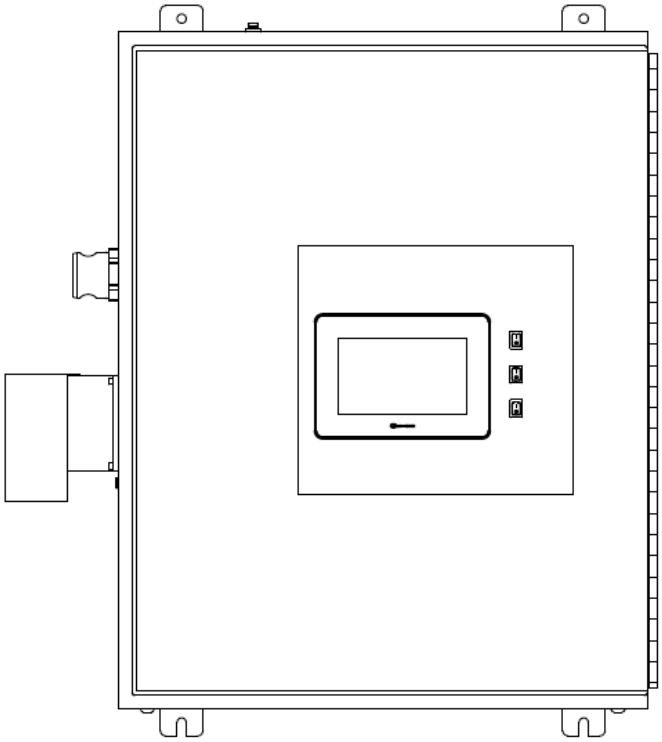
Version

1.12

Delta Measurement

NO Monitor



Operation and Maintenance Manual

DELTA MEASURMENT

Operations and Maintenance Manual

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Contents

Safety Precautions

AC Power Supply

The INSTRUMENT uses a universal power supply that can accept inputs of 100 to 240 VAC, 50/60 Hz. It is highly suggested that the unit be hardwired to the AC power source, preferably on its own circuit (with UPS or surge protection).

Protective Grounding

Under no circumstances should the unit be operated without connection to a protective ground. Doing so poses a potential shock hazard and is also a violation of electrical safety standards applicable to this type of equipment.

Explosive Atmosphere

Do not operate this equipment in the presence of flammable liquids, vapors or aerosols. Operation of any electrical instrument in such an environment constitutes a safety hazard.

Working Inside Instrument

Extreme care should be exercised when accessing the interior of this instrument. Only qualified electrical maintenance personnel should perform connections and adjustments. Always de-energize the power supply before working on the interior of the instrument.

Misuse and Modifications to Instrument

The protection provided by the instrument may be impaired if it is used in a manner not specified by EES. Changes or modifications to this instrument, not expressly approved, will void the warranty.

In Case of Malfunction

Do not continue to use this equipment if there are any symptoms of malfunction or failure. In the case of such occurrence, de-energize the power supply and contact a qualified repair technician.

What You Need to Know

This instrument is designed to be used as a combustion optimizing tool. It is NOT intended for environmental reporting.

The procedures in this manual require you to understand and follow safety practices at your site in addition to those identified in this publication.

Before installing any hardware, check the installation location for adequate electrical requirements and protection from the elements.

Be sure your organization adheres to a larger plan for the proper business and operational education of all aspects of NO monitoring. A complete description of planning considerations and launch plans and activities should be done in advance of system commissioning.

Warning Statements

The use of the word **WARNING** in this manual denotes a potential hazard associated with the use of this equipment. It calls attention to a procedure, practice, or condition, or the like, which if not correctly performed or adhered to, could result in injury or death of personnel using this instrument.

Caution Statements

The use of the word **CAUTION** in this manual denotes a potential hazard associated with the use of this equipment. It calls attention to a procedure, practice, condition, or the like, which if not correctly performed or adhered to, could result in damage to the instrument.

Hazard Symbols on INSTRUMENT

This symbol indicates the need to consult this operating instruction manual when opening the enclosure.
WARNING: A potential risk exists if the operating instructions are not followed.
This symbol indicates the presence of electric shock hazards when the enclosure is opened.
WARNING: To avoid risk of injury from electric shock, do not open the enclosure.

Specifications

General Specifications – ANALYZER

Product Type	NO monitoring system for low level continuous monitoring of NO gas.
Coverage	Dual zone
Measuring Range	0 to 500 ppm (default)
Monitoring Distance	Up to 100 feet maximum gas-sample line length
Detector Type	Chemiluminescence
Sensitivity	0.25% of reading
Zero Calibration Drift	± 0.2 ppm
Span Calibration Drift	± 1% of reading
Temperature Drift	± 0.2% of reading per ˚C
System Noise	Less than 40 dB(A) at 10 feet
Conditioned Signal	(2) 4-20 mA Analog Outputs, (2) Contact Closure Discrete Outputs (for Fault Indication)
Operating Temperature	32 to 122 ˚F (0 to 50 ˚C) Enclosure: thermostatically regulated to 60-90 ˚F (default) Sample lines: heat traced and regulated to 50˚ (default)
Ambient Humidity	5% to 90% RH (non-condensing)
Altitude Limit	2000 Meters
Enclosure	NEMA 4X (Powder Coated Aluminum)

Sample Gas Conditions – SAMPLE PROBE

Flow Rate	0.20-1.0 lpm
Process Gas Temp	Up to 950 ˚F (0 to 510 ˚C) continuous
Process Pressure	-0.5 to 1.0 psig
Process Gas Constituents	Common with coal-fired effluent
Pneumatic Connection	Heat traced 0.25” OD x .063 wall high temperature PTFE tubing

Functional Overview

General Description

The Delta NO Monitor continuously measures NO ppm and displays this reading per measurement zone on an HMI located on the front panel of the measurement enclosure. These values are also available to the plant DCS via 4-20 mA outputs. Furthermore, each zone is also equipped with a digital fault output.

Sample Conditioning

The Delta NO Monitor is an extractive measurement system that utilizes three stages of particulate filtering and sample drying to deliver a clean sample to the analyzer that enables the prolonged use of said analyzer without fouling.

Stage 1 occurs at the end of the probe where the flue gas first passes through a sintered silicon carbide filter (see Figure 1.1).

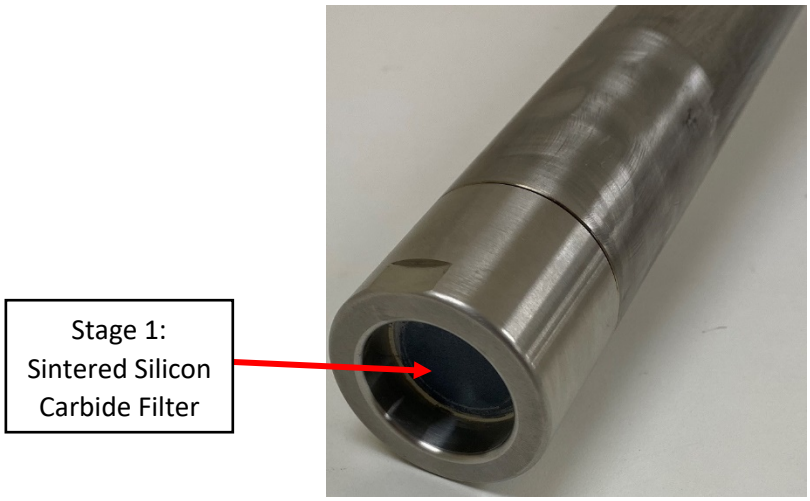

Figure 1.1: Stage 1 Filtration - Probe End

Stage 2 occurs upon entrance to the enclosure, where bulk moisture and any remaining fine particulate are removed via filters (see Figure 1.2).

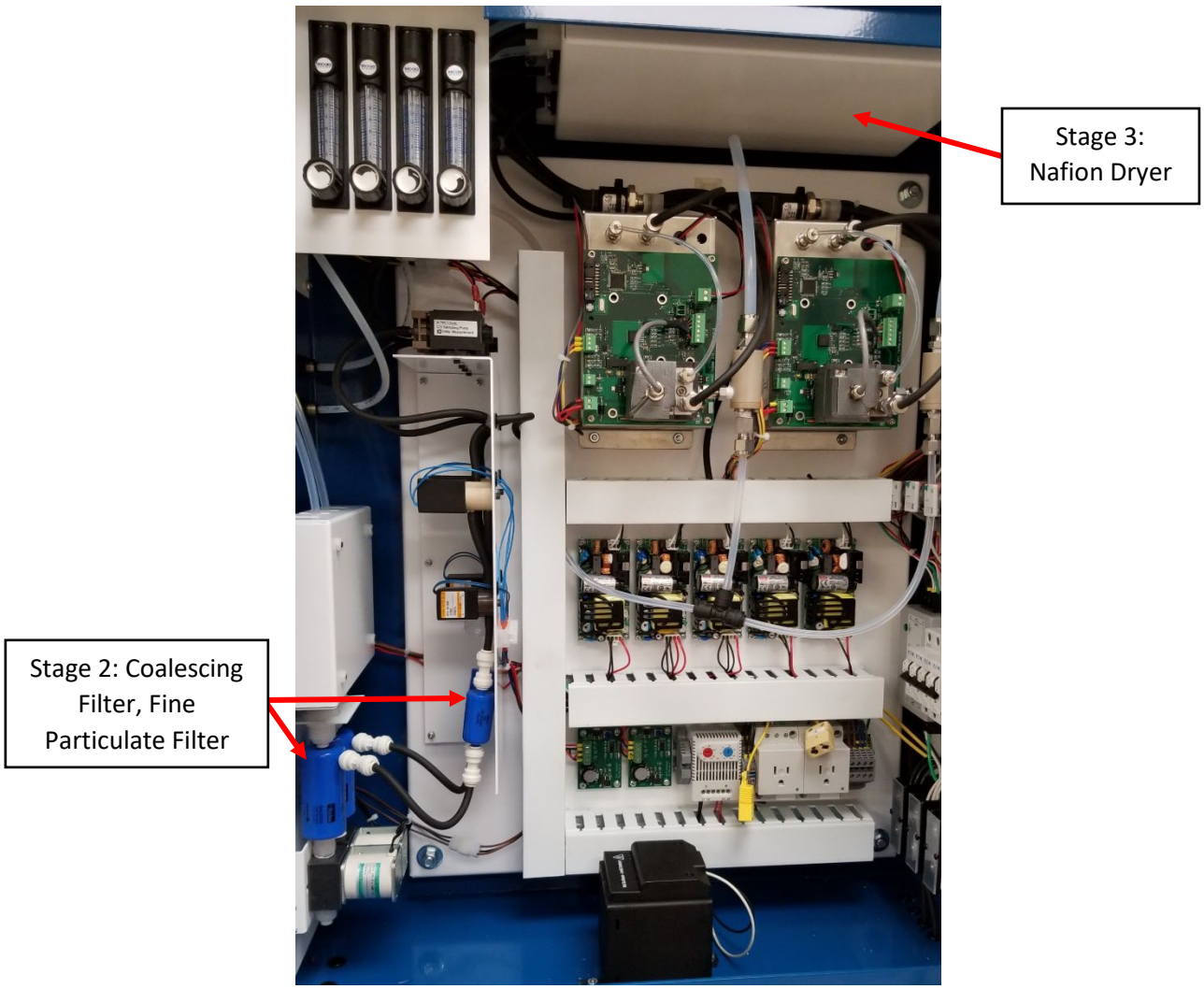

Figure 1.2: Stage 2 & 3 Filtration

Stage 3 occurs immediately prior to entrance to the NO analyzer where the sample passes through a nafion dryer to further reduce moisture (see Figure 1.2).

The monitor is equipped with programable probe purge and analyzer zero functions as well to ensure proper system function and accuracy

Chemiluminescence Analyzer (NO Module)

The analyzer operates by combining the extracted sample with ozone (O_3) provided by the Ozone Generator (see Figure 2.1 & Figure 2.2).

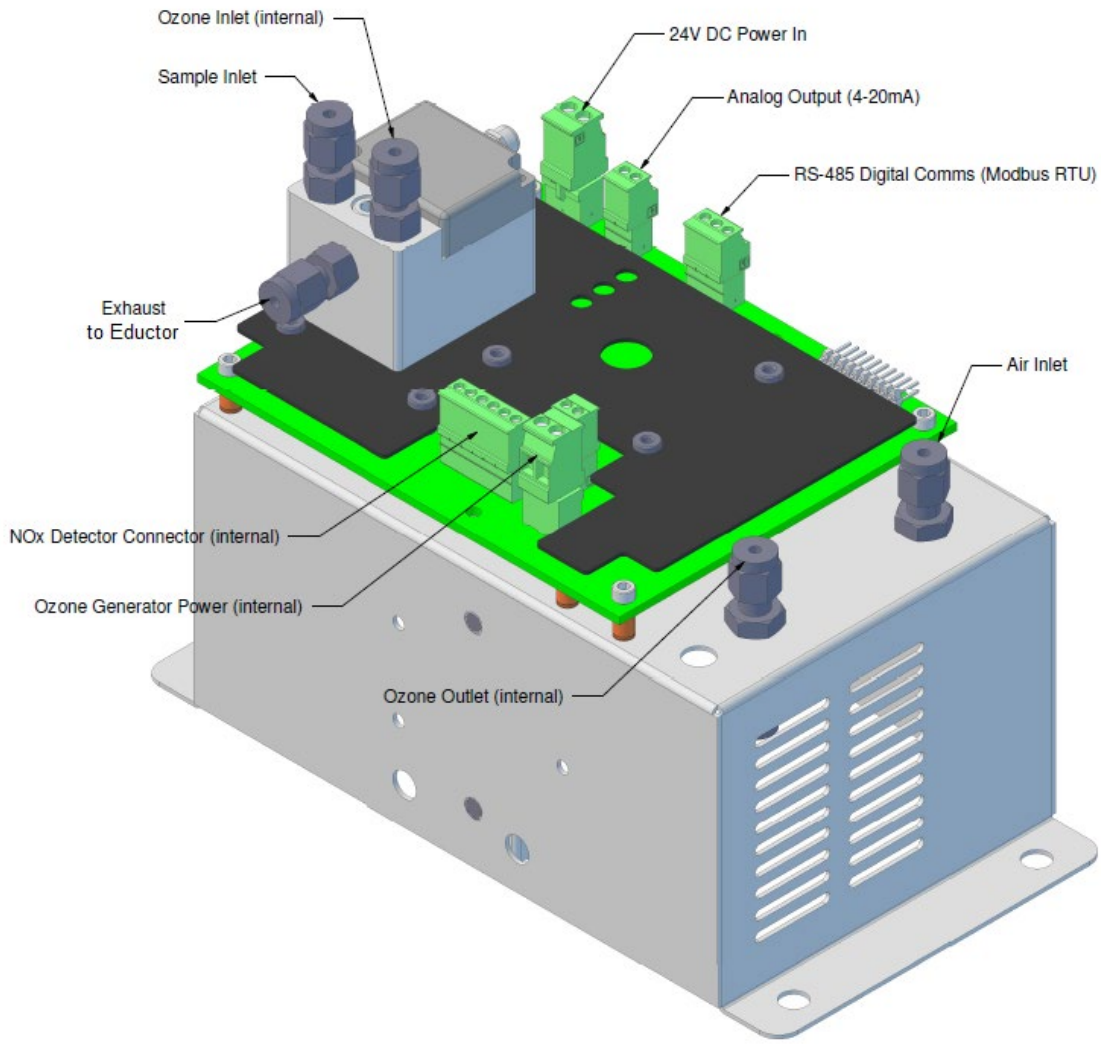

Figure 2.1: NO Module

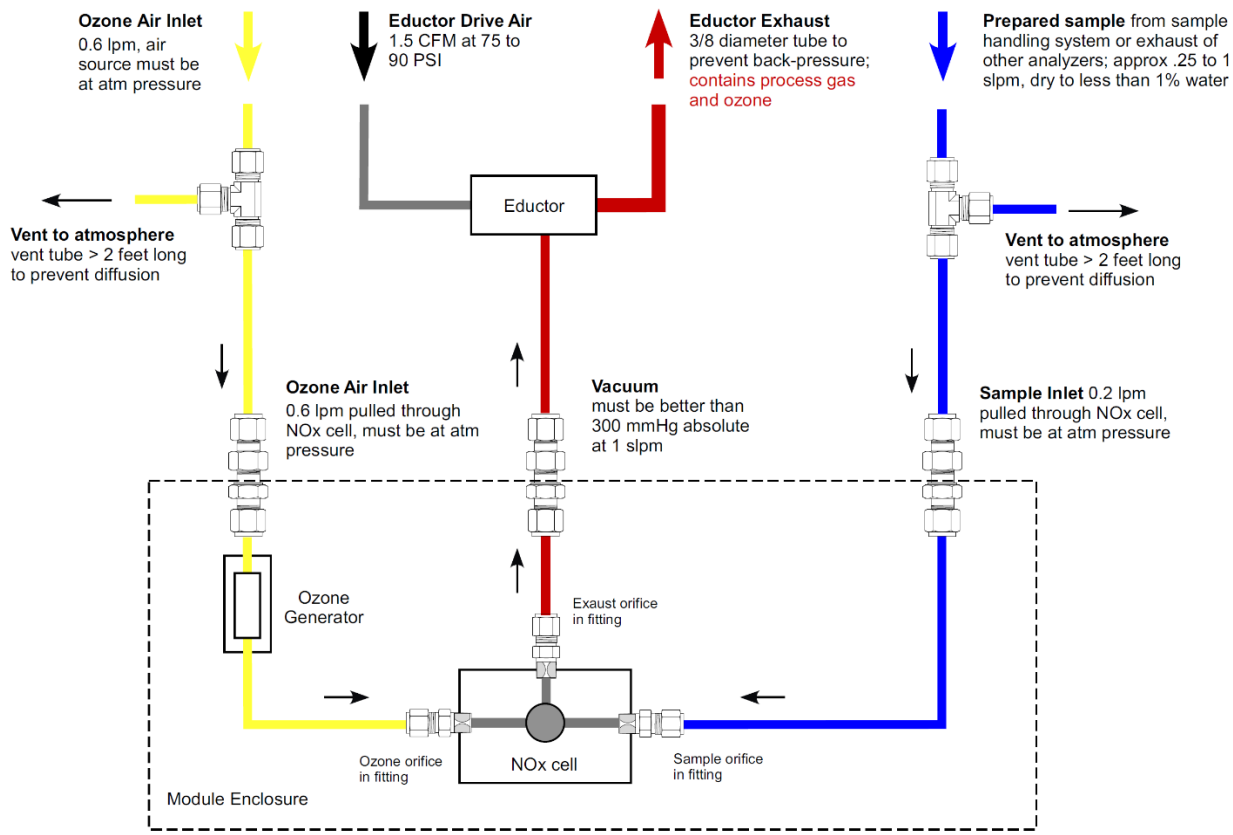

Figure 2.2: NO Module Pneumatic Flow Path

The instrument air flow to the Ozone Generator is controlled by the two rotameters on the right of rotameter cluster located in the upper left of the measurement enclosure. These rotameters should be set to 1.00-1.25 scfh for proper ozone generator operation. An Eductor (See Figure 2.1 & Figure 2.2) pump, supplied by 1.5 cfm 75-90 psi instrument air, pulls the O_3/flue gas sample mixture across the NO sensor housed in the NO module. NO reacts with O_3 to produce light proportional to the volume of NO in the sample which is read and processed into a ppm signal.

Instrument Operation

Setup and control of the NO monitor is accomplished via the HMI/PLC mounted on the enclosure inner white door. Programmed into the HMI/PLC are five user selectable touch screens (See Figures 3.1-3.5). Toggling between each screen is accomplished by pressing and releasing the particular screen tab located on the HMI's left margin. If the monitor is left idle at any screen for 2 minutes, it will reset to the Measure screen.

Measure Screen

Figure 3.1 below illustrates the Measurement Screen or "Home Screen." This screen displays live values of measured NO ppm for each zone in visual and numerical form. This screen also indicates the status of each zone, be it measuring, zeroing, purging or in fault. Furthermore, a manual probe purge override can be initiated by pressing and releasing the "Manual Purge" button.

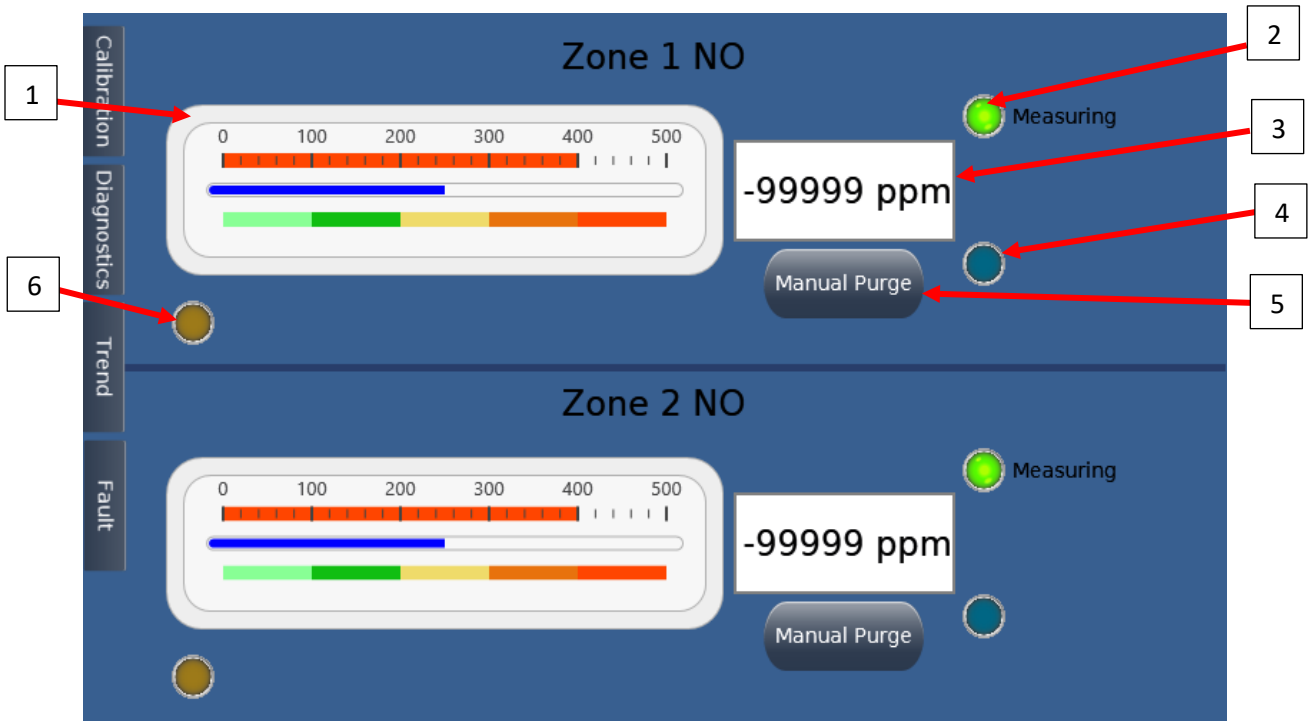

Figure 3.1: Measure Screen

Measure Screen Elements

Each element is listed below by corresponding number on figure 3.1. Elements of only one zone are defined as both zones are identical.

1. NO ppm Meter: This element displays live and peak NO ppm value in horizontal meter form. The peak NO ppm value is displayed by the red bar on the top of the element. This value will reset with a physical press and release. The blue bar in the middle of the element indicates live NO ppm value. Please note that the scale, in this case 0 – 500 ppm is preset by Delta during commissioning and can be changed by owner later if so desired (See *Calibration Screen Elements*).
2. Live Measuring Indicator: This LED is illuminated green when the measurement zone is actively measuring NO.
3. NO ppm Numerical Output: This element displays live NO ppm value in numerical form.
4. Purge Indicator: This LED is illuminated green when the measurement zone is purging (See *Diagnostics Screen Elements*). Please note that when this process is underway the last NO ppm value measured is held as the 4-20 mA output to the DCS until live measurement resumes.
5. Manual Purge Button: This press and release button initiates a probe purge (See *Diagnostics Screen Elements* for instructions on changing purge timing, interval and recovery).
6. Fault Indicator: This LED is illuminated yellow when a fault has occurred on the measurement zone (Please see *Fault Explanation and Corrective Action* for explanation of faults)

Trend Screen

Figure 3.2 below illustrates the Trend Screen. This screen displays live values of measured NO ppm for each zone in graphical and numerical form. Also, this screen is valuable in that NO ppm values are displayed as a time stamped trend allowing for local analysis of NO values outside of the DCS. Furthermore, this screen has a screenshot function allowing for .jpeg files to be downloaded to microSD card (See *Trend Screen Elements* for full explanation).

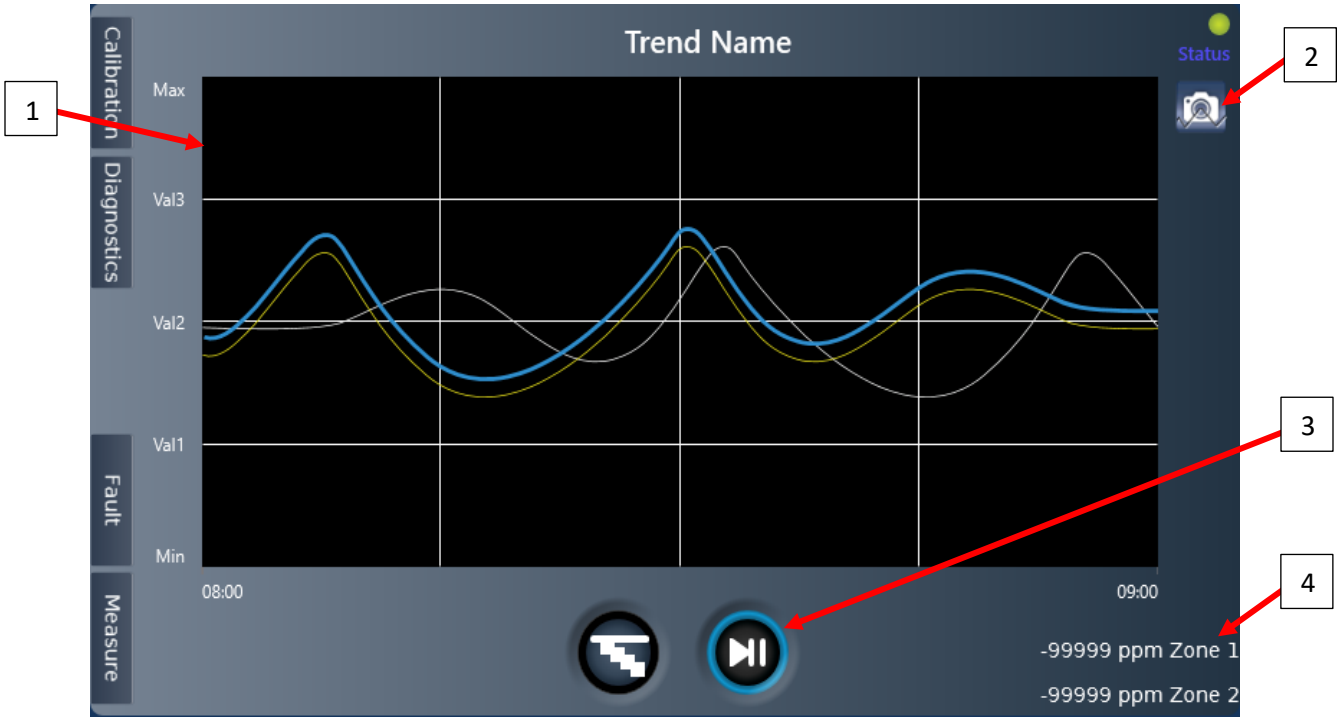

Figure 3.2: Trend Screen

Trend Screen Elements

Each element is listed below by corresponding number on figure 3.2. Elements of only one zone are defined as both zones are identical.

1. Graphical Trend: This element displays NO ppm values for both zones. The horizontals axis is time in minutes and the vertical axis is ppm. *Please contact EES for assistance in changing the time scale.*
2. Screenshot Button: This press and release button takes a screenshot of the Graphical Trend, creates a .jpeg file and saves it to the microSD card house on the side of the HMI/PLC. This function will only save if a microSD is inserted into the HMI/PLC.
3. Play/Pause Button: This press and release button will pause and play the live Graphical Trend for analysis.
4. Numerical PPM: Live numerical NO ppm for each zone is displayed here.

Calibration Screen

Figure 3.3 below illustrates the Calibration Screen. This screen enables the user to calibrate each NO module using calibration gas. Also, this screen allows to the user to force a zero and span output (4-20 mA) as well as a discreet fault output (I/O) for the purpose of DCS communication troubleshooting.

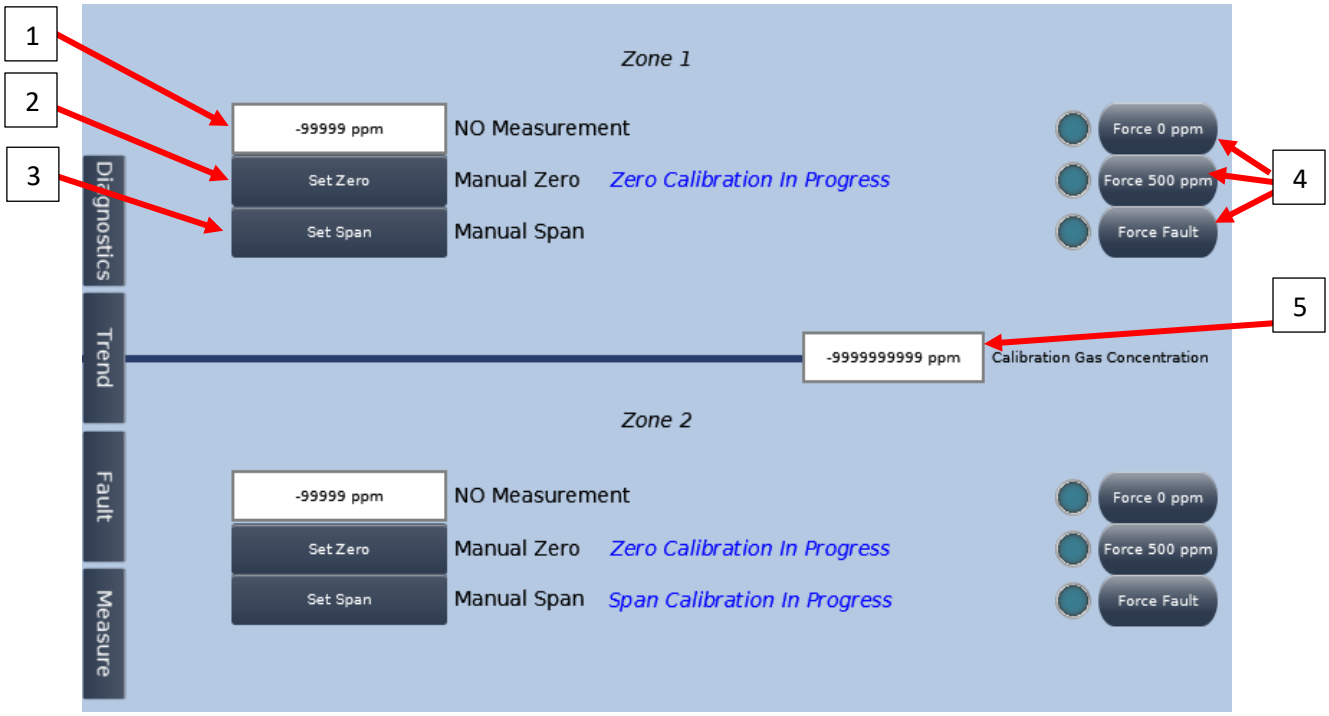

Figure 3.3: Calibration Screen

Calibration Screen Elements

Each element is listed below by corresponding number on figure 3.3. Elements of only one zone are defined as both zones are identical. For a complete explanation of the calibration procedure please see *Calibration Procedure* below.

1. NO Measurement: This element displays live NO ppm value in numerical form.
2. Set Zero: This push and release button initiates a zero sequence for the NO module.
3. Set Span: This push and release button initiates a span sequence for the NO module.
4. Force Zero, Span & Fault: These three press and release buttons force the respective output signal to the DCS. When engaged a blue LED will illuminate to the left of the button. To disengage the signal simply press the respective button again. By default, zero corresponds to 4 mA and span corresponds to 20 mA.
5. Calibration Gas Concentration: This button allows the user to specificy what concentration of calibration gas is being used for the calibration. To change the value press and release the ppm button, a numeric keypad will be displayed allowing the user to enter and save the desired NO ppm value. Gas concentration must be at or below the sensor full span (500 ppm) with an N_2 balance.

IMPORTANT: Calibration gas regulated above 0.50 lpm may cause damage to the instrument.

Fault Screen

When the fault light for either zone is illuminated on the measure screen, accessing the fault screen (figure 3.4) will show specific fault(s) currently active. By pressing any of the fault lights, a description of that fault will be shown.

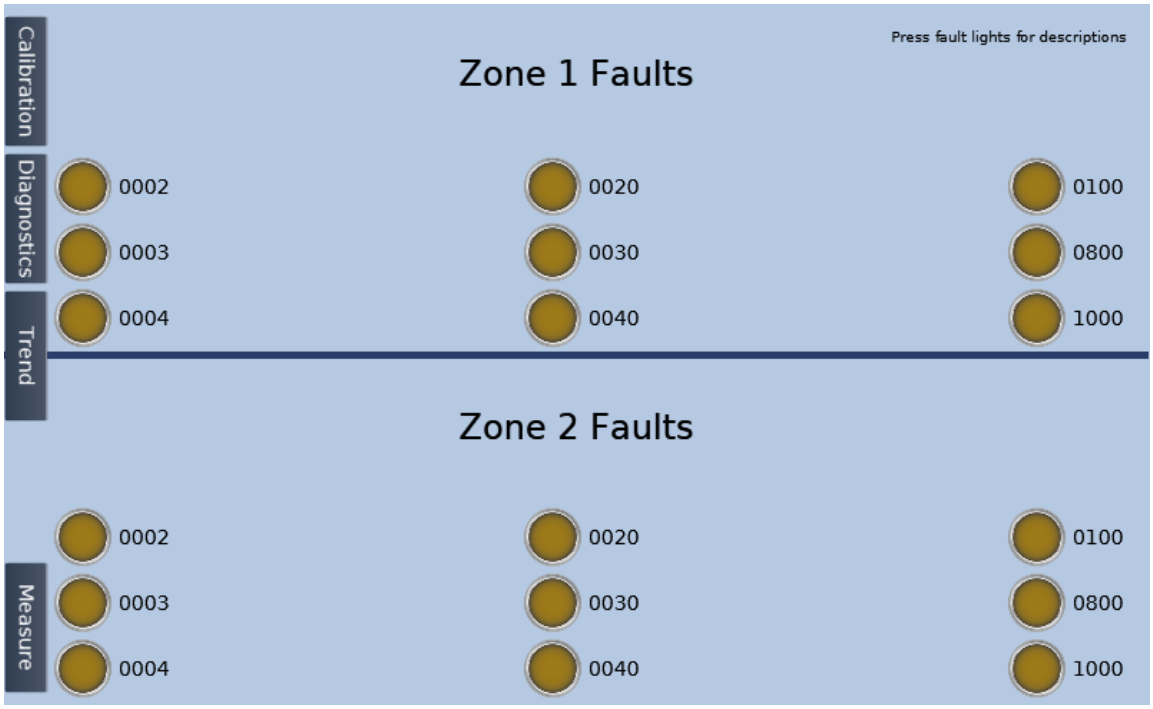

Figure 3.4: Fault Screen

Fault Explanation and Corrective Action

0002: High Chiller Temperature

Possible Causes:

- Failed chiller power supply
- Connection error with thermocouple
- Cool down not completed since startup

0003: Low Chiller Temperature

Possible Causes:

- Low ambient temperature (enclosure heater not on)
- Short to power in chiller circuit

0004: Chiller TC Error

Possible Causes:

- Damaged thermocouple
- Incorrect wiring of thermocouple

0020: High Ambient Temp

Possible causes:

- Vortex cooler not on or incorrectly set
- Enclosure left open
- Unsafe operating environment

0030: Low Ambient Temp

Possible causes:

- Heater not on or incorrectly set
- Enclosure left open

0040: Ambient TC Error

Possible causes:

- Damaged thermocouple
- Incorrect wiring of thermocouple

0100: RS-485 Communications Error

Possible causes:

- Loss of power to NO module(s)
- Failure of COM port on PLC
- Failure of NO module(s)

0800: High dP

Possible causes:

- Blockage of sample line
- Obstruction at probe head
- Failure of probe filter

1000: Low dP

Possible causes:

- Failure of sampling pump
- Leak on vacuum side of pump
- Disconnected tubing

Diagnostics Screen

To aid in troubleshooting a diagnostic screen (figure 3.5) is available to show pressures and various timers associated with purging, zeroing, and spanning.

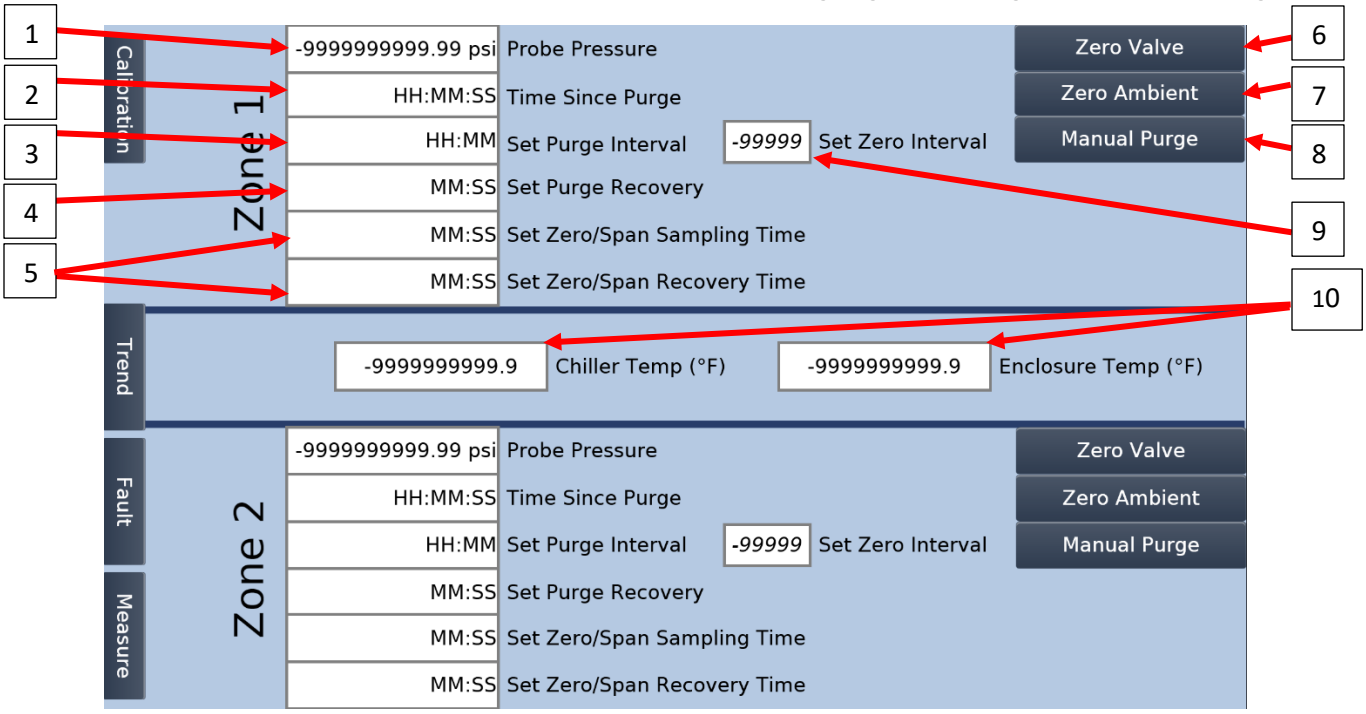

Figure 3.5: Diagnostics Screen

Diagnostics Screen Elements

1. Differential Pressure (psi): This is the amount of vacuum currently being pulled by the pump. By pressing the Zero Valve button (item #6), the Zero Valve is toggled. The words to the right of the pressure value will change to indicated whether the differential pressure is being measured through the probe or the zero filter.
2. Time Since Purge: This value resets after every purge (manual or automatic). It is the time elapsed since the probe, sample line, and coalescing filter were last purged.
3. Purge Interval: The purge interval can be changed by pressing and releasing the displayed current value. Consult EES prior to making changes greater than 30 minutes in either direction.

4. Purge Recovery: This value can be adjusted by pressing and releasing the displayed value. This represents the amount of time that the analog output is held following a probe purge and is necessary to allow the sample line to be primed with sample gas. Recovery time should always be at least 20 seconds.
5. Zero/Span Sampling & Recovery Time: Both of these values can be adjusted by pressing on their respective values. Sampling time is the amount of time that a zero or span sample will be allowed to flow through the NO sensor before a new zero or span value is stored. Recovery time, as with purge recovery, is the amount of time that the lines are primed with sample gas before the output is taken out of hold.
6. Zero Valve: Pressing this button will toggle the state of the zero valve, and its state will be indicated next to the differential pressure (item #1). This state will reset if nothing is touched for 2 minutes.
7. Zero Ambient: Pressing this button will turn off the pump and switch the zero valve to take a sample through the zero filter for a few seconds, at which point the ambient pressure reading will be stored.
8. Manual Purge: Like the button on the measure screen, pressing this will initiate a manual probe purge. This is useful in diagnostics for verifying flow out of the drain valve.
9. Set Zero Interval: In addition to the ability to manually perform a zero on the calibration screen, an automatic zero will happen periodically during a probe purge. Adjusting the interval adjusts the frequency of zeroes, from a value of 1 which would be every probe purge, to a value of 20 which would be every 20th probe purge (equal to every 40 hours at the default probe purge frequency).
10. Chiller and Enclosure Temperature: Chiller temperature is based on a thermocouple attached to the sample chiller. Enclosure temperature is based on a thermocouple resting in a wireway.

Calibration

Calibration Procedure

Calibration of the NO monitor is accomplished simply via the calibration screen with the following procedure.

1. Press the Set Zero button and wait until *"Zero Calibration In Progress"* is no longer displayed.
2. Ensure the calibration gas canister matches the on-screen Calibration Gas Concentration value. Adjust on screen if necessary.
3. Disconnect the sample line from the coalescing filter (see figure 4.1 below) and connect the calibration gas canister to that sample line. A 0.5 lpm regulator with an inline pressure relief valve should be used. Open the regulator to allow gas to flow.

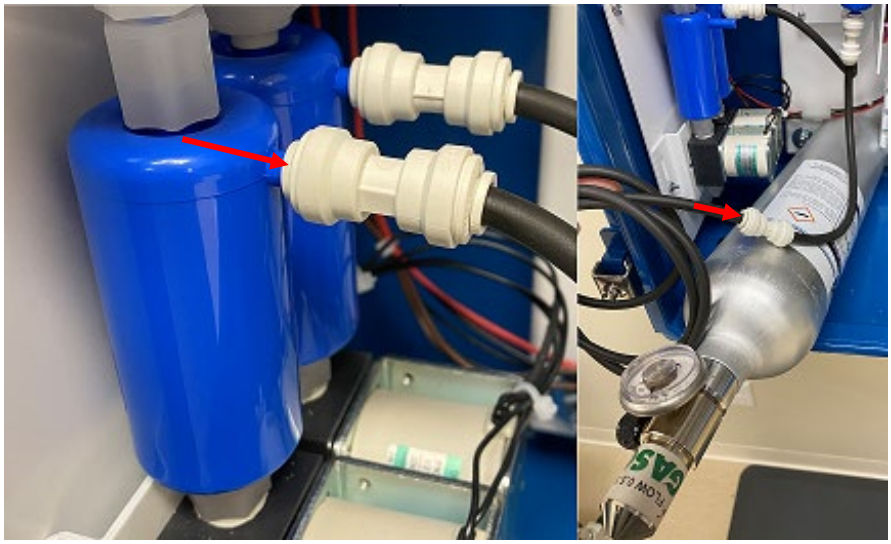

Figure 4.1: Connecting Calibration Gas

4. Press Set Span button and wait until *"Span Calibration In Progress"* is no longer displayed. NO Measurement should match the calibration gas value. If it is higher, the sampling time was not sufficient. Keep the gas canister connected and press Set Span again. Once complete the gas regulator should be closed, and the sample line should be reconnected to the coalescing filter.
5. Calibration complete. If during step 4 multiple spans were performed, be sure to navigate to the Diagnostics screen and increase the Zero/Span Sampling Time by 10 seconds.

Maintenance

A limited amount of maintenance is required to keep the NO analyzer running properly. On every zone the pump, coalescing filter, and fine particulate filter need to be replaced annually. The procedure for replacing each component is described below.

Pump Replacement

1. To replace a pump, first power down the system using the 5A breaker shown in figure 5.1.

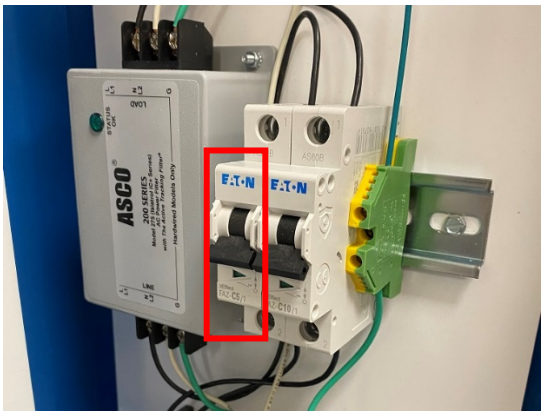

Figure 5.1: Circuit Breakers

2. Once the power is off remove the applicable mounting screws shown in figure 5.2. The rest of the pump replacement procedure should be done one pump at a time, so tubing/wiring does not get mixed between zones.

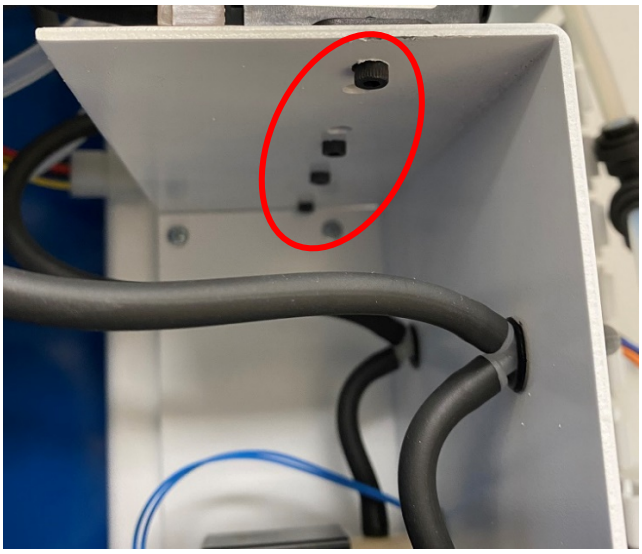

Figure 5.2: Pump Mount Screws

3. Remove the wire leads, and tubing connections to the pump. The tubing and wiring must attach to the new pump in the same orientation as the old pump, as shown in figure 5.3.

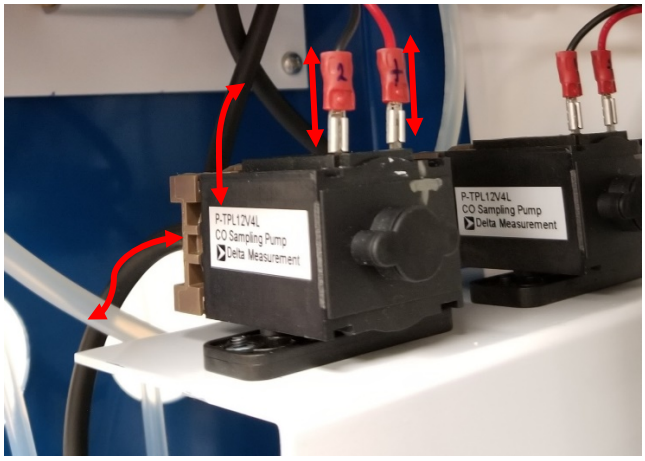

Figure 5.3: Pump Connections

4. Reinstall mounting pump mounting screws. Repeat this procedure for all pumps being replaced, and then restore system power. Following replacement, pressure should be checked in the diagnostic screen to ensure differential pressure is in the correct range.

Coalescing Filter Replacement

1. Remove 2-way push-on fitting from coalescing filter by pressing down on the white ring (figure 4.1). These tubes will need to go back to the same place they came off, so marking them prior to removal may be beneficial.
2. Loosen locknuts (2 on each side) until they spin freely (removal is not necessary). See figure 5.4.

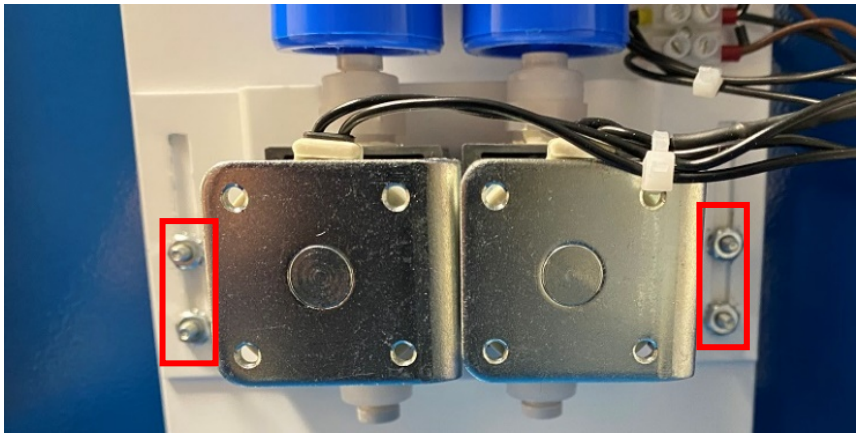

Figure 5.4: Drain Valve Bracket Locknuts

3. Using needle-nose pliers or a screwdriver, push up on white ring on the bulkhead fitting while pulling down on the filters (figure 5.5). Move from one filter to the next until they all completely release from the white fittings.

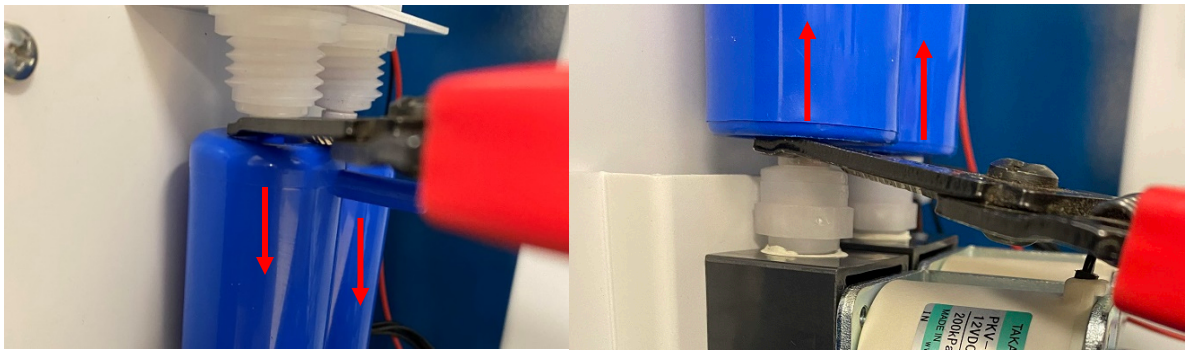

Figure 5.5: Removing Coalescing Filter

4. Using needle-nose pliers or a screwdriver, push down on the white ring on the drain valve fitting while pulling the filter up to remove each one by one (figure 5.5).
5. To install, reverse process, make sure all 4 filters are lined up/started in the fittings above before pressing them completely into the fittings (Hint: By rotating each filter as you push up, they will slide into the fittings easier). The arrow on the filters must point down. If the black tubing was not labeled, trace each one to the valves above to make sure it gets hooked up to the correct zone (Zones 1 is always towards the rear of the cabinet).

Fine Particulate Filter Replacement

The last maintenance item of the analyzer is the small blue inline filter (figure 5.6). It is replaced simply by pressing the white ring on either fitting and removing from said fitting. When installing the new filter, make sure the arrow points up (towards the isolate valve).

Figure 5.7: Removing Fine Particulate Filter