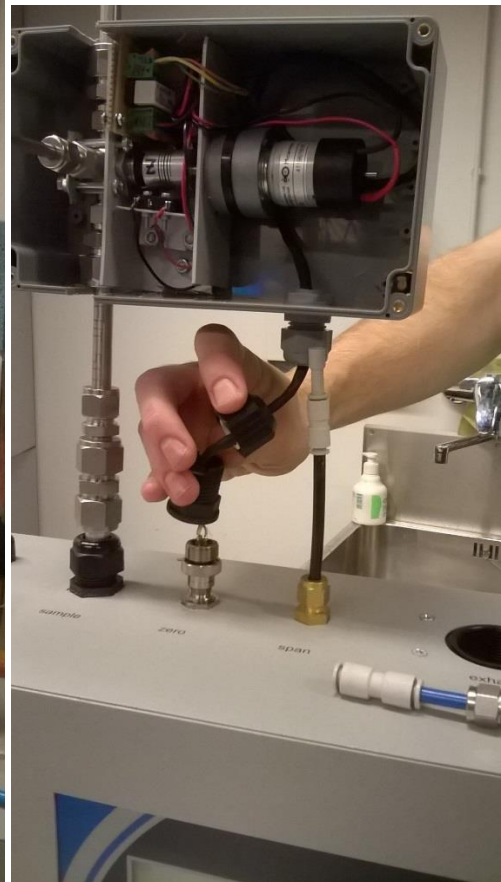Connection for the external pump

Figure 1. Installation of the external zeroing system. When connecting the signal cable note that there is cover that can be lifted. Be careful not to break the wiring connections in it.

After installing the zeroing system keep the cover of the valve box open so that you can see when the valve turns. Don't yet connect the inlet to the real outdoor air because the flows have to be checked and it has to be checked that the valve system turns like it should.

After installing the zeroing system and the external flow, attach computer serial cable to the nephelometer multi-drop port.

Turn the nephelometer on.

Check that dates are set correct in the nephelometer. To do that check the nephelometr's own manual.

Set a data logging program to communicate with the nephelometer. HyperTerminal is an easy example but you may use whatever program. See that the computer communicates with the nephelometer. See the command set in the manual. Give for instance the command ID to see that they communicate. The syntax of the commmand is "ID{<module address>}<CR> ". When the neph was here, the mopdule address was 0 so the command and the response was

>   ID0
>   Ecotech Aurora 3000 Nephelometer v1.14.000, ID #3-8683

Ok, when this works, give the commands

>   DO0011 and DO0010

and you should see the valve turning and the letters Z and S appear in the motor (see Fig. 1). Measure the flow from the inlet tube and adjust it. It is not sensitive to the flow but 4 LPM is fine. Ceck that the flow is the same both when the valve is in Z and in S position. Then it does not leak.

If this is fine then set the nephelometer's operation so that it does automatic zero check but not automatic zero adjustment. In the beginning set the timing so that it does the zero check very often so that you can follow the valve turning. When you have confirmed it works fine, set the automatic zero check to take place every 12 hours (AutoCal Intv in the neph Cal Settings menu) and zeroing time to be minimum 15 minutes, max 20 minutes (Cal min time and Cal max time in the neph Cal Settings menu). We might change that later.

When you have confirmed that it works fine, cover the box and try to insulate it thermally so that sample air and zero air are at the same temperature. Connect the top of the zeroing box to the main inlet of the measurement cabin. Use the conductive black silicone tube.

3. Running the measurements

The simplest way to log the data is to set the computer to read unpolled data at 1-second intervals. But according to the manual the measurement sequence is such that new values are calculated every 3 seconds. So, to keep raw data file size smaller, I recommend you set the computer to send send the command VI099 automatically every 3 seconds. That can be done for example with HyperTerminal.

4. Calibration

Normally only do SPAN CHECK. If that looks strange contact Aki and we discuss whether to do the full calibration.

Do span checks manually. Cal min time 15 min, max time 20 min is enough.

Let the data logging program run all the time.

1) Disconnect inlet. Don't remove the zeroing box, just the connection from the roof to the zeroing box.

2) Set CO_2 flow to 4 – 5 LPM.

3) Activate "span check" from the neph. The neph shows measurement data, press "enter", arrows to "calibration" then "Activate cal", then "Do span chk."

4) Remove quick connector "stop plug" from "span" and connect the CO_2 flow connector (See figs 2-4).

5) First let CO_2 flow out of the nephelometer both through the external pump connector and the inlet. Then we are sure that the nephelometer is full of CO_2 only. After a few seconds, remove the pump connector and put the "stop plug" there instead. Now all CO_2 flows out from the inlet. You can check it by connecting the flow meter to the inlet. It should now push CO_2 with the same flow as it was directly from the CO_2 bottle.

6) Just look at the neph display and compare the scattering coefficients with those shown in the manual for CO_2. If they look very different, contact Aki.

7) When the set time is over, the neph starts the normal measurements. Disconnect CO_2 and move the "stop plug" back to the "span" connector and the flow to the "to Pump" connector. Connect inlet back.

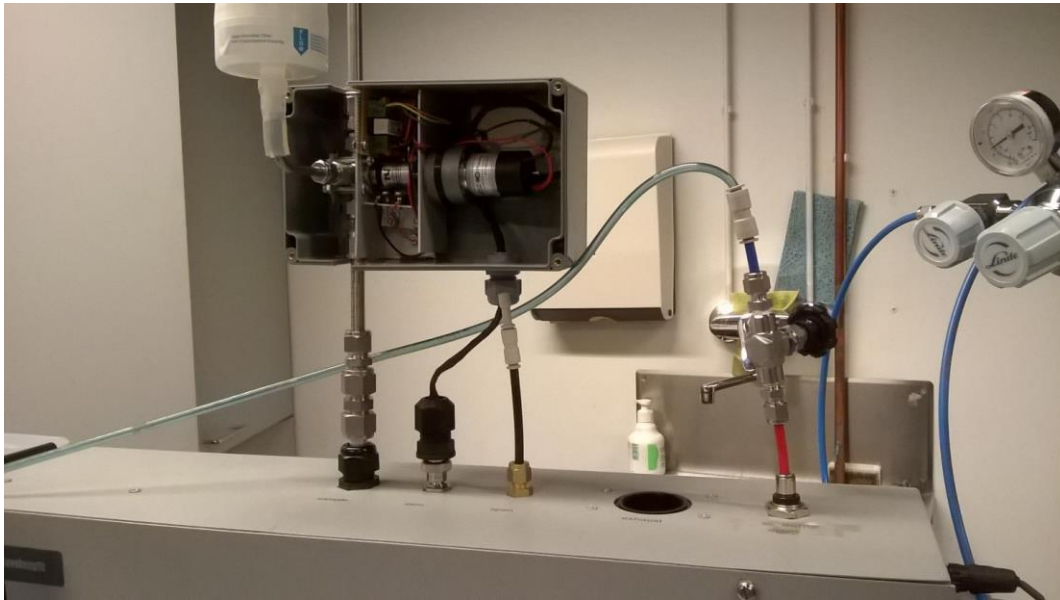The measurements should continue automatically just normal.
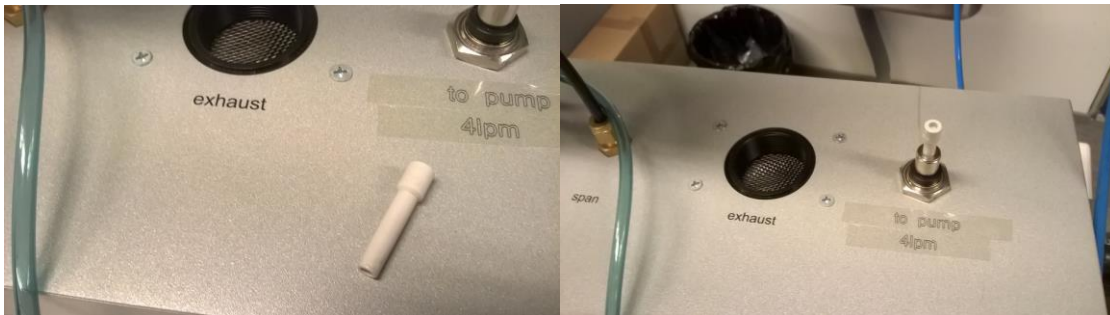
Figure 2. Setup during normal measurements.

Figure 3. The plug that is normally in the "span gas inlet" removed and plugged to the external flow connector
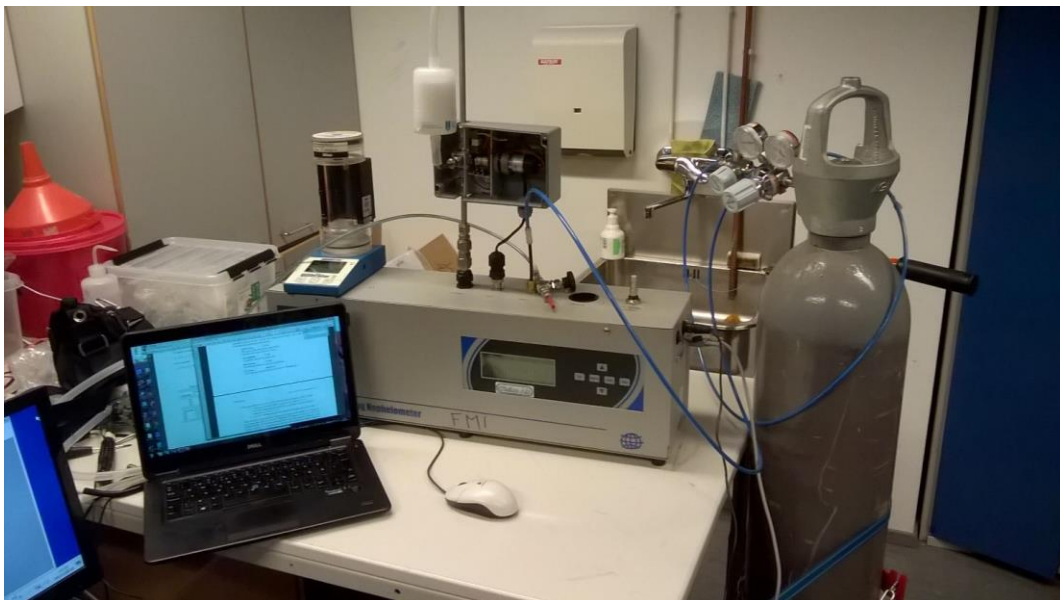

Figure 4. The setup for the span check.

4. What to do if zeroing box motor gets broken?

We are not sure whether the motor works in very cold conditions. It might get broken...¨
If that happens, remove the motor and replace it with a manual handle we have sent there also. It fits to the same place where the motor is now turning the valve.

Figure 5. A replacement handle for the zeroing valve.

Do zeroing manually every time you go to the measurement cabin.

Write the zeroing time to the diary.

APPENDIX. Details of the modifications done to the nephelometer

Aki Virkkula (Finnish Meteorological Institute) and Frans Korhonen (University of Helsinki), 2016-12-02

Insulation
to keep temperature as similar
during zeroing as during
actual sampling
Note: In the photo there is no
insulation yet.

From inlet
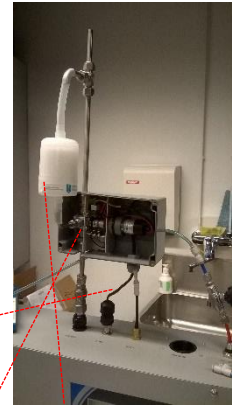
The signal that controls the original
zero valve and pump is now used for
controlling the external 3-way valve.
The signal cable is connected through
the original zero air hole.

HEPA filter

3-way ball valve

The flow through the original
zero valve is blocked
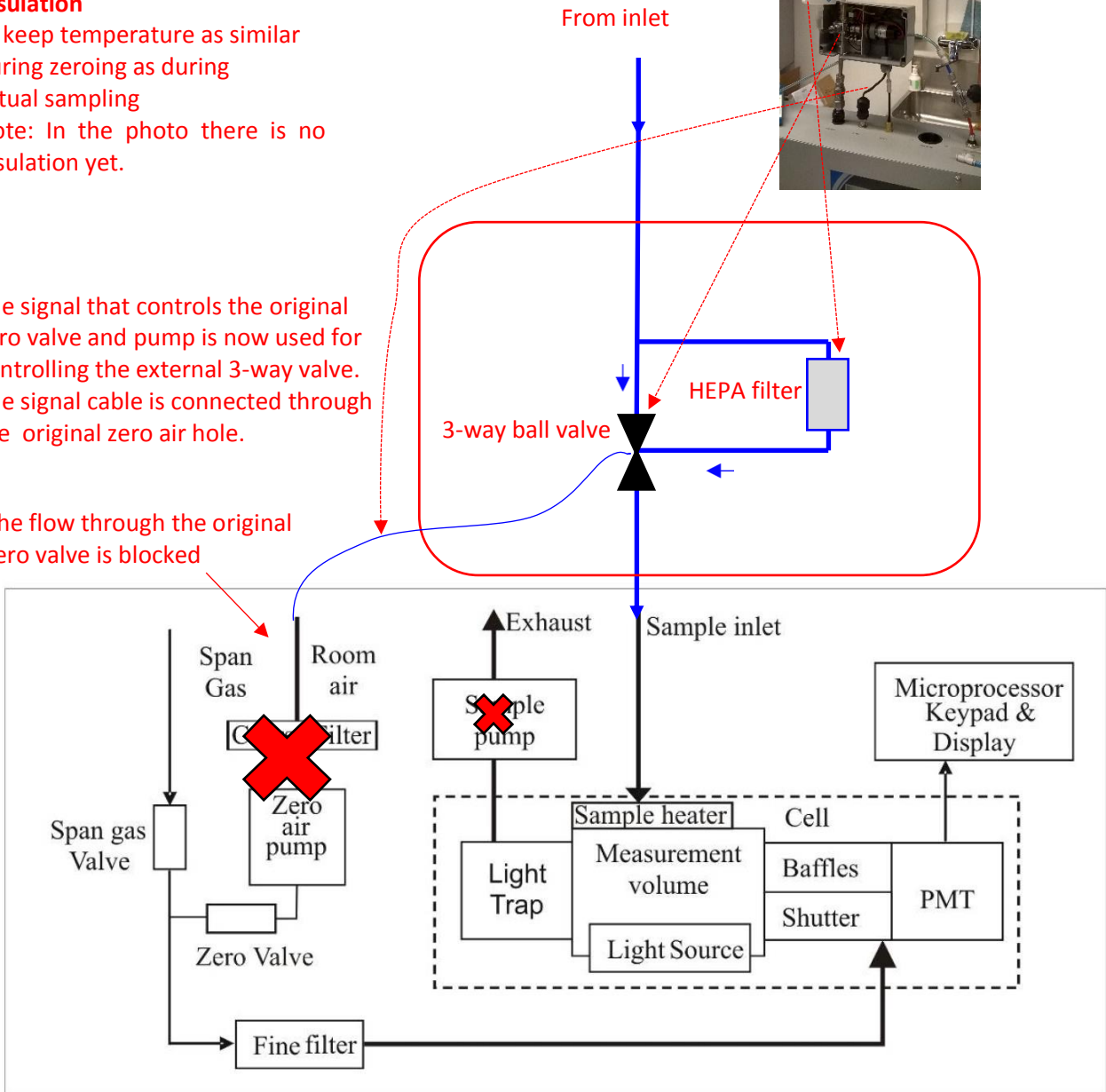
Figure 1. General overview of the modifications done. The schematic figure in the lower part is from the original manual.
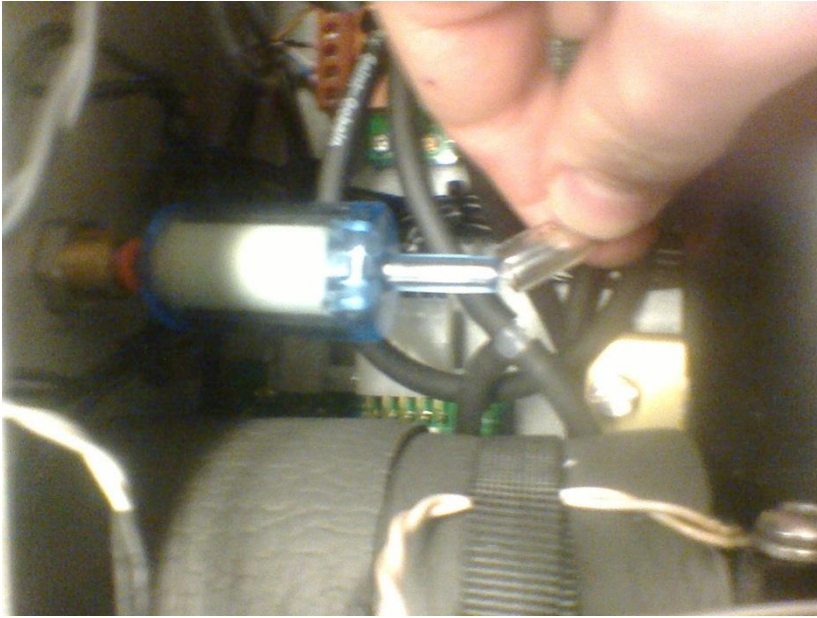
Figure 2. Removing the original zero air filter from the hose.

Figure 3. Plugging the zero air hose.

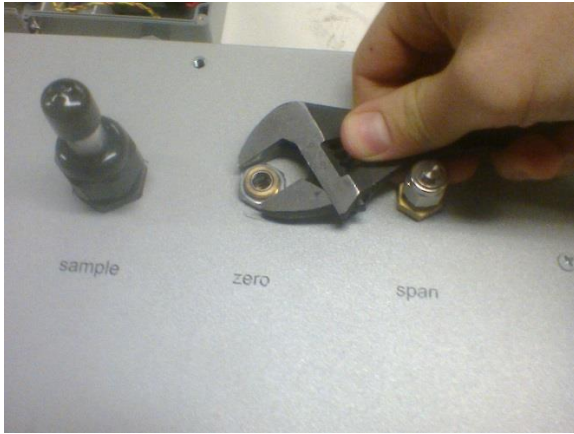Figure 4. Removing the original zero air filter.

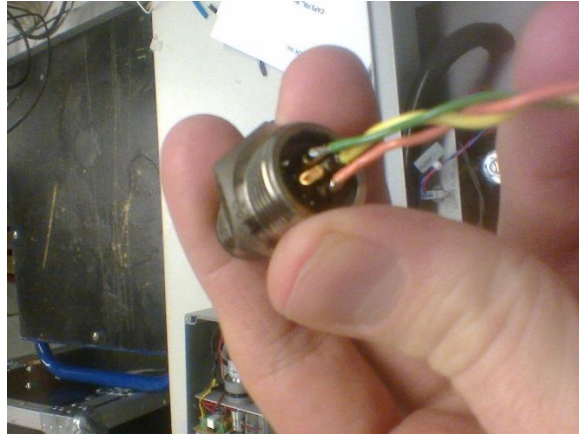Figure 5. Removing the zero air inlet.

Figure 6. New zero valve signal connector.
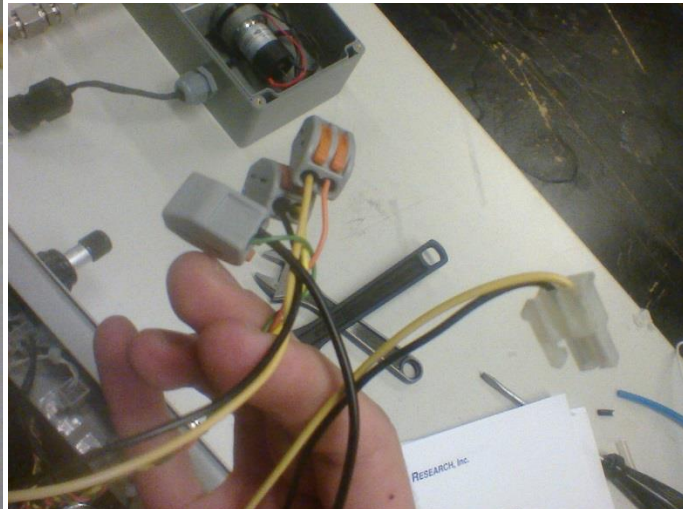

Figure 7. Zero air signal connector installed.

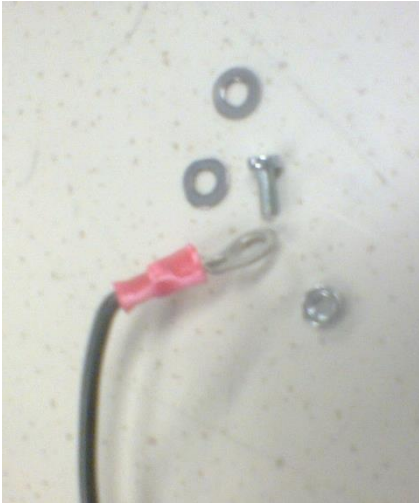Figure 8. Zero air valve connectors inside the nephelometer.

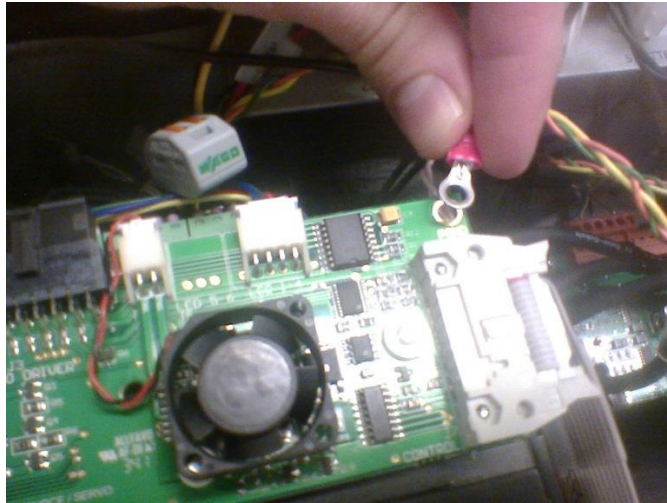Figure 9. Zero valve grounding parts.
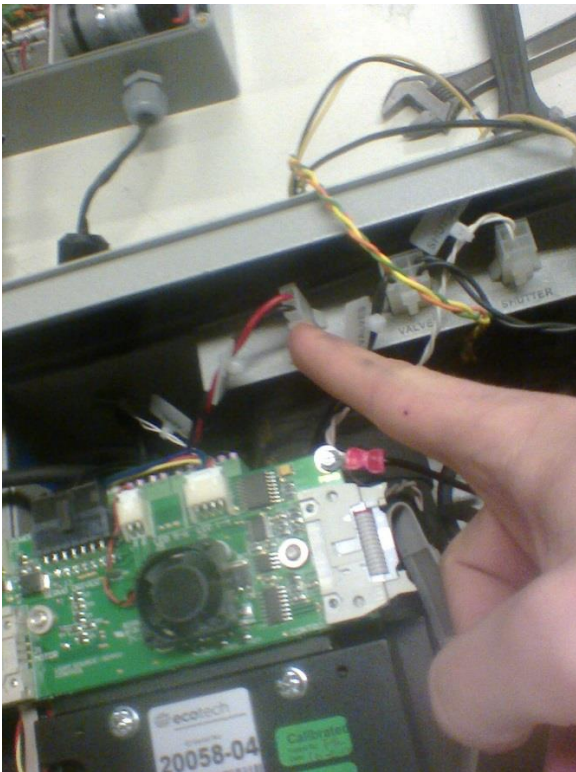

Figure 10. Zero valve grounding to PGND.

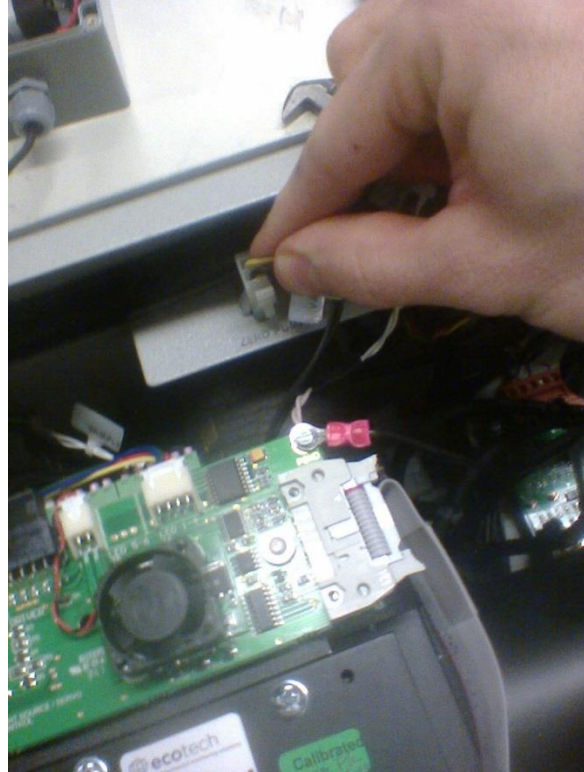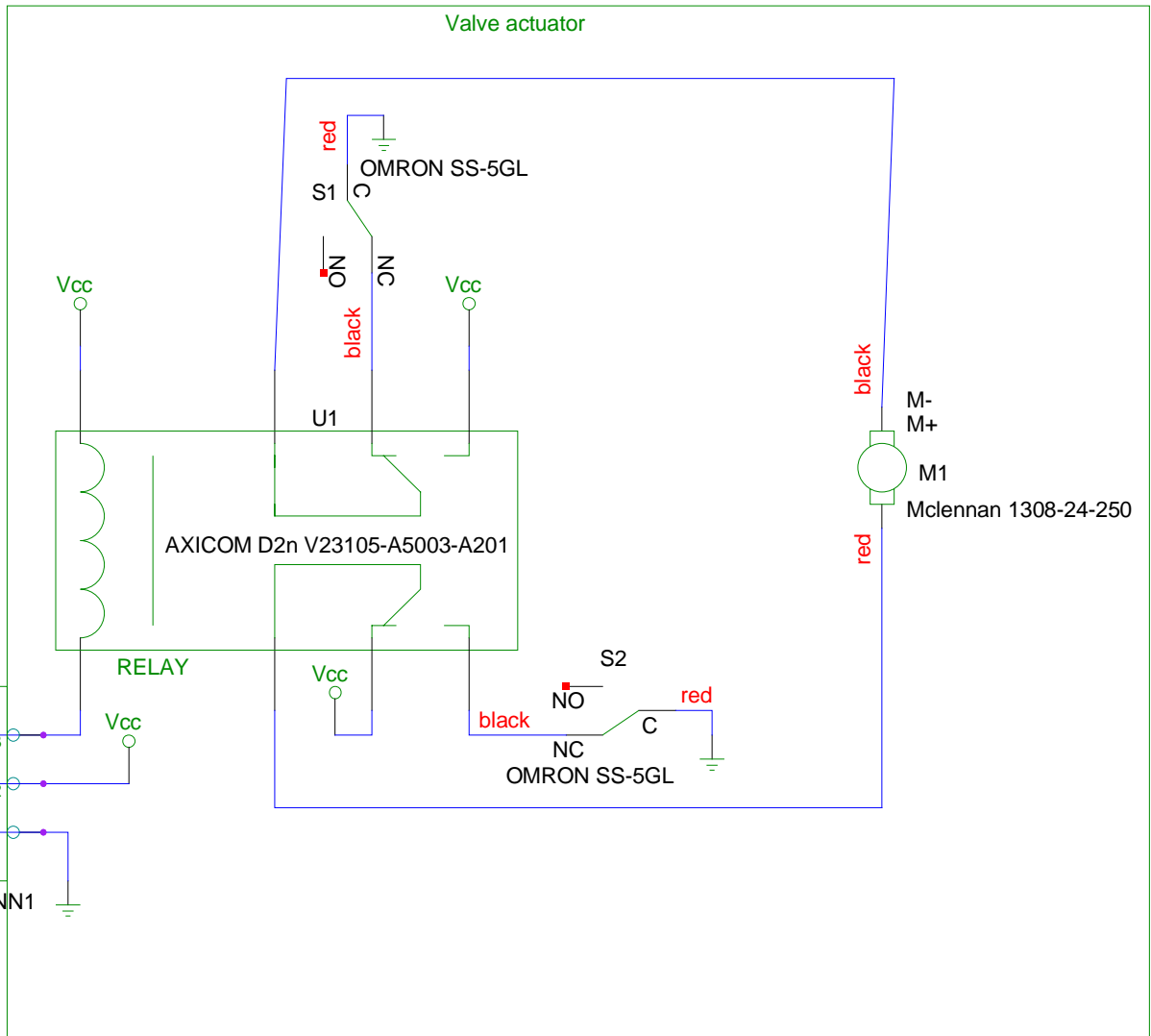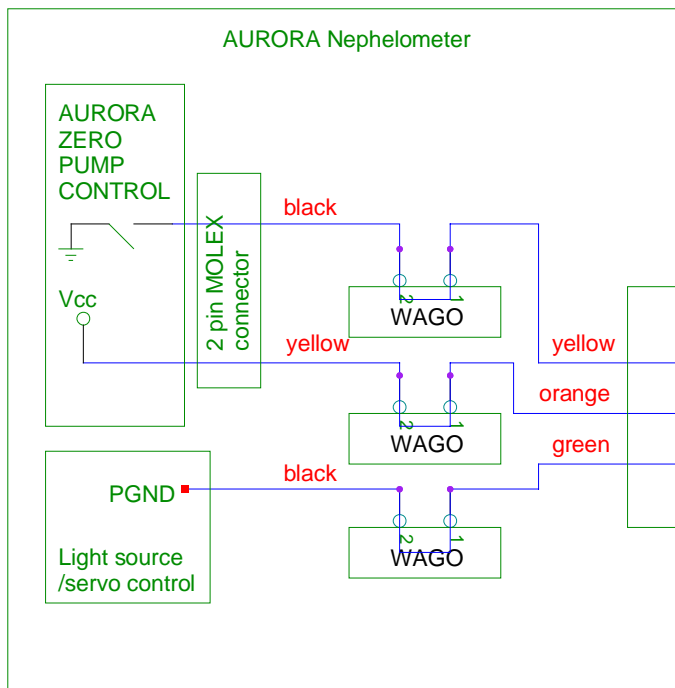Figure 11. Disconnect original zero pump.

Figure 12. Connecting signal for the new zero valve.

Figure 13. Removing the exhaust hose from the blower and connecting it to the external pump connector.

Valve actuator

OMRON SS-5GL

red

S1

C

ON

NC

black

Vcc

M-
M+
M1
Mclennan 1308-24-250

black

red

U1

AXICOM D2n V23105-A5003-A201

RELAY

Vcc

S2

NO

black

red

C

NC

OMRON SS-5GL

Vcc

AURORA Nephelometer

AURORA
ZERO
PUMP
CONTROL

2 pin MOLEX connector

black

WAGO

Vcc

yellow

WAGO

PGND

Light source
/servo control

black

WAGO

yellow

orange

green

5-pin M12 Connector

yellow

orange

green

CONN1

3

2

1

Vcc

TITLE	Valve control circuit For Aurora Nephelometer	
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