NEON PREVENTIVE MAINTENANCE PROCEDURE: PARTICULATE ANALYZER – SIZE

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Change Record

REVISION	DATE	ECO #	DESCRIPTION OF CHANGE
A	12/01/2016	ECO-04074	Initial release
B	12/01/2022	ECO-06920	Updated NEON logo and minor formatting fixes

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LIST OF TABLES AND FIGURES

1 DESCRIPTION

1.1 Purpose

NEON sites host sensors that take measurements from air, wind, soil, and sun. Regular maintenance of sensors and infrastructure is necessary for the continued operation of the observatory, and to identify small problems before they escalate.

This document details procedures necessary for preventive maintenance of the **Particulate Analyzer - Size: Dust Trak DRX Aerosol Monitor 8533EP**.

1.2 Scope

The procedures detailed in this document are strictly preventive. Any corrective maintenance issues uncovered while performing preventive maintenance should be addressed using the corrective maintenance procedure associated with this subsystem. Refer to RD[04] for a list of maintenance procedure document numbers.

2 RELATED DOCUMENTS AND ACRONYMS

2.1 Applicable Documents

Applicable documents contain information that shall be applied in the current document. Examples are higher level requirements documents, standards, rules and regulations.

AD [01]	NEON.DOC.004316	Operations Field Safety and Security Plan
AD [02]	NEON.DOC.050005	Field Operations Job Instruction Training Plan
AD [03]	NEON.DOC.00XXXX	Overarching Maintenance Document
AD [04]	NEON.DOC.002115	NEON Sensor Command, Control and Configuration (C3) Document: Particulate Analyzer – Size
AD [05]	NEON.DOC.00XXXX	TIS Tower Top Environmental Enclosure Preventive Maintenance Procedure

2.2 Reference Documents

Reference documents contain information complementing, explaining, detailing, or otherwise supporting the information included in the current document.

RD [01]	NEON.DOC.000008	NEON Acronym List
RD [02]	NEON.DOC.000243	NEON Glossary of Terms
RD [03]	NEON.DOC.00XXXX	NEON Training Curriculum Guide
RD [04]	NEON.DOC.00XXXX	NEON Maintenance Document Matrix

2.3 External References

ER [01]	DUSTTRAK™ DRX AEROSOL MONITOR MODEL 8533/8534/8533EP Service Manual http://www.tsi.com/uploadedFiles/_Site_Root/Products/Literature/Manuals/8533-8534-DustTrak_DRX-6001898-web.pdf
ER [02]	DUSTTRAK™ DRX AEROSOL MONITOR THEORY OF OPERATION EXPN-002 Rev. B http://www.tsi.com/uploadedFiles/_Site_Root/Products/Literature/Application_Notes/EXPMN-002_DustTrak_DRX_Theory_of_Operation.pdf

2.4 Acronyms

Acronym	Description
HEPA	High-Efficiency Particle Arrestor
LC	Location Controller
MFC	Mass Flow Controller

3 SAFETY AND TRAINING

This document identifies procedure-specific safety hazards and associated safety requirements. It does not describe general safety practices or site-specific safety practices.

Personnel working at a NEON site must be compliant with safe field work practices as outlined in the Operations Field Safety and Security Plan (AD[02]) and EHS Safety Policy and Program Manual (AD[01]). Additional safety issues associated with this field procedure are outlined below. The Field Operations Manager and the Lead Field Technician have primary authority to stop work activities based on unsafe field conditions; however, all employees have the responsibility and right to stop their work in unsafe conditions.

All technicians must complete required safety training and protocol-specific training for safety and implementation of this protocol as required in Field Operations Job Instruction Training Plan (AD[03]).

4 OVERVIEW

4.1 Description

The Particulate Analyzer - Size consists of two main components: the DustTrak DRX 8533EP ("DRX Module"), which contains the instrumentation and user display (**Figure 2a**), and an external pump module (**Figure 2b**) which draws air through the monitor. The sampling inlet port is located at the top right of the DustTrak monitor, above the touchscreen interface, and connects to a chimney to sample outside its protective enclosure. The instrument exhaust port is located at the rear of the instrument, and is connected to the external pump module. Power is supplied to the external pump module via a power cable connected from the rear of the DRX module above the exhaust port. USB and Ethernet ports are located on the left side of the instrument. The on/off switch is directly above the touchscreen (**Figure 4**, **a & b**), while the power supply is on the right side of the instrument (**Figure 4c**).

Table 1. Overview images of the DustTrak DRX 8533.

	**Figure 1.** The main enclosure holding the DustTrak DRX 8533. The DustTrak is located directly under the chimney.

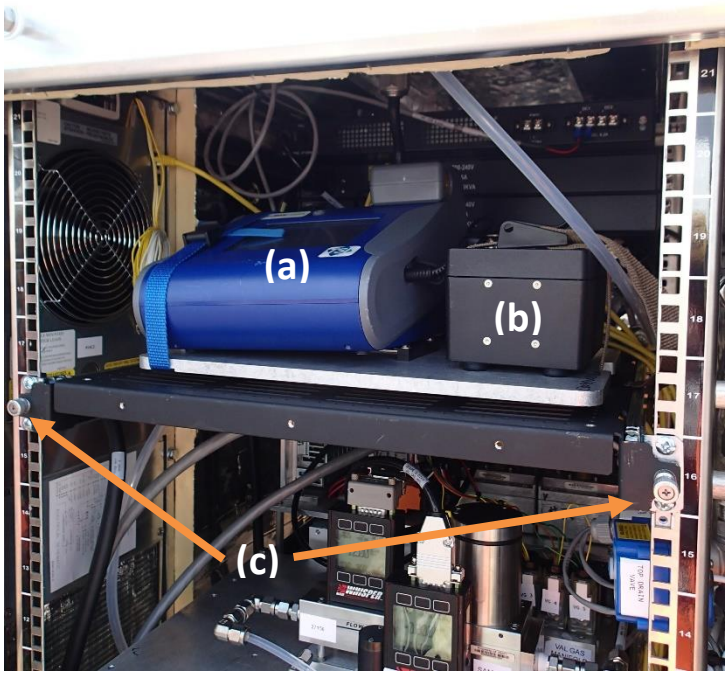


Figure 2. The DustTrak (a) and external pump (b) are located on the top tray in the enclosure. The tray is secured to an internal frame by locking screws (c). Both units are secured to the tray by straps.

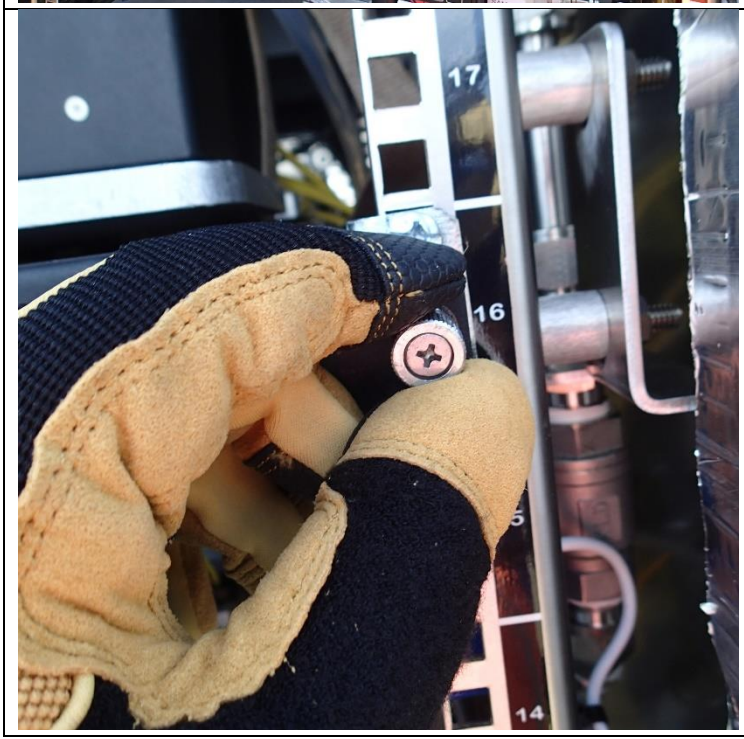


Figure 3. The tray can be freed from the frame by unscrewing the locking screws by hand.

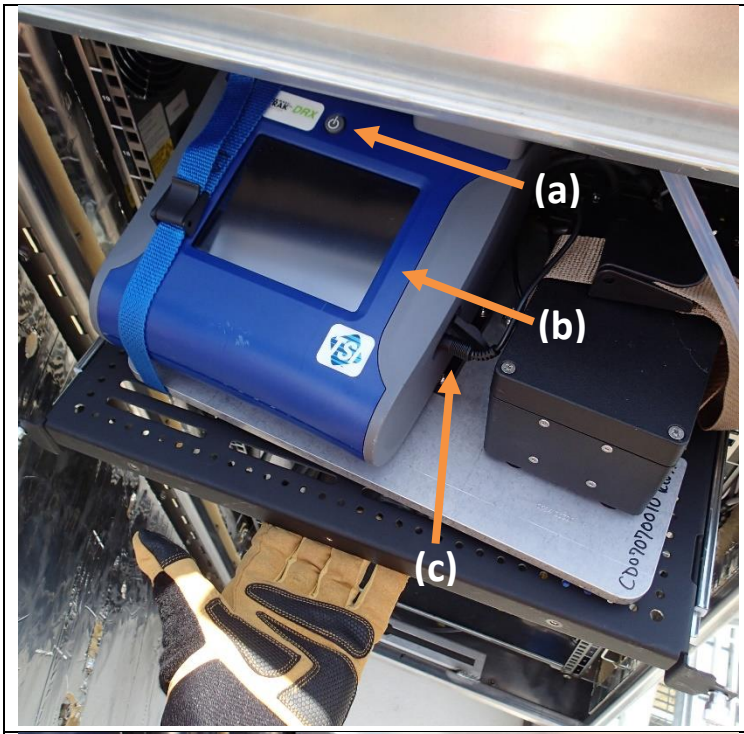


Figure 4. The DustTrak's tray can be pulled out for easier access to the instrument. Lines and tubing from other equipment can snag on the tray, so pull gently. The on/off switch (a) is on the face of the DRX unit above the touchscreen (b). The tower supply to the instrument (c) is on the right side of the DRX, and can should only be removed after the instrument is powered down.

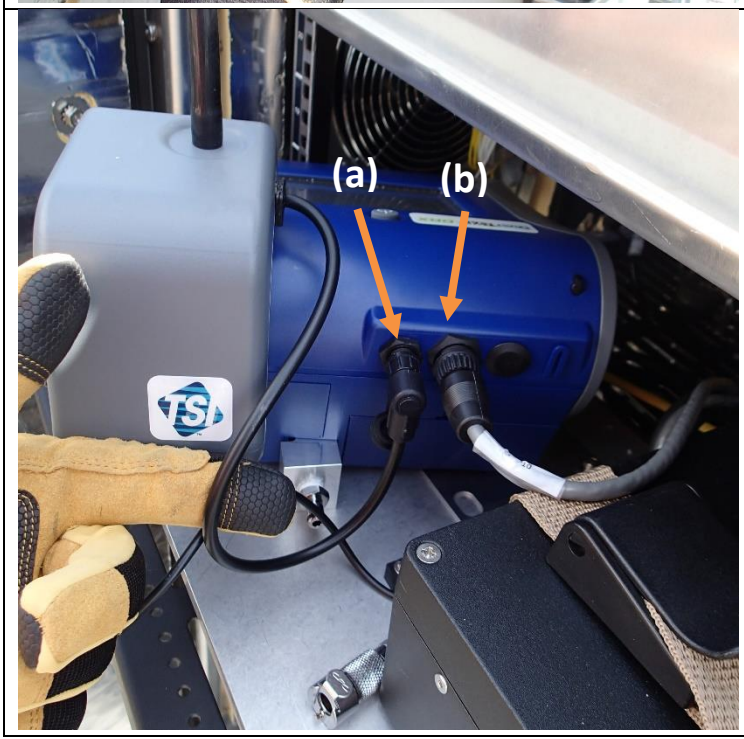


Figure 5. The power cable to the auto zero unit (a) and the external pump (b) are also located at the back of the instrument. These can both be unplugged after the instrument is powered down.

4.2 Sensor Specific Handling Precautions

The DustTrak DRX 8533 uses sheath flow to protect the internal optics from dust contamination during operation. However, dust entering the instrument via the inlet port during maintenance can cause

contamination of the optics. Be careful not to introduce dust into this port with dirty connectors or by spraying directly into it with compressed air.

In order to avoid electrical damage to the instrument, always plug the external pump module into the monitor when the DRX is powered off. Only after the pump module is fully connected can the DustTrak monitor module be powered on. Always turn off the instrument before disconnecting any cords or tubes.

4.3 Operation

The DustTrak DRX 8533 detects the size of aerosol particles in sampled air optically. Aerosols are drawn into the instrument in a narrow stream, and passed through an optical measurement chamber. Within the chamber, the aerosol stream is directed through a sheet of laser light, which is scattered onto a photodetector by particles in the stream. This scattered light from the particles allows the detection of the size of particles.

The internal optics are protected from dust by a sheath of filtered air around the aerosol stream. A fraction of the air drawn in through the inlet is split off, filtered through a HEPA filter, and directed back around the aerosol stream. This sheath of particulate-free air isolates the aerosol stream from the sensors and optics. An additional filter downflow of the optics protects them from contamination through the exhaust port.

5 INSPECTION AND PREVENTIVE MAINTENANCE

5.1 Equipment

Table 2. Tools and consumables list for field maintenance.

Item No.	Description	Quantity
Tools		
1	Cylindrical Internal Filter	1
2	37-mm Filter Removal Tool	1
3	Small (1/4” or 1/2”) Acrylic Brush	1
4	10” Adjustable Wrench	1
5	Inlet Dust Cap	1
6	Cassette opening tool	1
7	Heat Gun* [Maximo: MX102926]	1
8	Horsehair Brush* [Maximo: MX106583]	1
9	Set of metric Allan wrenches** [Maximo: MX109746]	1
10	Large Bottle Brush** [Can be ordered from Grainger, part no.: 3UUZ3]	1
Consumable items		
11	Lint-Free Cloth	1-2
12	Cylindrical Internal Filter	1
13	Compressed Air [Maximo: MX107548]	1 Canister
14	Kimwipes [Maximo: MX100642]	1 box
15	Formula 409	1 bottle
16	95% Ethanol*	~22 oz. bottle
17	Teflon Tape**	1 roll
18	4” x 6”, 4 mil, clear reclosable plastic bag** [Maximo: MX111032]	1
19	No. 1 Phillips-head screwdriver**	1
20	HEPA filters (for internal pump module)**	2

**Only needed in cold or snowy conditions*

*** Only needed for annual maintenance*

5.2 Subsystem Location and Access

The DustTrak DRX 8533 is located in the environmental enclosure on the top level of the tower (**Figure 1**). A chimney on the outside of the NEMA enclosure indicates the approximate location of the DustTrak. Inside the enclosure the DRX and the external pump are mounted on the topmost sliding rack, and secured to the rack by straps (**Figure 2**).

5.3 Maintenance Procedure

Table 3. DustTrak DRX Aerosol Monitor 8533 sensor maintenance frequency checklist.

	Maintenance	Bi-Weekly	Quarterly	Annual	As Needed
DustTrak DRX Aerosol Monitor 8853					
	Visual Inspection	X			
	Perform Zero Check	X			X
	Clean Inlet	X			X
	Replace Cylindrical Internal Filter				X
	Clean Mesh Filter	X			
	Clean Chimney			X	
External Pump Module					
	Visual Inspection	X			
	Replace HEPA Filters			X	
	Replacement				X
Visual Inspection			X		

See page 47 of ER [01] and AD[04] for a comprehensive table of required and recommended preventive maintenance schedules.

5.4 Bi-Weekly Maintenance Procedure

Table 4. Biweekly maintenance procedure figures.

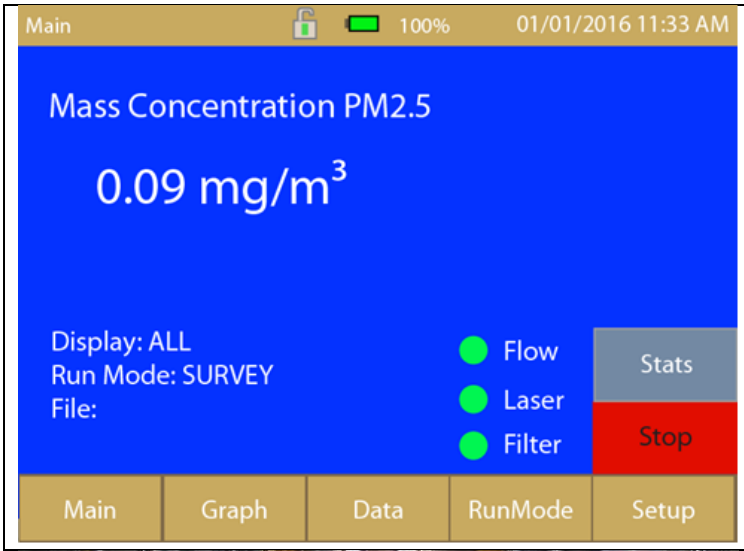
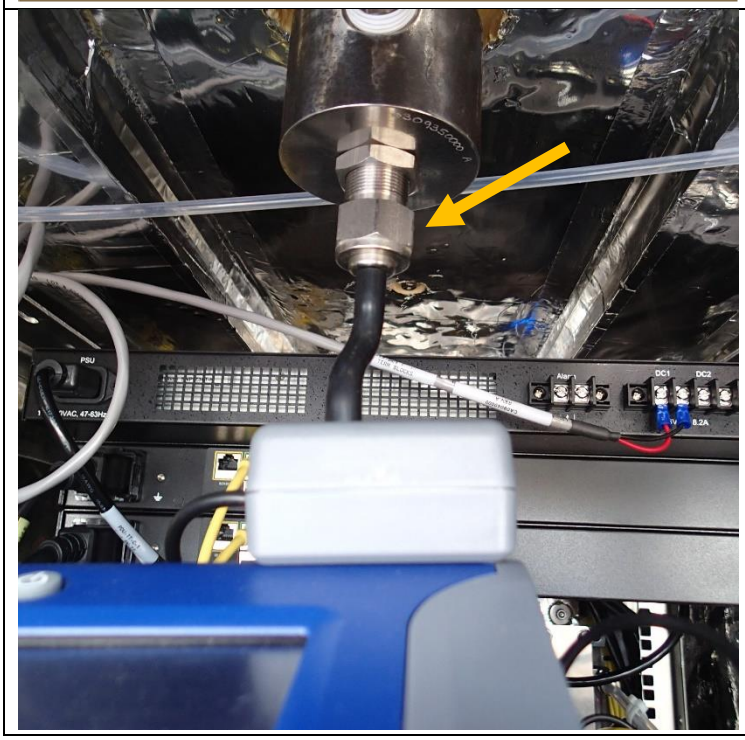
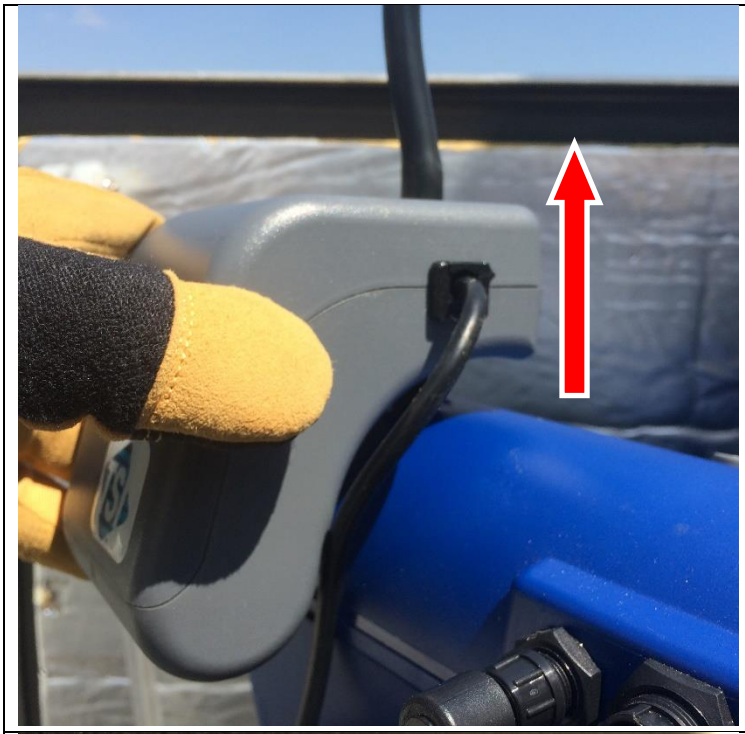
	**Figure 6.** The main screen while the instrument is running. Selecting "Stop" will halt sampling. Once sampling has stopped the power button can be pressed to turn the instrument off.
	**Figure 7.** The air intake from the chimney to the instrument. An auto-zero module (the grey box) is attached to the instrument inlet. After powering down the instrument, and before working on the instrument, the tubing should be disconnected from the chimney at the nut (indicated by an arrow).

	**Figure 8.** An Ethernet cable, located on the left side of the instrument, should also be disconnected prior to working on the instrument.
	**Figure 9.** Disconnect the power supply to the pump from the DRX module by unscrewing the cable a quarter turn.

Figure 10. At the back of the instrument the external pump module is plugged into the instrument exhaust via a quick connect. Pressing down on the metal tab and pulling will decouple the flow tube to the external pump.

Figure 11. Access to the pump's internal filters is through a door at the rear of the instrument, as indicated by the arrow. Both the auto zero unit and the exhaust port adapter need to be removed before the access door can be opened. (The other access door is for the battery compartment, and is unused for this instrument).

	**Figure 12.** To access the filter compartment the auto zero unit must be removed. Pulling firmly up on the unit will detach it from the instrument. The cord from the DustTrak to the auto zero module can also be unplugged.
	**Figure 13.** Place the dust cap from the tool pouch (item #6) on the inlet to the DRX, to keep dust out during the rest of the maintenance procedure.

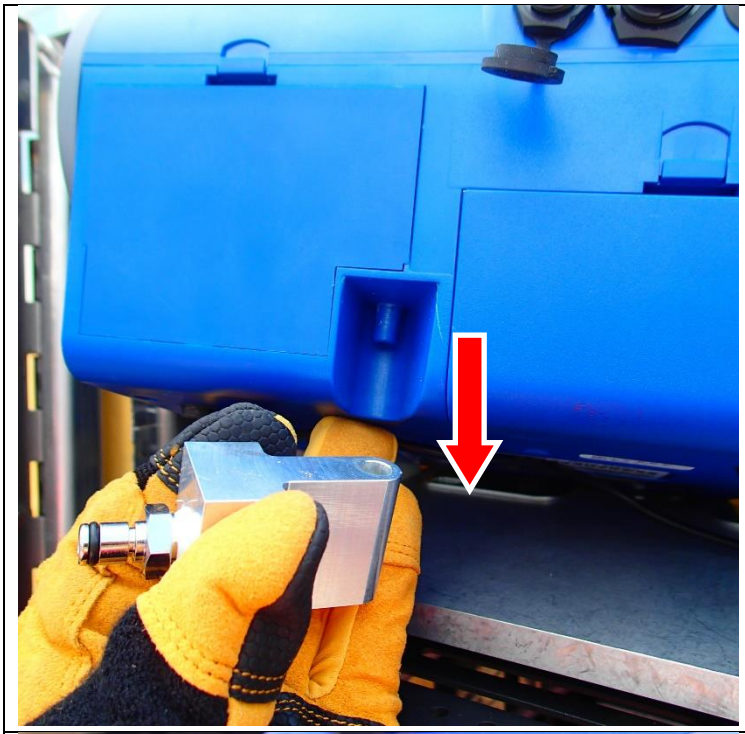


Figure 14. Removing the exhaust port adapter is also necessary to access the filter compartment. Pulling down on the adapter will disconnect it.

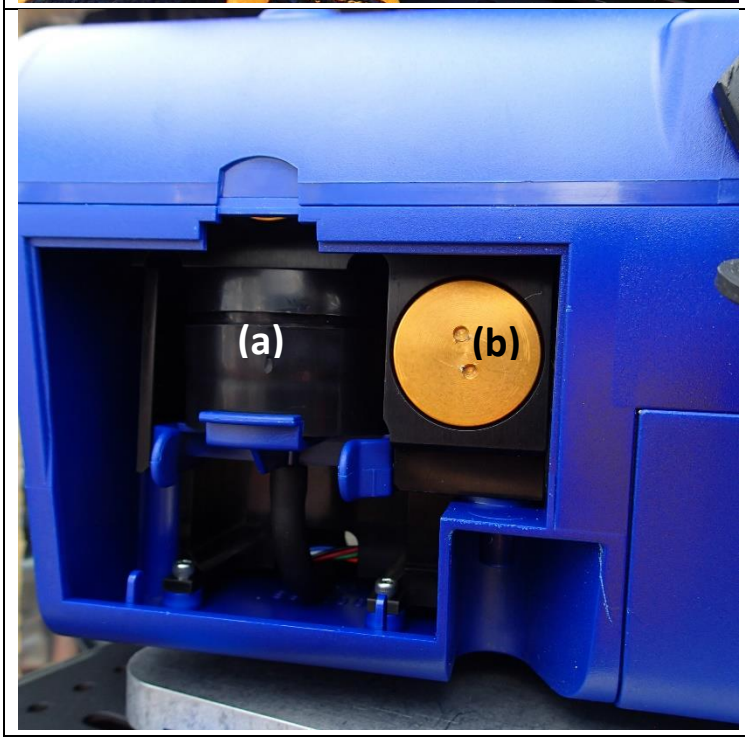


Figure 15. The interior of the filter compartment. The mesh filter is located in the cassette (a), while a cylindrical internal filter is located beneath the brass plate (b).

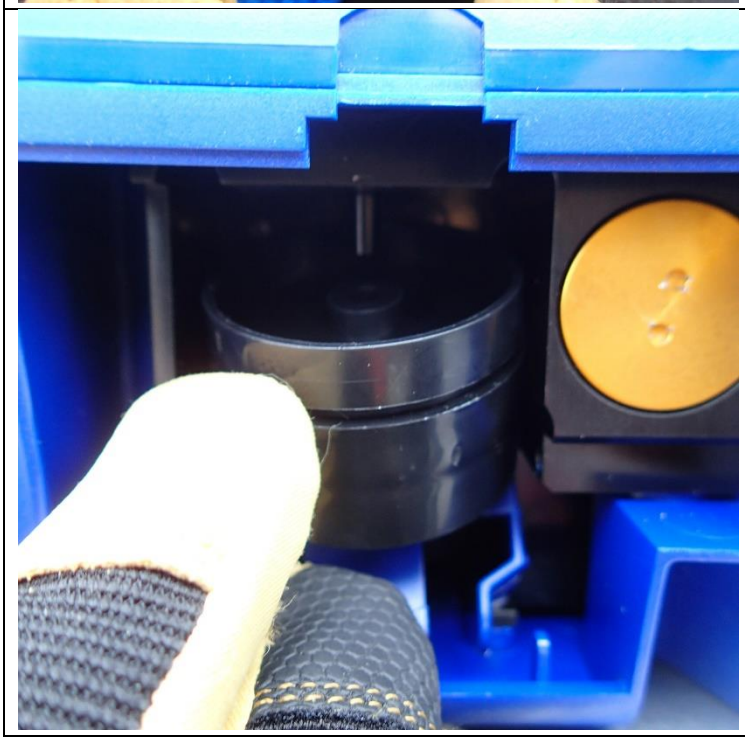
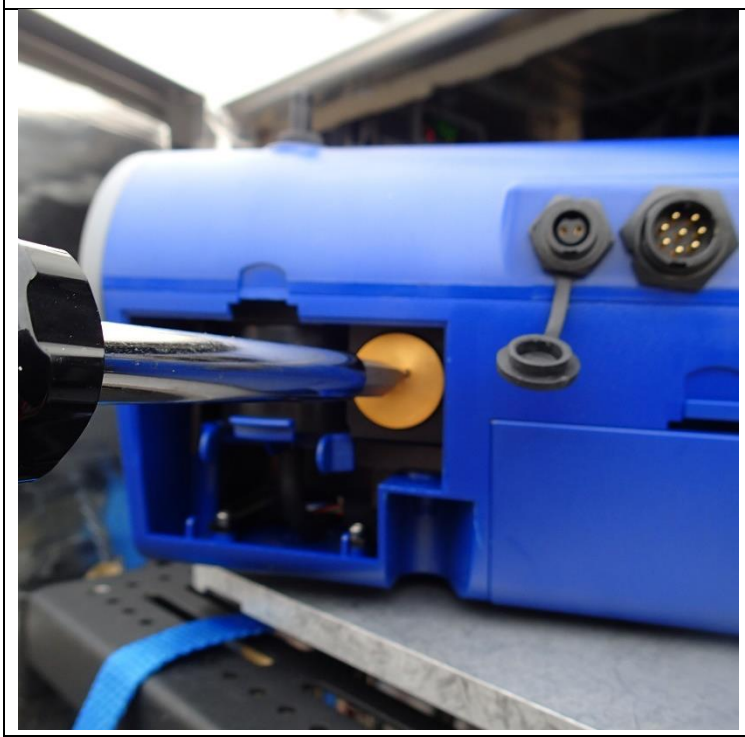
	**Figure 16.** Access the gravimetric filter cassette by first pinching the two blue tabs at the bottom of the cassette (shown), then pushing down on the middle tab. The retention clip should swing down.
	**Figure 17.** Once the retention clip is released, the cassette can be removed by pulling it down and outward.

	**Figure 18.** To open the cassette, slide the aluminum cassette opening tool (item #6) into the slot running around the cassette and press. The cassette should pop open.
	**Figure 19.** Take the mesh filter out of the enclosure, and blow both sides of the filter and the inside of the cassette off with compressed air.

	**Figure 20.** Also blow both halves of the cassette out with compressed air.
	**Figure 21.** Close the cassette by pressing the two halves together. Check that the cassette is fully closed by measuring around it with the filter tool, as shown.

	**Figure 22.** Locate the filter removal tool (item #1) in the tool pouch for the DRX.
	**Figure 23.** Access the cylindrical filter by unscrewing the brass plate with the two-pronged filter removal tool.

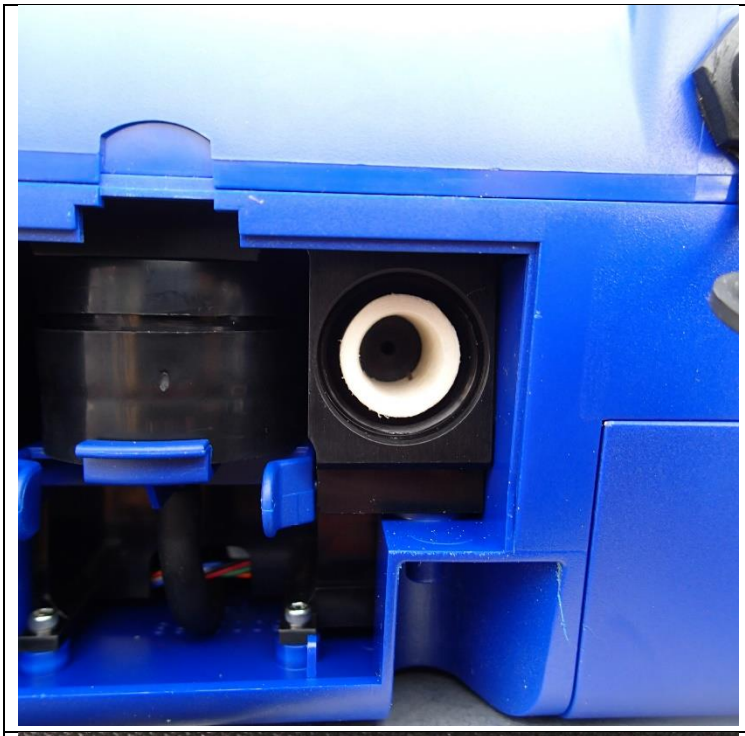
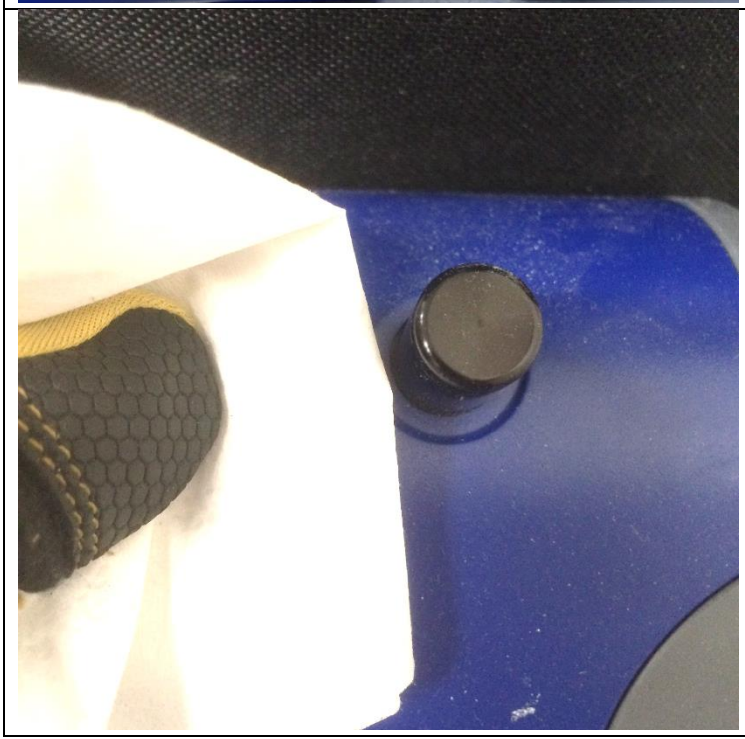
	**Figure 24.** The cylindrical filter can now be pulled out and replaced with a fresh one. While the filter is out, the filter compartment may be blown out with compressed air.
	**Figure 25.** Wipe the area around the inlet (under the auto zero unit) with a Kimwipe dampened with 95% ethanol.

	**Figure 26.** Unscrew the inlet from the instrument
	**Figure 27.** Using a brush dampened with 95% ethanol, bush the dirt from the inlet. Let it dry thoroughly before inserting back in the instrument.

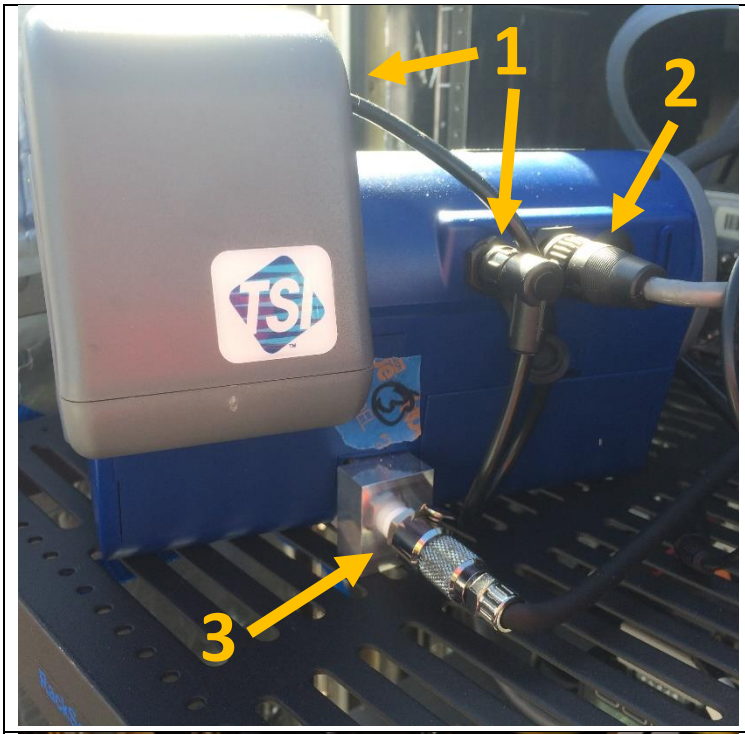


Figure 28. After performing maintenance on the DustTrak, be sure to plug all the connectors back into the back of the DRX module: They are

1. The zero module and its power cable
2. Power to the pump module
3. The tubing from the exhaust port to the external pump

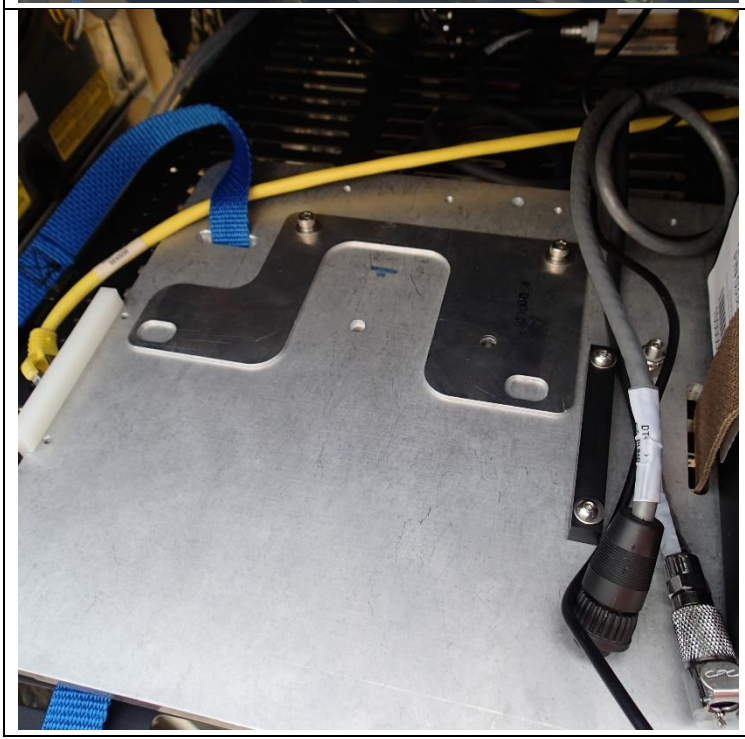


Figure 29. The bracket below the DRX module. The bracket captures two of the feet of the instrument, and provides some protection against falling when the strap is undone.

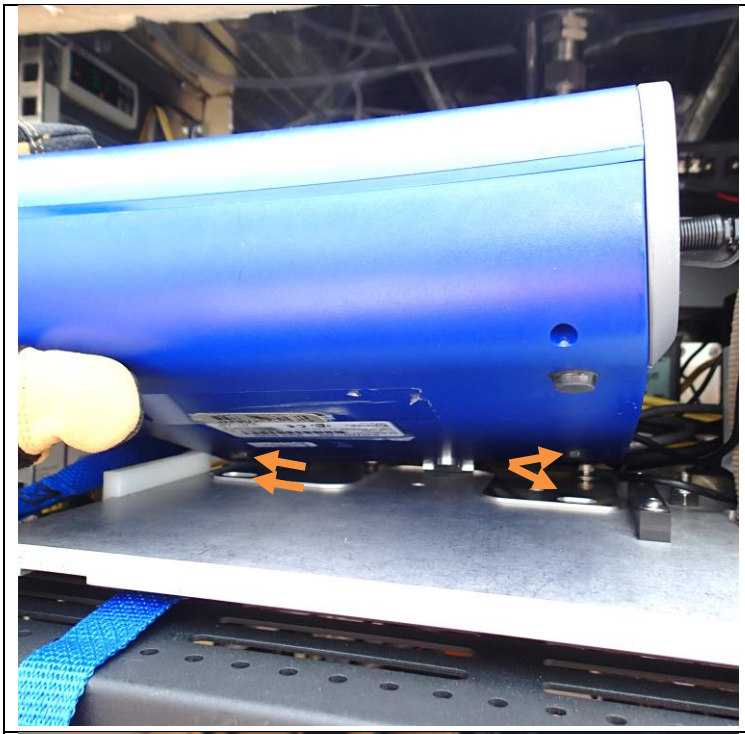
	**Figure 30.** When returning the DRX module to the tray, be sure to align the feet with the holes in the bracket, as indicated by the arrows.
	**Figure 31.** Be sure to strap the DRX module down once it has been returned to the tray. Slide the tray back into the enclosure, and be sure to plug the Ethernet cable back into the DRX Module (**Figure 8**) and reconnect the zero module to the chimney (**Figure 7**).

	**Figure 32.** Wipe the bottom cowl on the chimney clean with Formula 409 on a lint-free cloth.
	**Figure 33.** Check the guy wire tension on the chimney. If they seem loose, use the adjustable wrench on the tensioners until the wire barely deflect when pushed, as shown in the photo.

Figure 34. The guy wire tensioners (indicated by arrows) should be adjusted if the guy wires have poor tension.

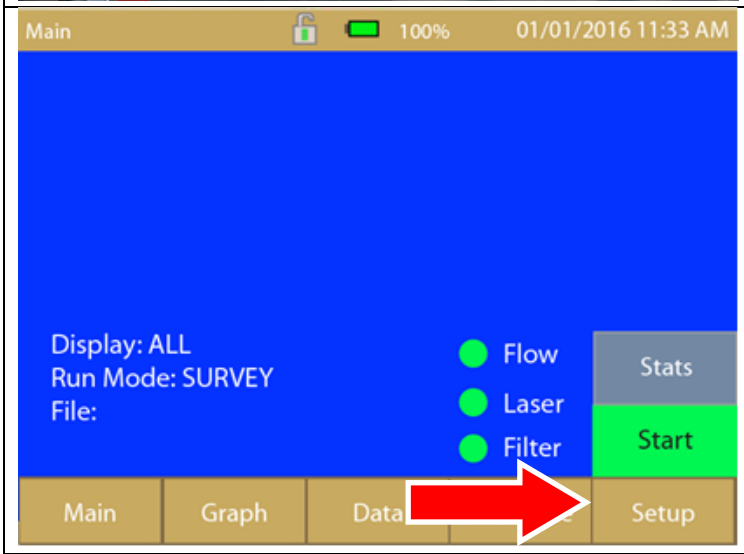


Figure 35. The main screen. Selecting "Setup" in the bottom right corner of the screen will open the setup page.

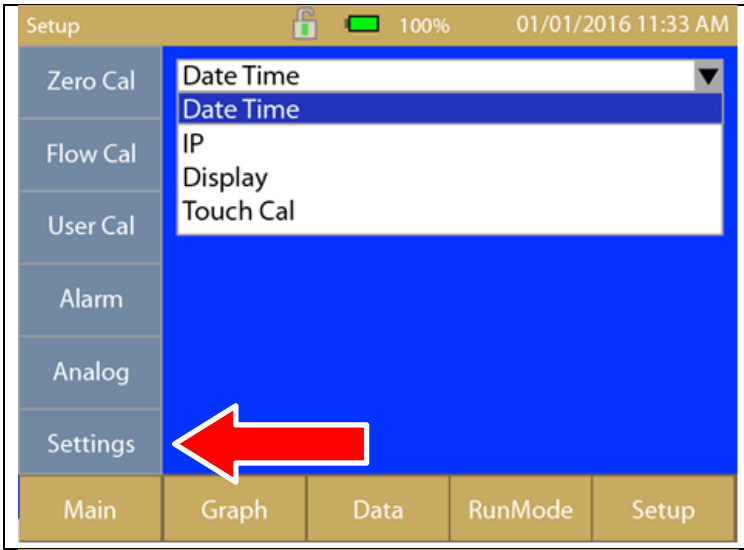


Figure 36. The selecting "Settings" will bring up a screen where network and date/time information can be accessed, as well as screen settings.

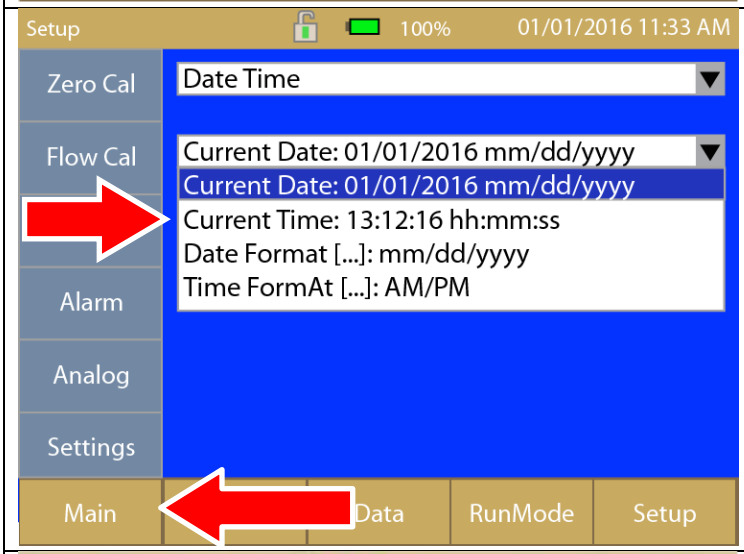


Figure 37. The current time (to the second) can be viewed from the dropdown menu. Do not change any settings here; if the time differs from the reference clock by more than a minute submit a JIRA ticket.

Return to the main screen by selecting "Main" in the lower left corner.

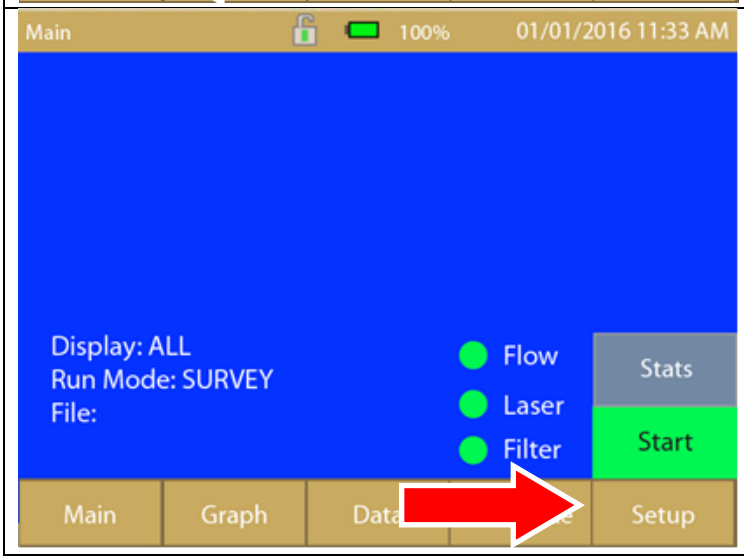


Figure 38. Begin zeroing the instrument by selecting setup in the lower right corner of the main screen.

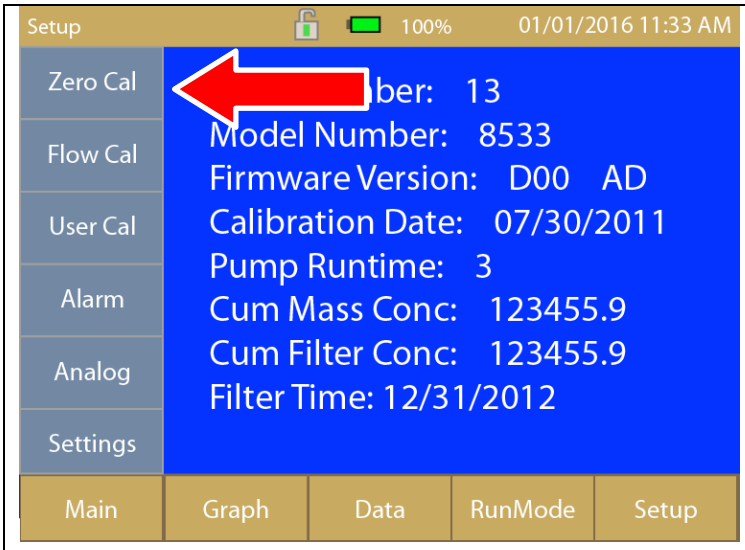


Figure 39. Press "Zero Cal", then press "Start" on the dialogue that appears. A countdown will appear as the unit calibrates.

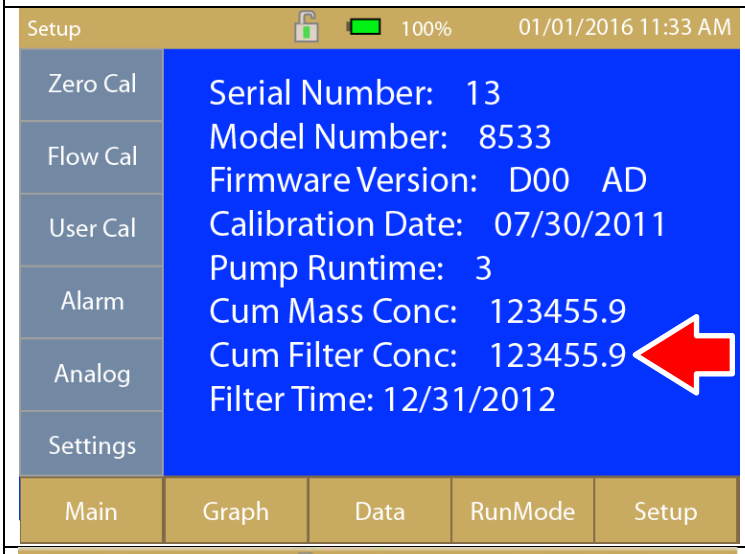


Figure 40. Once the zero calibration is done, return to the setup screen and select the "Cum Filter Conc" text. A dialogue to reset the filter concentration value will open. Select "OK", then "Yes" to reset this value.

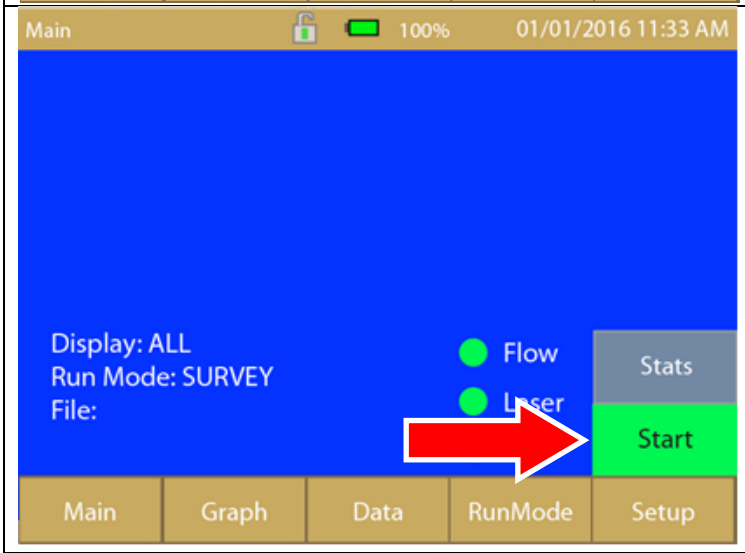


Figure 41. When the instrument has been fully reassembled and configured, resume sampling by pressing the "Start" button.

5.4.1.1 Powering Down the Instrument

Before moving, cleaning, or disconnecting cables from the DustTrak, it must be powered down. To do this first press the red "Stop" button in the lower right-hand corner of the screen (**Figure 6**), then press the power button (**Figure 4a**), and confirm that you want to power the instrument down in any dialog that appears.

5.4.1.2 Freeing the instrument from the tray

After powering the instrument down, the strap securing the instrument to the tray may be removed. Note that before the tray can be fully extended, the connection to the chimney (**Figure 7**) and Ethernet cable (**Figure 8**) must be undone. The DRX module sits in a bracket (**Figure 30**), which provides some extra security while the DRX module is unstrapped. When strapping the module back into the bracket, be sure to align the rear-two feet of the instrument with their respective holes, as shown in **Figure 30**.

5.4.1.3 DRX Module Filter Maintenance

To access the 37-mm filter cassette and the cylindrical internal filter, both the auto zero unit and exhaust port adapter must be removed. The zero unit is removed by pulling up on the unit (**Figure 12**), while the exhaust adapter can be removed by pulling down on the unit (**Figure 14**). Once cleared of these obstructions, the filter department door can be opened (**Figure 11**).

1. Cleaning the 37-mm Filter Cassette
    a. Open the blue retention clip by pinching ends inward and pushing down (**Figure 16**).
    b. Remove the 37-mm filter cassette by pulling downward and outward (**Figure 17**).
    c. Open filter cassette using the cassette-opening tool (**Figure 18**).
    d. Remove the screen mesh from filter cassette (**Figure 19**).
    e. Blow out using compressed air. Blow out in reverse direction to remove captured particulates.
    f. Blow the cassette out with compressed air.
    g. Place the mesh filter back in the cassette and press halves together. Ensure filter has been fully closed, using the filter tool (**Figure 21**).
    h. Place filter cassette back into position and close blue retaining clip by pushing up.
2. Replacing Cylindrical Internal Filter
    a. Use the Filter Removal Tool (item # 2) to unscrew the filter cap (**Figure 22**).

b. Pull out the single cylindrical internal filter from the filter well. If the filter well is visibly dirty, blow out with compressed air.

c. Put a new cylindrical internal filter back into the filter well

d. Screw filter cap back into place.

Once the filter compartment door is replaced, slide the auto zero unit and exhaust port adapter back onto their respective ports. Once the instrument has been powered on again, the filter counter must be reset (see section 5.4.1.9).

5.4.1.4 Cleaning the Inlet

1. Remove the auto zero module by pulling it straight up off the DRX (**Figure 12**), if it is attached.
2. Put the dust cap (item # 5) in the inlet (**Figure 13**).
3. Clean the inlet port:
    a. Use a Kimwipe dampened with 95% ethanol to clean the outside of the inlet port (**Figure 25**).
    b. Unscrew the inlet nozzle from the instrument (**Figure 26**). Use a small acrylic brush dampened with 95% ethanol to clean the inside of the sample tube (**Figure 27**).
    c. Dry the tube by blowing it out with compressed air or let it air-dry thoroughly. Do not use compressed air to dry the area around the inlet port, and be mindful of keeping dust from entering the inlet port.
4. Screw (hand-tighten) inlet back into instrument and return the auto zero module to the instrument inlet.

5.4.1.5 Other Cleaning

In case of precipitation or dust storms, no internal maintenance (operations requiring the instrument itself to be opened) should take place. Inspections and cleaning should still be performed, except when obviously not beneficial (no need to wipe moisture off of the chimney when it is raining or snowing, for example).

Snow

While precipitation should not make it into the DustTrak itself, accumulated snow may still interfere with airflow into the instrument.

1. Power down the instrument as outlined in section 5.4.1.1.

2. Brush snow from the top of the chimney with a horsehair brush.
3. Use a horsehair brush to brush off any snow accumulated on the lower cowl.

Ice

In the case of ice buildup at the chimney cowls, only the lower cowl needs cleaning, unless there are icicles hanging from the upper cowl that may disturb airflow into the instrument. To clean ice off the instrument:

1. Power down the instrument as outlined in section 5.4.1.1.
2. Icicles hanging anywhere on the chimney may be broken off
3. An ice sheet on the lower cowl can be removed with ethanol:
    a. If the ice sheet is thin, spray the iced area with 95% ethanol. If it is a thick sheet of ice, use a heat gun.
    b. Allow the ice to melt
    c. Wipe the cowl clean with a lint-free cloth
4. Loose ice can simply be swept off the cowl with a lint-free cloth or camelhair brush

Insect Nests

Insect nests may form on the lower cowl or further inside the SSI. They should be removed as follows:

1. Power down the instrument as outlined in section 5.4.1.1.
2. Use a lint-free cloth to remove as much of the nest or web as possible
3. Wipe the SSI down with a lint-free cloth dampened with Formula 409 to remove any other remnants of the nest or web.

5.4.1.6 Cleaning the Chimney

1. Power down the instrument as outlined in section 5.4.1.1.
2. Remove any debris from the mesh screen at the top of the chimney.
3. Dampen a lint-free cloth with Formula 409.
4. Wipe the bottom cowl clean with the cloth (**Figure 32**).

5.4.1.7 Reassemble and reconnect the instrument

After external maintenance is complete, all cables must be reconnected prior to powering the instrument on. Specifically, the following must be connected:

- Instrument Power cable (**Figure 4c**)
- Auto Zero Cable (**Figure 5a**)
- External Pump Power Supply (**Figure 5b**)
- External Pump Flow Tube (**Figure 10**)
- Connection from inlet to chimney (**Figure 7**)
- Ethernet Cable (**Figure 8**)

The first four cables can be connected before the instrument is secured to the tray, but the Ethernet cable and connection to the chimney can only be connected after the instrument has been secured to the tray and the tray has been pushed back into the enclosure. After the first four cables are connected, place the DRX module back onto its bracket (**Figure 29**). Be sure that the rear feet of the DRX module fit into their appropriate holes in the bracket (**Figure 30**). Strap the instrument down, push the tray in, connect the last two cables, and power the instrument back on by pushing the power button. Be sure to screw the tray back into the frame (**Figure 3**).

5.4.1.8 Date and Time Verification

As part of a visual inspection of the instrument, the date and time settings should be checked for agreement with the time at the LC. Login to the LC at your site using PuTTY. In the terminal window, type the following command to view the current LC time:

```
watch -n0.1 'date +%T'
```

The time reported in the console is Coordinated Universal Time (UTC), so when verifying the time please keep this in mind. See Appendix Section 7.1 for a list of US time zones and the offsets from UTC. To exit the time display in the terminal and execute other commands, press control-C.

If you are unable to access the timestamp data from the LC or GPS at your site, your cellphone may be used to verify the time on the DRX module. Remember the DustTrak will be in UTC time, but you (almost certainly) are not. If you are unable to use a cell phone, a GPS with a good position fix may also be used.

While the time is displayed on the title bar of the instrument, seconds are not displayed there. To view the current instrument time with seconds:

1. Enter the Settings screen from the setup menu (**Figure 35**).
2. Select “Date Time” from the dropdown menu (**Figure 36**).

3. By opening the second dropdown menu, the current time with seconds should be visible (**Figure 37**).

Do not change any date or time settings – submit a JIRA ticket if there is a discrepancy in the times greater than 1 minute.

5.4.1.9 Zeroing Instrument and Resuming Sampling

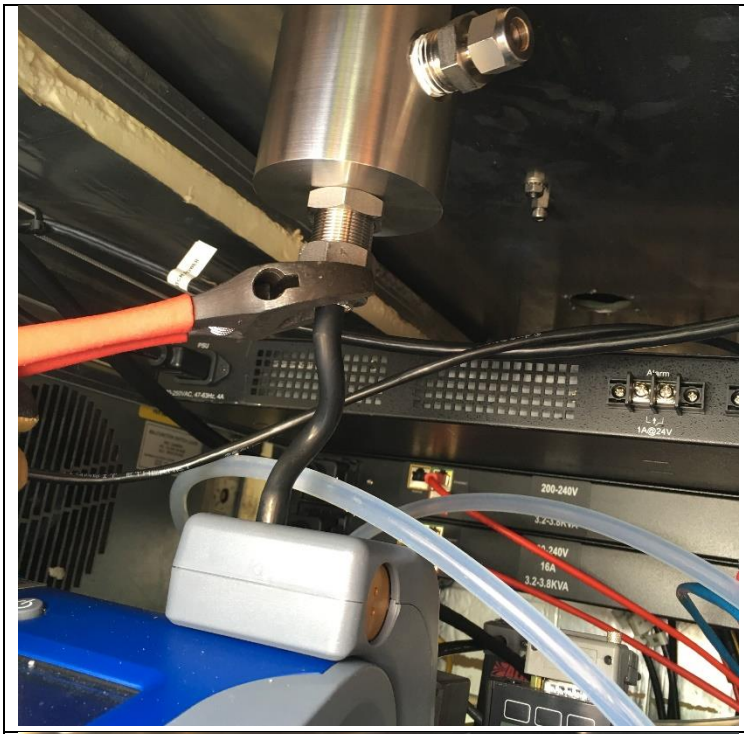
A zero check must be performed on the instrument before resuming sampling after the instrument has been powered off. With the auto zero unit installed, the instrument can be zeroed by simply pressing "Setup" on the main screen (**Figure 38**). Within the setup menu, select the "Zero Cal" button, and press "Start" to begin the calibration (**Figure 39**). A count-down clock will appear displaying the time until calibration is complete. When finished calibrating, the screen will read "Zero Cal Complete".

After the instrument has been zeroed, the cumulative filter concentration ("Cum Filt Conc") value must be reset, and sampling must be resumed.

1. Press the "Setup" button to go into the setup screen
2. Touch the "Cum Filter Conc:" (the text) to reset this statistic (**Figure 40**)
3. *Replace user serviceable filters?* Dialog will appear. Press "OK"
4. *Reset filter concentration?* Dialog will appear. Press "Yes" to reset the cumulative filter concentration to zero.
5. The Setup screen will now show zero for the Cum Filter Concentration and the current date for the Filter Time.
6. Return to the Main screen by selecting "Main" in the bottom left corner of the Setup screen (**Figure 40**)
7. Press the green "Start" button in the bottom right of the screen. Sampling will resume automatically (**Figure 41**).

5.4.2 Annual Maintenance

Table 5. Annual Maintenance Figures.

	**Figure 42.** Disconnect the air inlet from the chimney by unscrewing the nut with the help of an adjustable wrench. If the tubing is a hindrance to disconnecting the inlet, it can be pulled off the barbed tailpiece directly below the nut.
	**Figure 43.** Unscrew the manifold at the base of the chimney. This can be done by hand, but if the manifold is particularly stubborn it can be unscrewed with the help of tongue and grove plyers or an adjustable wrench.

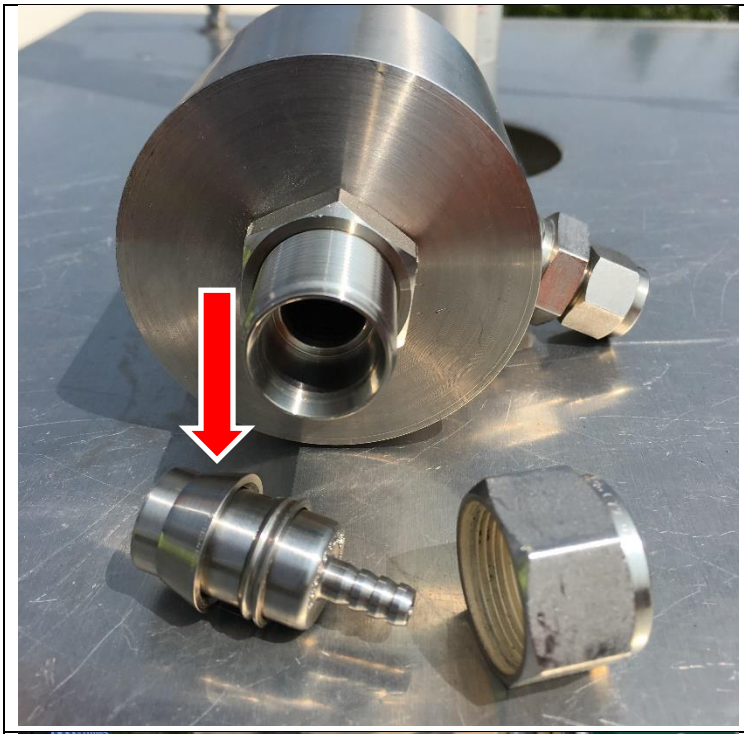


Figure 44. The manifold, barbed tailpiece, and nut from the bottom of the chimney. The ferule of the compression fitting (arrow) is free, so be careful not to lose it.

Figure 45. Blow the manifold out from the bottom with compressed air.

	**Figure 46.** Blow the manifold out from the top with compressed air as well.
	**Figure 47.** Using a small acrylic brush (or small bottle brush) remove any accumulated dust from around the tube inside the manifold.

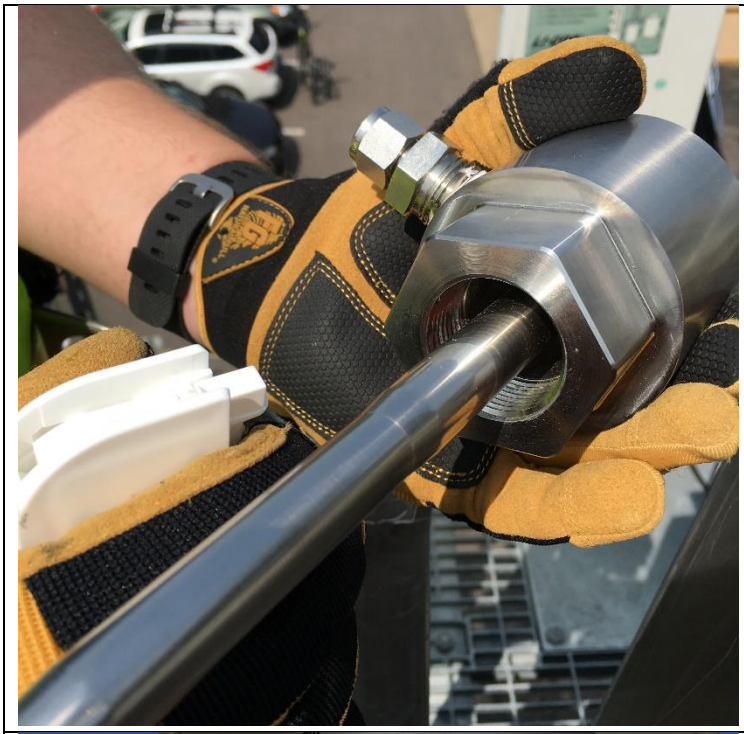
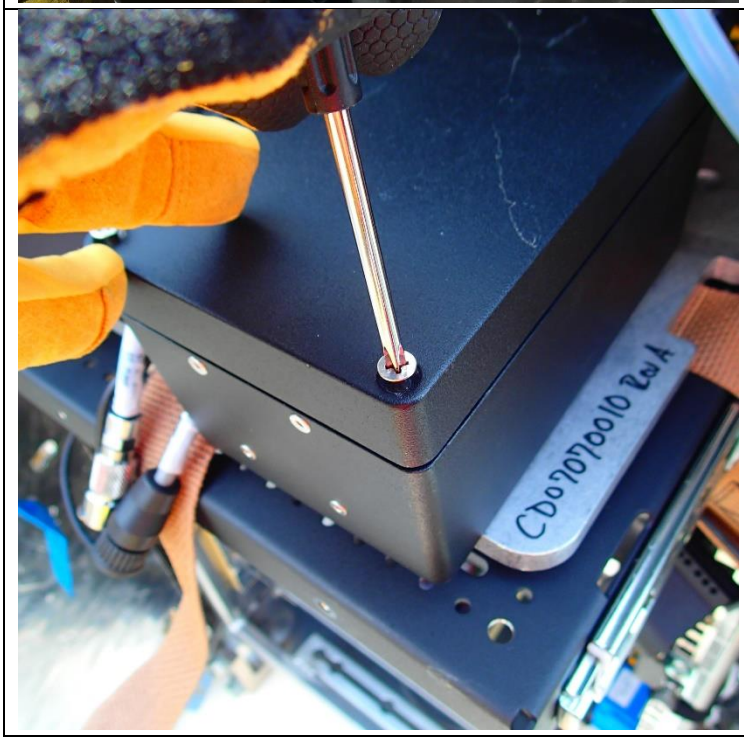
	**Figure 48.** Use compressed air to blow dust from the inside of the manifold.
	**Figure 49.** Use an Allen wrench to loosen the collar below the chimney top.

Figure 50. The top of the chimney can then be lifted free.

Figure 51. Place a plastic bag or small container below the bottom of the chimney to collect any dirt that comes loose while cleaning.

	**Figure 52.** Using a large bottle brush, scrub the inside of the chimney down.
	**Figure 53.** With a large bottle brush, also clean the inside of the chimney top.

	**Figure 54.** Use compressed air to blow out the inside of the chimney top.
	**Figure 55.** Also blow the chimney top out from between the cowls.

	**Figure 56.** Use a lint-free cloth dampened with Formula 409 to wipe down all external surfaces of the chimney top before reassembling the chimney.
	**Figure 57.** To access the HEPA filters inside the external pump module, unscrew the four screws on the top of the pump module.

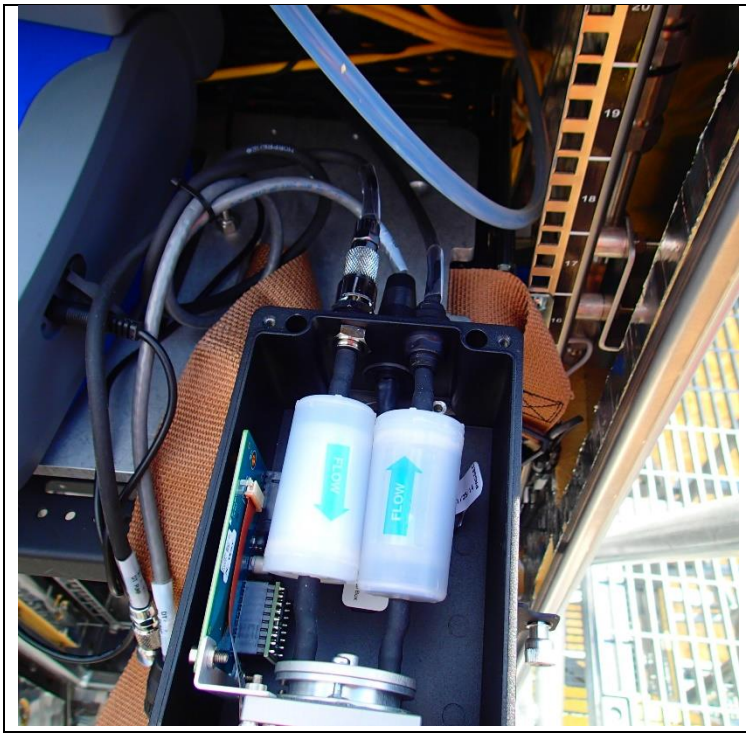


Figure 58. Once opened, the filters can be removed by simply pulling the black tubing from the filter cartridges. New filters can be installed by slipping the tubing over the ports of the new cartridges. Be sure to match the flow directions.

5.4.2.1 Cleaning the Chimney

Once a year built-up dust should be removed from the entire chimney assembly.

1. Ensure that the instrument is properly powered down (see section 5.4.1.1)
2. Using an adjustable wrench, disconnect the inlet tubing from the chimney (**Figure 42**). If the inlet tubing is becoming kinked or is inhibiting the removal of the nut, it can be disconnected from the barbed tailpiece.
3. The manifold at the bottom of the chimney may now be removed. Unscrewing it by hand is possible, though a pair of tongue and groove plyers or an adjustable wrench may be employed, if needed (**Figure 43**).
4. Blow the manifold out from the bottom with compressed air (**Figure 45**).
5. Also blow the manifold out from the top with compressed air (**Figure 46**).
6. Using a small acrylic brush, clean the inside of the manifold out as shown in **Figure 47**.
7. Blow the interior surfaces of the manifold off with compressed air (**Figure 48**).
8. Use an Allen wrench to loosen the collar below the chimney top (**Figure 49**). The top assembly of the chimney can now be lifted out of the column (**Figure 50**).

9. Before cleaning the portion of the chimney still attached to the environmental enclosure, place a plastic bag or small container below the chimney inside the environmental enclosure to catch any dirt (**Figure 51**).

10. Using a large bottle brush, brush out the inside of the chimney (**Figure 52**).

11. Also using the large bottle brush, clean out the inside of the chimney top (**Figure 53**).

12. Use compressed air to clean out the chimney top (**Figure 54** and **Figure 55**).

13. Wipe down the exterior surfaces of the chimney top with a lint-free cloth dampened with Formula 409 (**Figure 56**).

14. Reassemble the chimney:

    a. Place the chimney top back in its collar, and tighten the collar down

    b. Screw the manifold back into place at the bottom of the chimney inside the environmental enclosure. Note the condition of the Teflon tape on the chimney bottom (**Figure 43**); removing the old and applying new if needed.

    c. Reconnect the compression fitting to the bottom of the manifold, and the inlet tubing to the barbed tailpiece if that was disconnected.

5.4.2.2 Replacing the Filters in the External Pump Module

There are two HEPA filters within the pump that protect the pump from contamination – one on the suction side of the pump and the other on the discharge side of the pump. The discharge side of the pump collects particles shedding from the vanes of the pump and will turn black over time.

1. Remove the strap attaching the pump module to the tray. Open the top cover of the pump module by unscrewing the four screws in the corners (**Figure 57**).

2. Disconnect the soft tubing between the filters, pump, and the casing connector (**Figure 58**)

3. Remove old filters and dispose of them

4. Replace with new filters, being sure to match the flow directions.

5. Replace the top of the pump module and screw back in place.

6. Plug the quick connect tubing and power cable back into the DRX, if they were removed. Re-secure the module to the tray with the strap.

Note: The DRX unit must be turned off before the pump can be disconnected or connected. Always wait to power on the DRX until after the pump has been properly connected.

6 REMOVAL AND REPLACEMENT (SUBSYSTEM ONLY)

Table 6. Tools, consumables, and resource lists for removal and replacement of the collector.

Product No.	Description	Quantity
Tools		
	10” Adjustable Wrench	1
	Tongue and Grove Plyers	1
	Allen Wrench	1
	Large Bottle Brush	1
	Screwdriver	1
Consumable items		
	Gloves	1
	95% ethanol	A/R
	Kimwipe(s)	A/R
	Compressed air	1
	Lint-free cloth	A/R
	Formula 409	1
	Plastic Bag or Small Container	A/R
Resources		
CD07280000	Guy Wires and Clamps	A/R
CD07110020	Above Roof Flow Path	A/R
CD07070000	Assembly, Particle Size Sensor Tray System	A/R
0332740000	Tube, ISO Down Flow, Particle Size, Length 22.219 Inches	A/R
	Carrying Case (Original package shipped from CVAL to Domain)	1
NA	VELCRO® Strap (accessory kit)	A/R

Note: It is recommended to take back up tools and consumables up the tower in the event of dropping the original tools/consumables.

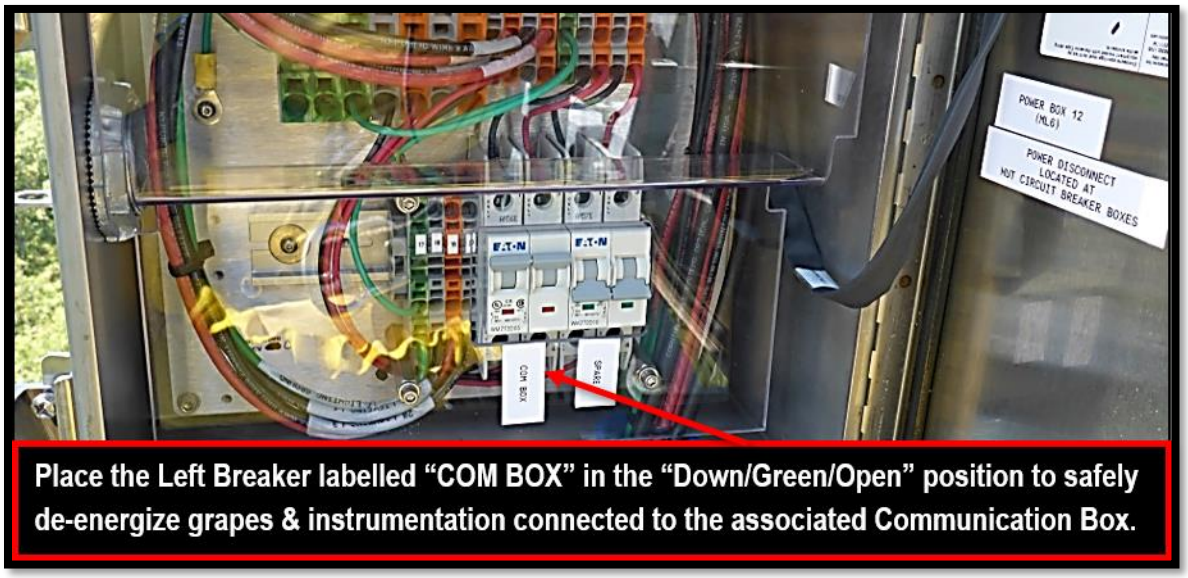
6.1 Removal and Replacement Procedure

The Field Operations Domain Manager is responsible for managing the removal and replacement of the sensors on site. The NEON project Calibration, Validation and Audit Laboratory (CVAL) is responsible for the calibration and validation of sensors, as required.

The Particulate Analyzer – Size requires annual calibration from the manufacturer[1] (NOT CVAL). Once it is time for annual calibration, NEON HQ will notify the Domain office and CVAL will provide a calibrated sensor to swap with the uncalibrated sensor.

In addition, see AD [04], NEON.DOC.002115 NEON *Sensor Command, Control and Configuration (C3) Document: Particulate Analyzer – Size* for sensor field C3 procedures.

WARNING! Prior to connecting or disconnecting sensor cables at the grape, ensure the grape is de-energized by opening the breaker inside the associated tower power box. **FAILURE TO DISCONNECT POWER BEFORE PLUGGING OR UNPLUGGING SENSOR CABLES CAN PERMANENTLY DAMAGE THE EQUIPMENT.**



Before removing, cleaning, or disconnecting cables from the DustTrak, it must be powered down via the sensor software application. To do this, first press the red "Stop" button in the lower right-hand corner of the screen (**Figure 6**), then press the power button (**Figure 4a**), and confirm that you want to power the instrument down in any dialog that appears. This is also displayed below for easy reference.

[1] This sensor is a Class I laser product as defined by U.S. Department of Health and Human Services standards under the Radiation Control for Health and Safety Act of 1968. A certification and identification is established by the manufacturer.

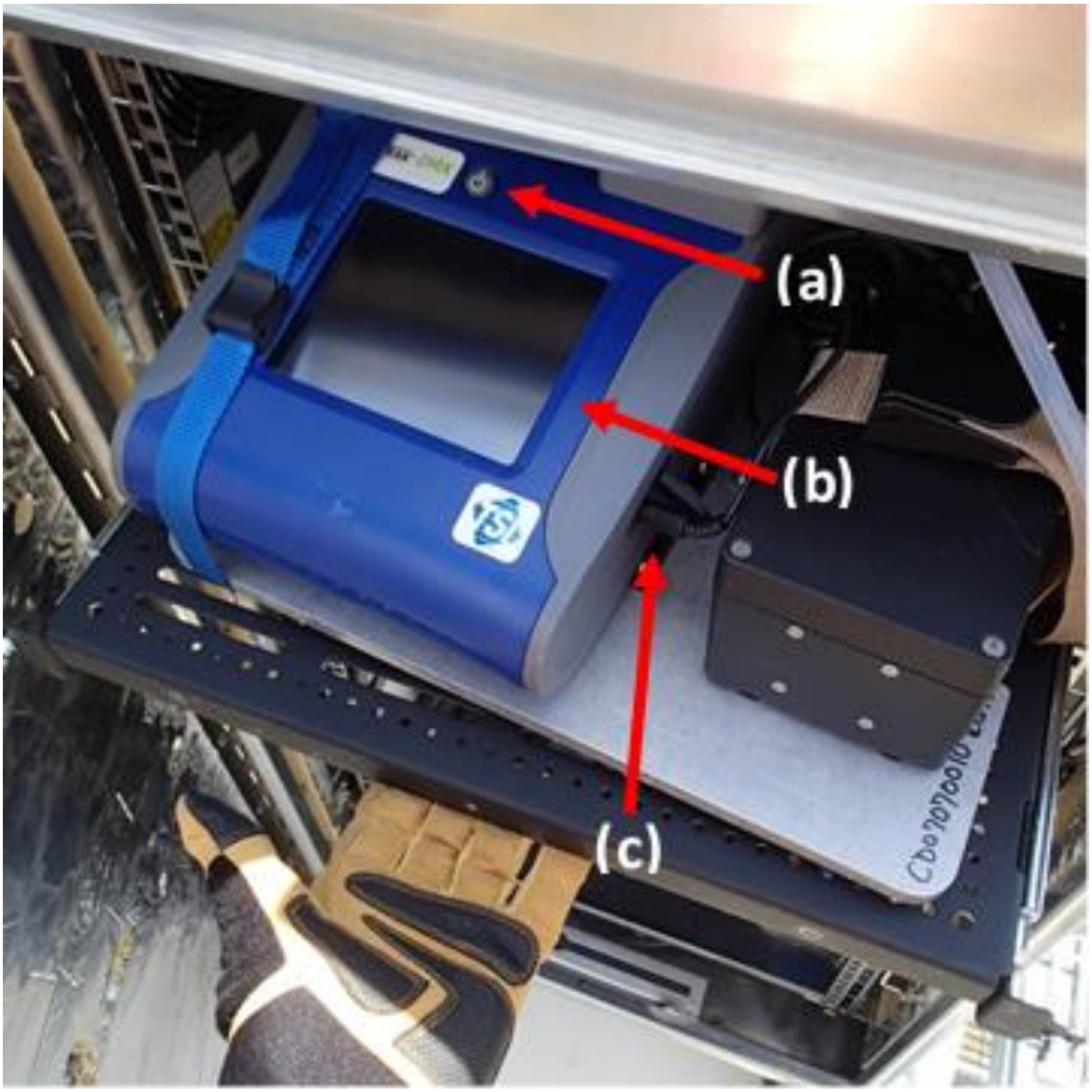


Figure 59. The DustTrak's tray can be pulled out for easier access to the instrument. Lines and tubing from other equipment can snag on the tray, so pull gently. The on/off switch (a) is on the face of the DRX unit above the touchscreen (b). The tower supply to the instrument (c) is on the right side of the DRX, and can should only be removed after the instrument is powered down.

In addition, shut down power via the Communication Box pictured above for the tower top level to power off the sensor to unplug the unit or unit connections from its respective subsystem.

As mentioned earlier, the DustTrak pump (a) and external pump filters (b) are located on the top tray in the enclosure. The tray is secured to an internal frame by locking screws (c). Both units are secured to the tray by straps. A chimney on the outside of the enclosure indicates the approximate location of the DustTrak internally, which is connected via an intake tube.

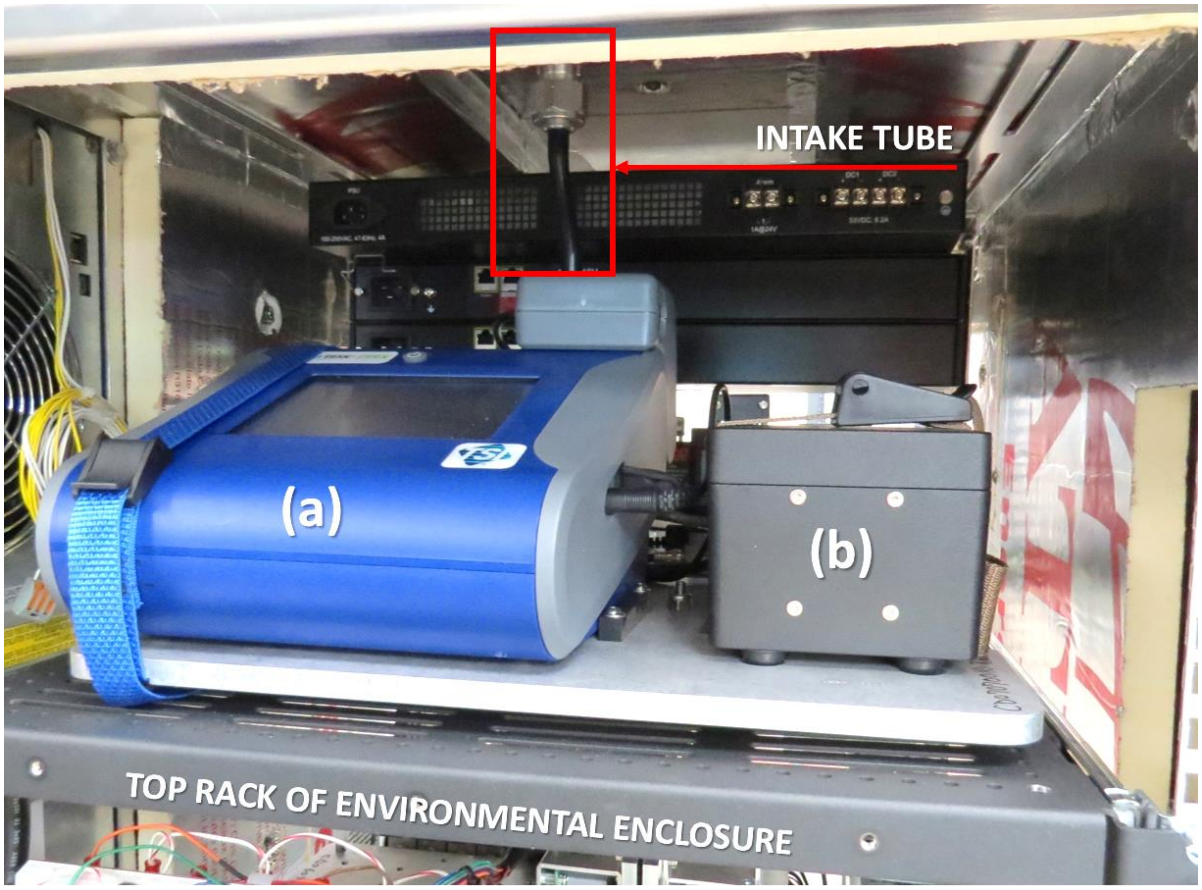


Figure 60. Inside View of NEMA Enclosure for Particulate Analyzer – Size Removal

Disconnect the intake tube inside the enclosure as displayed in **Figure 60** above, **Figure 7**, and **Figure 42** and Ethernet cable in **Figure 8**.

Follow the instructions in **Figure 8-10** to remove the DustTrak unit and external pump filter unit from the enclosure. If the level for the sensor is de-energized via the communications box, unplug the two power cords located on the back of the DustTrak. (Ensure proper Lock Out/Tag Out procedures are followed for powering down that level of the tower to remove the sensor.)

To remove the chimney, reference **Figure 43-44** and **49-51**. Follow this procedure in reverse order to reinstall the sensor and/or reference section 5.3.1.7 – 5.3.1.9. Place all parts of the sensor carefully within its original carrying case.

This sensor subsystem contains one Concord Grape (**Figure 61** and **Figure 62**) to provide power the a Mass Flow Controller (MFC), which maintains and monitors the volume metric flow rate to calculate the

mass flow for the sensor's additional pump (a Rotary Vane Pump).

Power must be shut down to remove the sensor from the Grape to ensure there is no damage incurred to either mechanism.

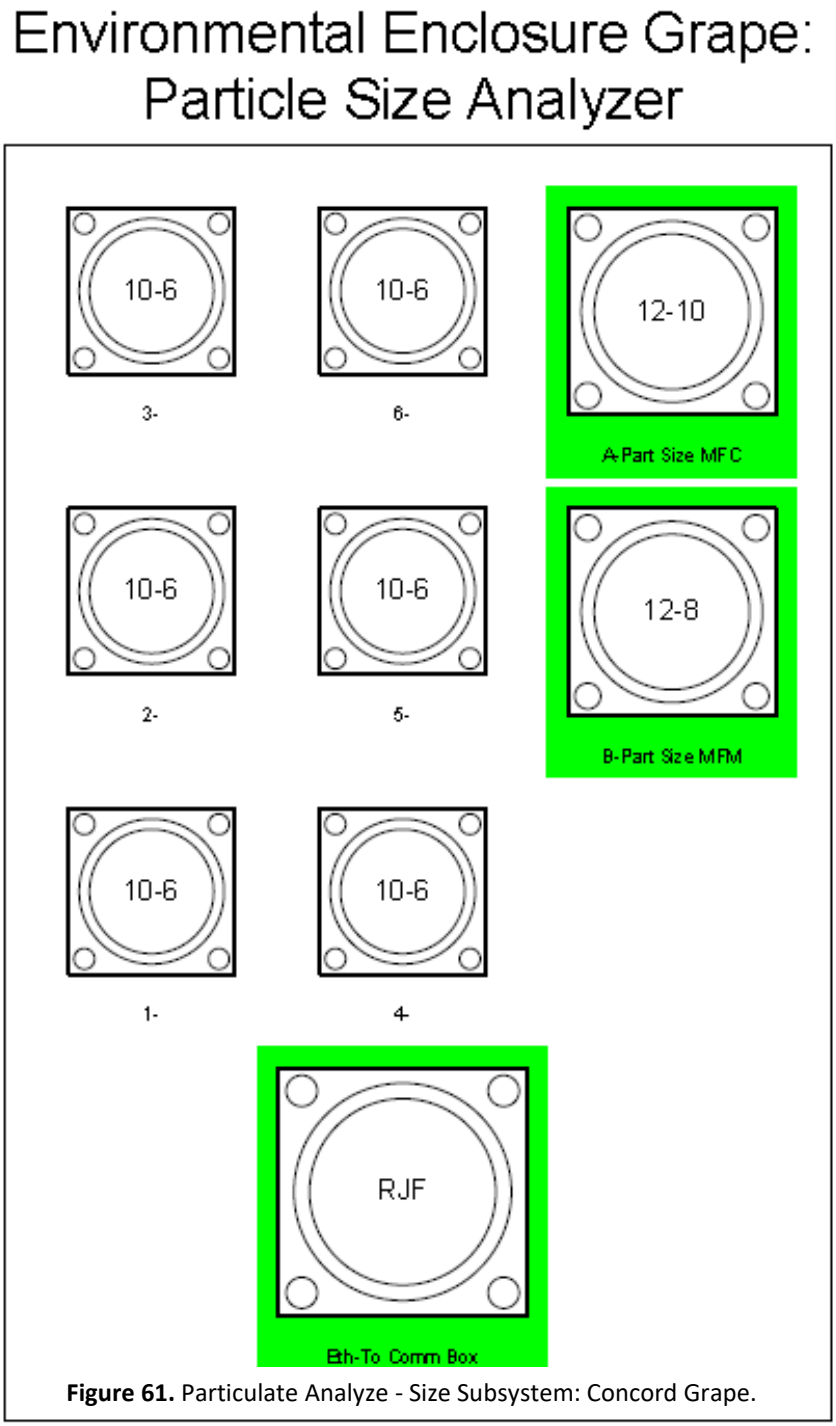


Figure 61. Particulate Analyze - Size Subsystem: Concord Grape.

The Grape is maintained via firmware, which requires updates per the NEON project's headquarters team

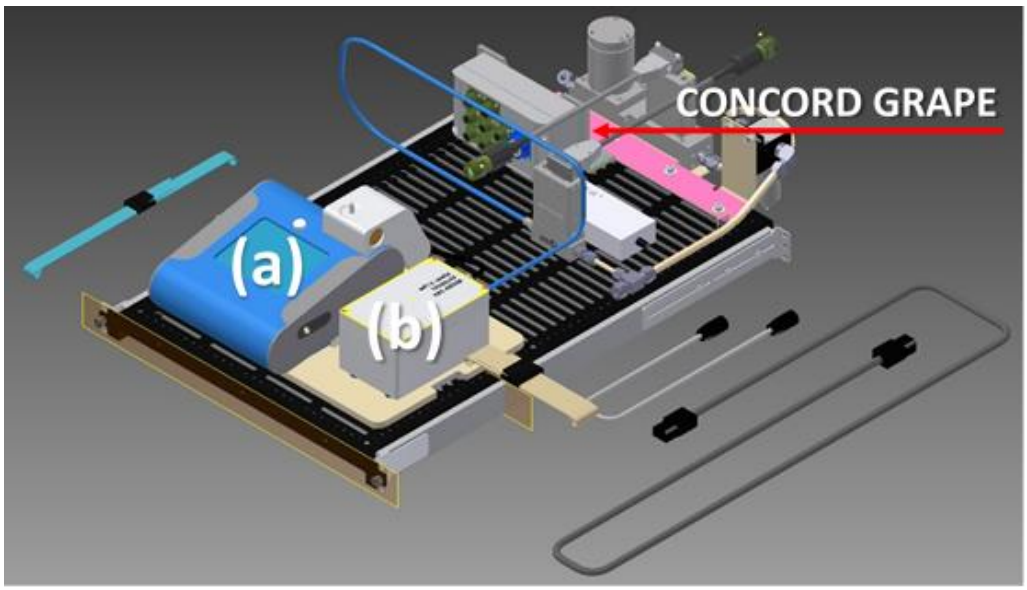


Figure 62. Location of Concord Grape that powers the MFC, which monitors the volume metric flow of the sensors other pump that resides in the "belly pan".

The MFC maintains a constant flow rate of 16.67 LPM (liters per minute), which is pulled through the particulate analyzer - size assembly. The set point of the flow rate should be 16.67 LPM during the normal operation or after resuming operation from interruption. Monitoring via the Location Controller (LC) and MFC to ensure the flow rate is within range is a form of condition monitoring to determine the health of the sensors rotary vane pump. The rotary vane pump resides within the "belly pan" of the NEMA enclosure (**Figure 63**) next to the Eddy Covariance Turbulent Exchange (ECTE) rotary vane pump (ECTE subsystem).

Figure 63. Looking down at the two Rotary Vane Pumps that reside in the “belly pan”.

A complete operational concept of the sensor's subsystem is illustrated in **Figure 64**.

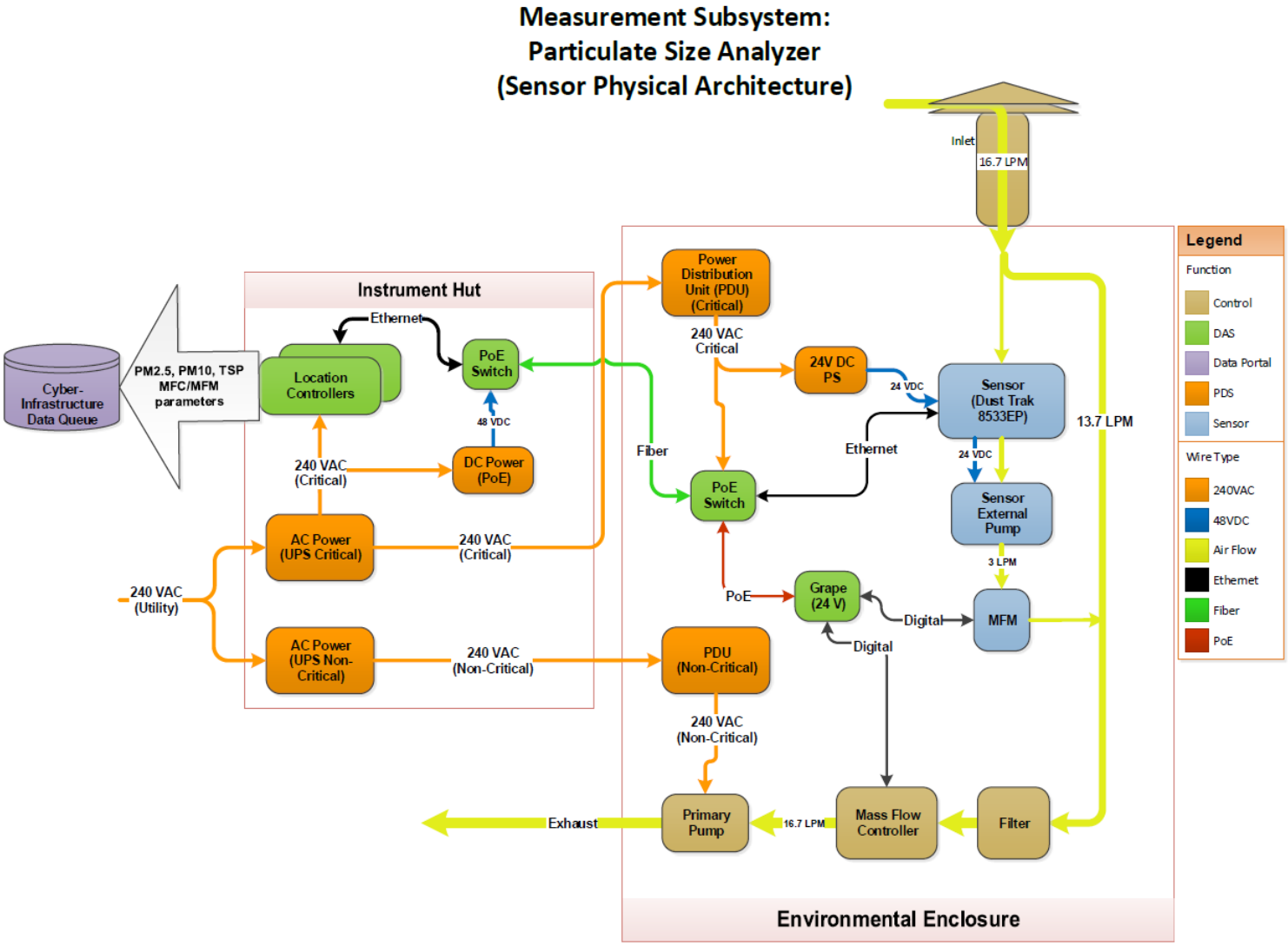


Figure 64. Measurement Subsystem: Particulate Size Analyzer (Sensor Physical Architecture).

More information for the Particulate Analyzer – Size subsystem for preventive maintenance, troubleshooting (for post-installation/reinstallation purposes), and proper shut down and rebuilding of the sensors second pump (GAST Rotary Vane Pump) is maintained within AD [05], *TIS Tower Top Environmental Enclosure Preventive Maintenance Procedure*.

6.2 Cleaning & Packaging of Returned Sensor

Field Operations staff clean, package, and ship the sensors back to the CVAL at the NEON project HQ (Battelle Ecology) for annual sensor swap/calibration requirements. Cleaning of the sensor instrumentation is provided in earlier sections, as it is part of the preventive maintenance procedures; reference portions of Table 4 and Table 5 for cleaning instructions of each sensor component.

The Domain office maintains the original packaging for the Particulate Analyzer – Size (carrying case). Please be aware the monitor is a sensitive instrument and MUST be transported inside the carrying case. Upon receiving the calibrated sensor, return the uncalibrated sensor to the NEON project HQ using the following address:

BATTELLE ECOLOGY
1685 38TH STREET, SUITE 100
BOULDER, CO 80301

7 APPENDIX

- 7.1 UTC Time Conversion Chart
- 7.2 Issue Reporting Sheet

7.1 UTC Time Conversion Chart

Time zone	Name	Offset from UTC
UTC	Coordinated Universal time	0
PST	Pacific Standard Time	-8
ALDT	Alaskan Daylight Time	-8
PDT	Pacific Daylight Time	-7
MST	Mountain Standard Time	-7
MDT	Mountain Daylight Time	-6
CST	Central Standard Time	-6
CDT	Central Daylight Time	-5
EST	Eastern Standard Time	-5
EDT	Eastern Daylight Time	-4
AST	Atlantic Standard Time	-4
ALST	Alaskan Standard Time	-9
HST	Hawaiian Standard Time	-10

UTC	PST ALDT	PDT MST	MDT CST	CDT EST	EDT AST	ALST	HST
0000	1600	1700	1800	1900	2000	1500	1400
0100	1700	1800	1900	2000	2100	1600	1500
0200	1800	1900	2000	2100	2200	1700	1600
0300	1900	2000	2100	2200	2300	1800	1700
0400	2000	2100	2200	2300	0000	1900	1800
0500	2100	2200	2300	0000	0100	2000	1900
0600	2200	2300	0000	0100	0200	2100	2000
0700	2300	0000	0100	0200	0300	2200	2100
0800	0000	0100	0200	0300	0400	2300	2200
0900	0100	0200	0300	0400	0500	0000	2300
1000	0200	0300	0400	0500	0600	0100	0000
1100	0300	0400	0500	0600	0700	0200	0100
1200	0400	0500	0600	0700	0800	0300	0200
1300	0500	0600	0700	0800	0900	0400	0300
1400	0600	0700	0800	0900	1000	0500	0400
1500	0700	0800	0900	1000	1100	0600	0500
1600	0800	0900	1000	1100	1200	0700	0600
1700	0900	1000	1100	1200	1300	0800	0700
1800	1000	1100	1200	1300	1400	0900	0800
1900	1100	1200	1300	1400	1500	1000	0900
2000	1200	1300	1400	1500	1600	1100	1000
2100	1300	1400	1500	1600	1700	1200	1100
2200	1400	1500	1600	1700	1800	1300	1200
2300	1500	1600	1700	1800	1900	1400	1300
2400	1600	1700	1800	1900	2000	1500	1400

Note: 0000 and 2400 are interchangeable

7.2 Issue Reporting Sheet

Table 7. Metadata Output Checklist.

Issue Reporting Datasheet		
Datasheet field	**Entry**	
NEON Site Code		
Maintenance Date		
Maintenance Technician		
Preventive Maintenance	**Issue Noted**	**Issue Summary**
Cables & Connectors - Condition Check	☐	
Sensor – Cylindrical Internal Filters Changed	☐	
Sensor – 37 mm Filter Cassette Cleaned	☐	
Sensor – Inlet Cleaned	☐	
Sensor – Chimney Cleaned	☐	
Sensor – Date And Time Verified	☐	
Sensor – Instrument Zeroed	☐	
Sensor – (Annual) HEPA Filters Changed	☐	
Sensor – (Annual) Full Chimney Cleaning	☐	
Environmental Information	☐	
Notes		