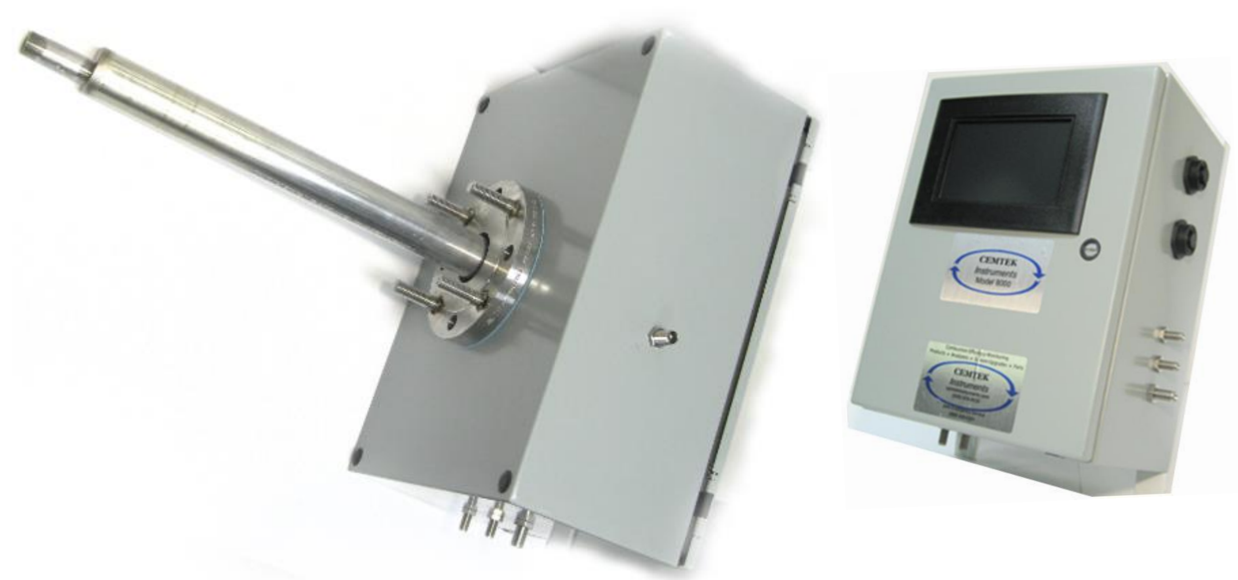
CEMTEK Instruments- Model 8000
NO_x - CO_2 / SO_2 / O_2 Analyzer
User's Manual



May 2018

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Section 1 – General Overview

1.1- Overview

The CEMTEK Instruments Model 8000 Close-Coupled Dilution Extractive NO_x-CO_2 / SO_2/O_2 Analyzer is designed specifically for use in Combustion Process applications for Low NO_x Burner Tuning, SCR Inlet/Outlet monitoring applications. Total NO_x is measured using a solid state Chemiluminescence sensor while CO_2 is measured using a NDIR absorption technique, SO_2 using UV florescence and a Zirconia Planar sensor is used for O_2. The system requires no sample conditioning, thus reducing costly maintenance. It is designed to operate for long periods between adjustments.

The Model 8000 meets the demands for accuracy, linearity, and calibration drift in tough combustion applications, in Coal fired Boilers, Gas Turbines and Internal Combustion engines. Providing a fast response for all feedback/ feed forward control systems

1.2- Important Precautions

Use dry, oil-free instrument air only

Caution: This instrument will be damaged if used with instrument air that is not completely dry and oil-free. Ensure instrument air has –30 °F dew point and has been filtered to remove all oil and particulates.

Safety Notice

This instrument operates from potentially lethal line voltage. In addition, some internal components operate at high temperature and can cause serious burns. Observe all precautions when using this device, and particularly be sure that all devices connected to the instrument are safely wired and properly grounded. Always disconnect power to the instrument before opening the enclosure or making any adjustments.

Caution: The analyzer should not be operated without the cover in place and the fan fully functioning.

The exterior surface of the probe enclosure may be >50°C if operated with an Oxygen Sensor. Serious burns can result if the proper precautions are not taken.

1.3- Theory of Operation

Meso-Dilution Gas Analysis

Our m*eso-dilution* gas analysis system provides fast response, robust flow control, and reliable sample extraction with far-fewer components than traditional dilution-extractive systems. Temperature controlled filtering, heating, NO2 conversion (for full NOx systems), and moderate (meso) dilution of sample all occur within the process before extraction, preventing any opportunity for condensation or precipitation due to cooling as the sample is being transported through the probe. It provides greatly simplified pneumatics, integrating sample flow control (and ozone in the NOx analyzer module) with dilution rate control at the probe, reducing the number of flow control elements and eliminating the need for any dilution eductors or fast-loop extraction components. Flow through the analyzers and dilution rate are all controlled using critical flow orifices and a single vacuum source. Filtered, diluted sample exits the probe, visits a secondary particle filter and scrubber, and is then pulled through one or two compact gas analyzer modules before being exhausted to atmosphere by the internal air-driven vacuum pump (eductor). The system provides sample that is diluted to a sample/diluent ratio of about 10:1, allowing the detection of gas constituents much closer to their native process concentrations, as opposed to traditional systems that often dilute sample to 100:1 and 150:1. Lower dilution rates and thus higher concentrations allow for simplified gas detection components that can be ruggedized for high temperature, high vibration, and heavy-industrial environments.

Chemiluminescence Measurement of NO and NO_x

Chemiluminescence refers to a chemical reaction that gives off light. Nitric oxide (NO) can be detected by allowing it to react with ozone (O3) to form an excited state of NO2 that subsequently decays and gives off infrared light. By introducing a sample containing NO into a reaction cell and mixing it with ozone, one can measure the amount of light emitted by the ensuing reaction and can infer the amount of nitric oxide present in the original sample. This is the overwhelming choice for NOx measurement due to its sensitivity, linearity, and specificity. NO is the only species directly measured. NOx, defined as the sum of NO and NO2 in a sample, is measured by first converting any NO2 to NO before it enters the measurement cell. Thus the measurement will include the original NO content plus the NO that was converted from NO2, resulting in a total NOx measurement. For coal-fired sources, NO is usually sufficient for SCR control or other similar process applications. For combustion turbines, diesel engines, or other similar sources that may have significant NO2 present, a full NOx measurement is often desirable. In instruments configured for full NOx measurement, the converter is integrated into the probe tip so that conversion takes place immediately at the sampling point. NO2 transport problems, common in other systems, are almost completely eliminated in this manner.

NDIR Absorption Measurement of CO_2

Non-dispersive Infrared (NDIR) absorption refers to the simple optical measurement made by shining light through a sample and measuring the absorption by the species of interest. Specificity is achieved by selecting wavelengths that corresponding only to energy level changes in the molecule of interest. This is perhaps the simplest optical measurement that can be performed, and works well for species to be measured in the percentage, rather than PPM, ranges. Source light is produced by a hot-wire filament pulsed at approximately 1 Hz. The source light is filtered to reject most of the light outside of the 4.65-micron absorption bands of CO2. The filtered light is passed through a 10 cm sample gas cell, and the unabsorbed light is measured by a detector containing an array of solid state sensors. Some of these sensors include- precision interference filters tuned for the CO2 bands, while others are optimized for the detection of background (out of-band) light. The pulsed source allows for synchronous AC detection, using high-performance lock- in amplifier technology, which allows for superior zero-drift suppression and noise reduction. The background sensors are employed to account for any change in signal intensity due to source changes or optical transmission (dirty source or detector windows).

Fluorescence Measurement of SO_2

Fluorescence refers to the optical excitation of an atom or molecule at one wavelength and the subsequent emission at another, typically longer wavelength (Stokes emission). SO2 can be effectively measured in this manner by exciting the sample with ultraviolet light at approximately 214 nm, and measuring the emission in the 300-400 nm range. Just as Chemiluminescence is the first choice for NOx detection, fluorescence is the optimal choice for SO2 detection because of its sensitivity, linearity, and specificity as well. Excitation is achieved with a zinc discharge lamp, as is with most commercial SO2 fluorescence analyzers. This source light is filtered and focused on an interaction region where the optical detection train is designed to reject the excitation wavelength but optimized for the fluorescence signal. As with the NOx module, a high performance, high temperature solid-state detector is used instead of the delicate photomultiplier tubes employed in most other analyzers.

Zirconium Oxide Measurement of Oxygen

The oxygen measurement makes use of the fact that zirconium oxide conducts oxygen ions when heated above 600 °C. Platinum electrodes on the interior and exterior of a zirconium oxide tube provide a catalytic surface for the exchange of oxygen molecules and oxygen ions. As molecules encounter the platinum electrodes, they become ionized and are transported through the body of the zirconium oxide. This charge transport ultimately sets up an electric potential across the electrodes that is proportional to the log of the ratio of oxygen concentrations on each side of the oxide. Thus, if a reference gas (usually instrument air at 20.9 % O2) flows across the inner electrode, the concentration of sample gas flowing across the outer electrode can be determined. In a conventional zirconium-oxide oxygen analyzer, this voltage is logarithmic and therefore must be exponentiated to determine the concentration. Our oxygen analyzer, a second zirconium-oxide cell is integrated into the first cell to pump oxygen into the first cell, which is maintained at a constant voltage. The required rate at which oxygen is pumped into the cell to maintain a predetermined primary cell voltage is a more sensitive measurement of sample concentration, and allows for measurement at zero oxygen concentration. This pump signal is carefully measured and linearly related back to the sample concentration. The linear relationship allows the measurement and calibration at zero oxygen concentration, which is not possible with a conventional single-chamber zirconium oxide cell.

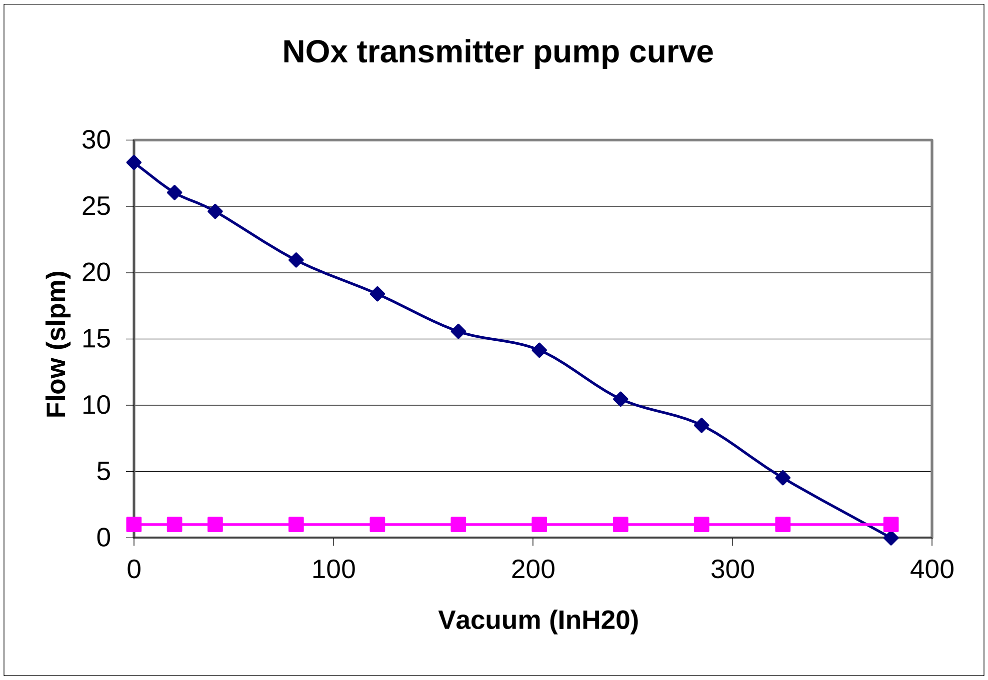
Pneumatic Design

Although the chemiluminescence technique is extraordinarily sensitive, specific to NO_x, and inherently linear, there are many subtle variables involving pressures, flows, cell geometries, and etc. that must be correctly engineered to produce a properly functioning analyzer. The pneumatic design of the Model 8000 takes into account all these variables, making the flow scheme substantially different than other gas analyzers. In order to properly operate and service the analyzer, it is important that the flow scheme be well understood. Besides the following description please refer to the Flow Schematic in the appendix.

Instrument air is delivered to the analyzer at 80-100 psi. This pressurized air is what provides the sample extraction, sample dilution, and pressure necessary for ozone generation. The instrument air is first directed through the air driven pump which creates a vacuum that pulls the gas sample and pressurizes the entire system. Once the sample is drawn off the stack it is diluted through the sample orifice. It then flows through the NO_2 converter (optional) followed by the NH_3 scrubber (optional). Next is when the sample enters the NO_x cell, mixing with O_3 from the ozonator. Finally, the sample gas is exhausted back through the probe into the gas stream.

- The instrument air is used as the Span gas for the optional O_2 sensor and provides the zero gas for NO_x calibration.

- The air flow through the system is controlled by the flow balance rotometer located inside the controller.



The air driven pump is designed to overcome most duct pressures encountered in combustion applications. With optimum flow settings, vacuum over 300" H2O can be accommodated.

1.4- Performance Specifications

Gas Detection Specifications

	NO_x	SO_2	CO_2	O_2
Measurement technology	Chemilumin-escence	UV fluorescence	NDIR absorption	Amperometric zirconium oxide
Measurement range	0 to 1000 PPM	0 to 1000 PPM	0 to 30 %CO2	0 to 25 %O2
Zero noise	< 0.02 PPM	< 0.25 PPM	< 0.01 %CO2	< 0.02 %O2
Zero cal-drift drift per day	Better than ± 0.1 PPM	Better than ± 2 PPM	Better than ± 0.1 %CO2	Better than ± 0.2 %O2
Span noise	< 0.25% of reading	< 0.25% of reading	< 0.25% of reading	< 0.02 %O2
Span cal-drift per day	Better than ± 2% of reading	Better than ± 2% of reading	Better than ± 1% of reading	Better than ± 0.2 %O2
Linearity error	< 2% full scale	< 2% full scale	< 2% full scale	< 2% full scale

System Specifications

Parameter	Value
Ambient conditions	-20 to 55 C, continuous outdoor use
Power required	120 VAC, 15A max
Instrument air required	2 SCFM, 80 to 100 PSI
Sample flow required	50 SCCM
Calibration flow rate	1-5 SLPM
Response Time	T95 < 15 seconds
Gas concentration signal	4 to 20 mA analog output for each gas, adjustable concentration range
Digital inputs	
Digital outputs	Dry relay contacts rated to 30 VDC or 120 VAC, 1A For Instrument OK, Cal-valve open, In Maintenance

1.5- Features

- Proven technology for detection, accurate, precise, stable & long life.
- Simple Close Coupled Dilution Extractive System with Climate Control
- Low Flow – Low Dilution technology.
- Fast Response < 8 seconds for improved process control
- High Process Temperature up to 1200F
- Front panel Touch Screen Display and Control.
- 4-20 mA analog outputs for NO_x, SO_2, CO_2, and O_2 (Optional output configurations- Modbus or TP/IPC)

1.6- Mechanical Specifications

Probe Enclosure: NEMA 4 mounted directly to the flange 12” W x 7” D x 16” H

Probe: Stainless Steel with ANSI 150lb flange (3” or 4”) Standard lengths at 3’ and 6’

Controller: Wall Mount NEMA4- 12”W x 9” D x 16” H

Weight: 40 lbs depending on probe

1.7- Electrical Specifications

AC input (supplied by customer):

- Gauge wire- 14-30 AWG
- 120 VAC power that can source at least 15 amp to the AC power terminal.

Output Contacts (supplied by customer):

- Gauge wire- 8-24 AWG

Minimum rating 12V, 60mA.

Maximum rating 12V, 3.5A

Section 2 – Configuration and Operation

2.1- Pre-Setup Details

Getting started using your new CEMTEK Instruments analyzer should be quick and easy. In this section we have included the information needed for “standard” installations only. **To ensure the quickest and most reliable startup, please follow the subsequent steps.**

INSTALLATION OF THE SYSTEM:

The system consists of 3 major components:

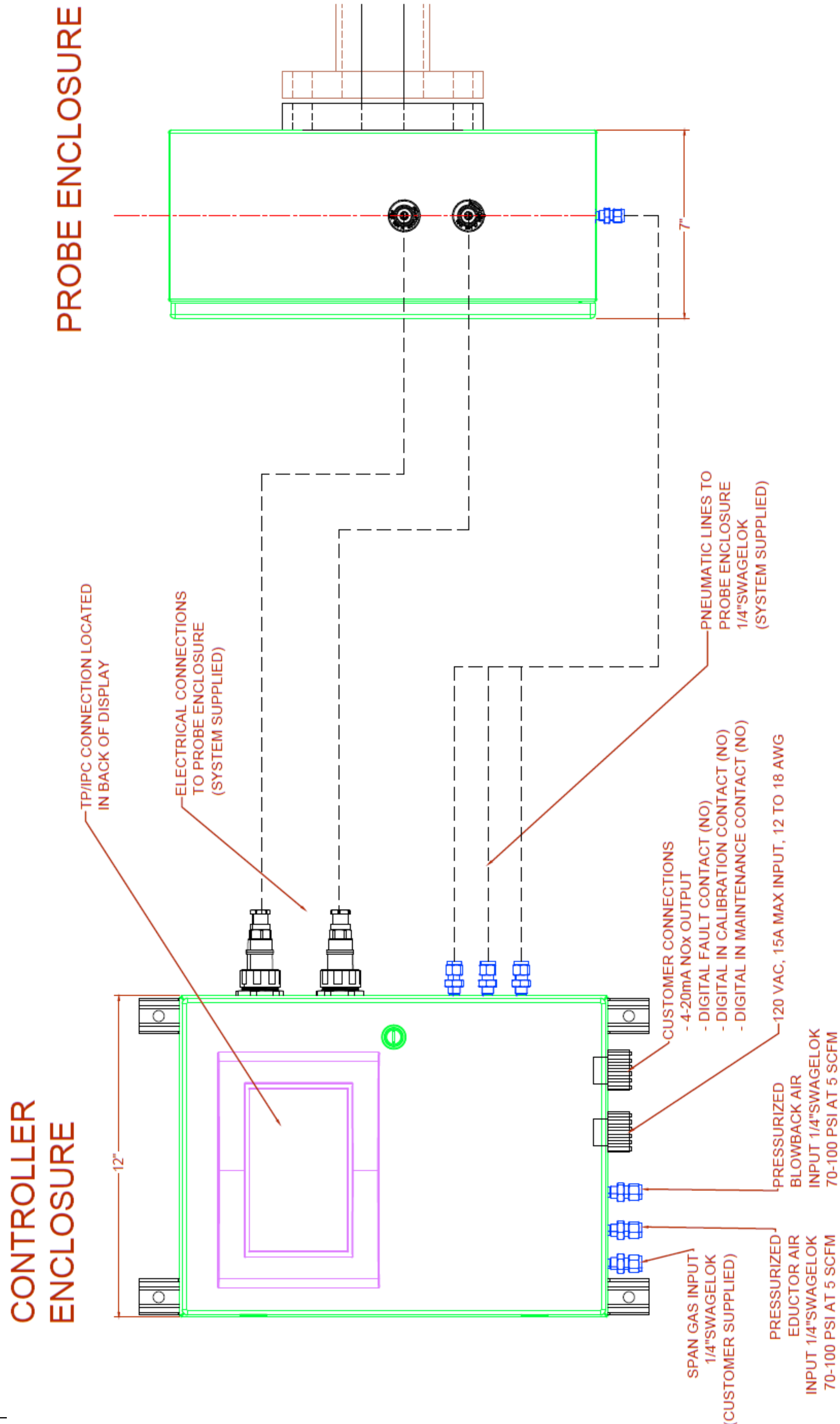
- The Analyzer Controller which houses the electronics and main system controls.
- The Probe which contains the dilution block and optional Oxygen Sensor along with the NO2 converter (if applicable) and NO sensor.
- The interconnect cables which contains the calibration gas line, pressurized air line, signal cables, and power cables.

Ensure all required services such as power supply, instrument air, and signal interface cabling are available prior to installation.

* Once the sample location has been identified, mount the probe at the sample port.

* Next mount the controller appropriately so that the sample line can be run between the controller and probe enclosure without danger of being damaged upon completion of installation.

The interconnect cables all should be labeled to ensure correct configuration and communication between the probe and the controller.


PROBE ENCLOSURE
7"
CONTROLLER ENCLOSURE
12"
TP/IPC CONNECTION LOCATED IN BACK OF DISPLAY
ELECTRICAL CONNECTIONS TO PROBE ENCLOSURE (SYSTEM SUPPLIED)
PNEUMATIC LINES TO PROBE ENCLOSURE 1/4"SWAGELOK (SYSTEM SUPPLIED)
CUSTOMER CONNECTIONS
- 4-20mA NOx OUTPUT
- DIGITAL FAULT CONTACT (NO)
- DIGITAL IN CALIBRATION CONTACT (NO)
- DIGITAL IN MAINTENANCE CONTACT (NO)
120 VAC, 15A MAX INPUT, 12 TO 18 AWG
PRESSURIZED BLOWBACK AIR INPUT 1/4"SWAGELOK 70-100 PSI AT 5 SCFM
SPAN GAS INPUT 1/4"SWAGELOK (CUSTOMER SUPPLIED)
PRESSURIZED EDUCTOR AIR INPUT 1/4"SWAGELOK 70-100 PSI AT 5 SCFM

2.2- Initial Setup Procedure

1. Connect Outer Controller Lines

1. Make sure that the analyzer is NOT powered on.

*****If the pneumatic block is NOT installed please go to the Appendix, page x. Otherwise continue on.***

2. Connect instrument air and span calibration gas to inlets shown below via ¼" Swagelok fittings. Span gas is connected to the far left and Instrument air on the right.

   a. Calibration gas: Should be at 3-4 SLPM at 10-40 PSI
   b. Instrument air: Should be at least 5 SCFM at 80-100 PSI
   c. Blowback air: Should be at least 5 SCFM at 80-100 PSI

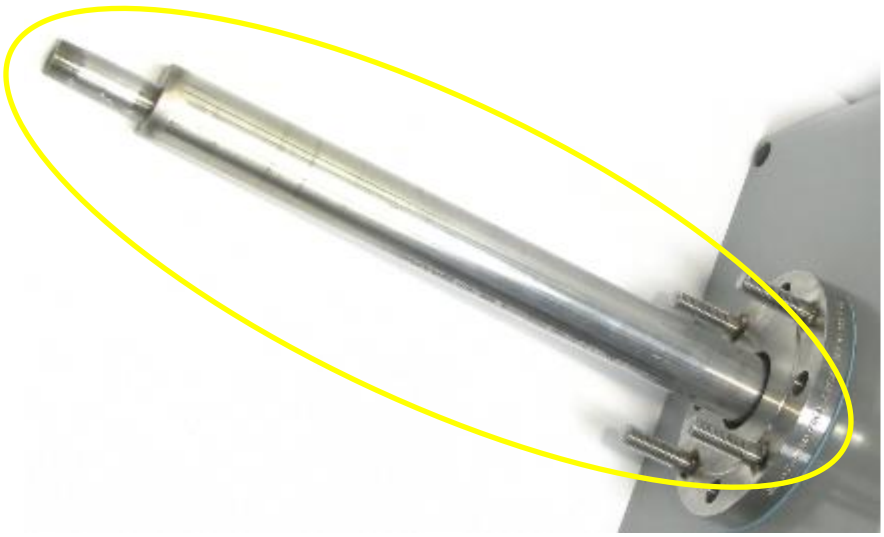
All connections in and out of controller (blowback air input connection not seen)

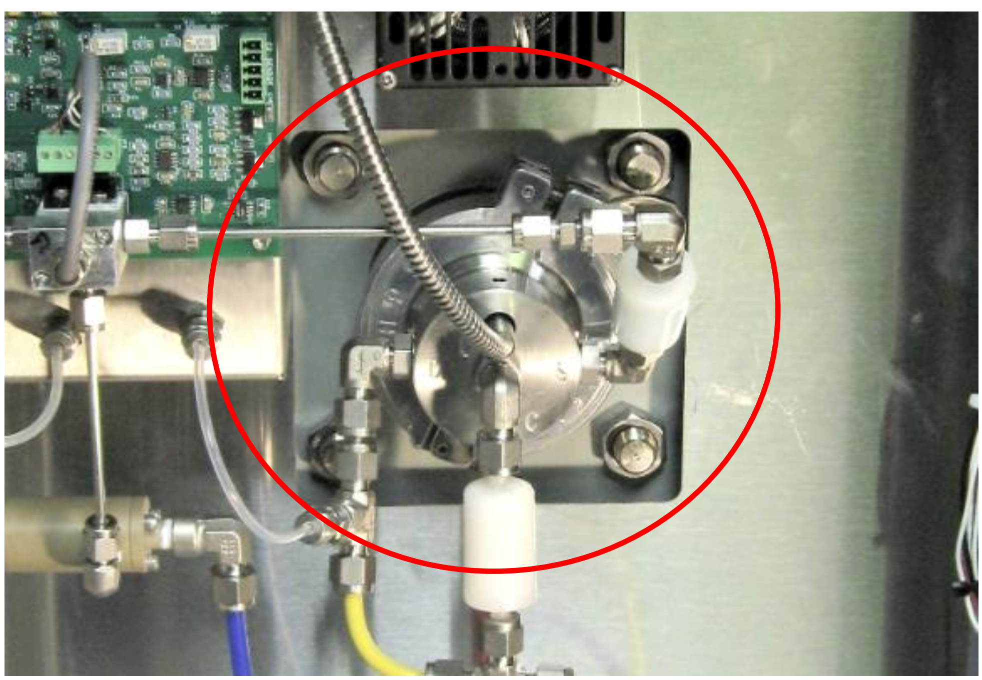
2. Insert Probe Stinger Into the Probe Enclosure Flange

1. Take the Dilution Probe Stinger (shown in yellow) and insert into the middle of the Probe Enclosure Flange.

2. Take the Stringer Clasp that fits around the base of the Probe Stinger and Flange mount and tighten down until in place and O-ring is snug (shown below in red).

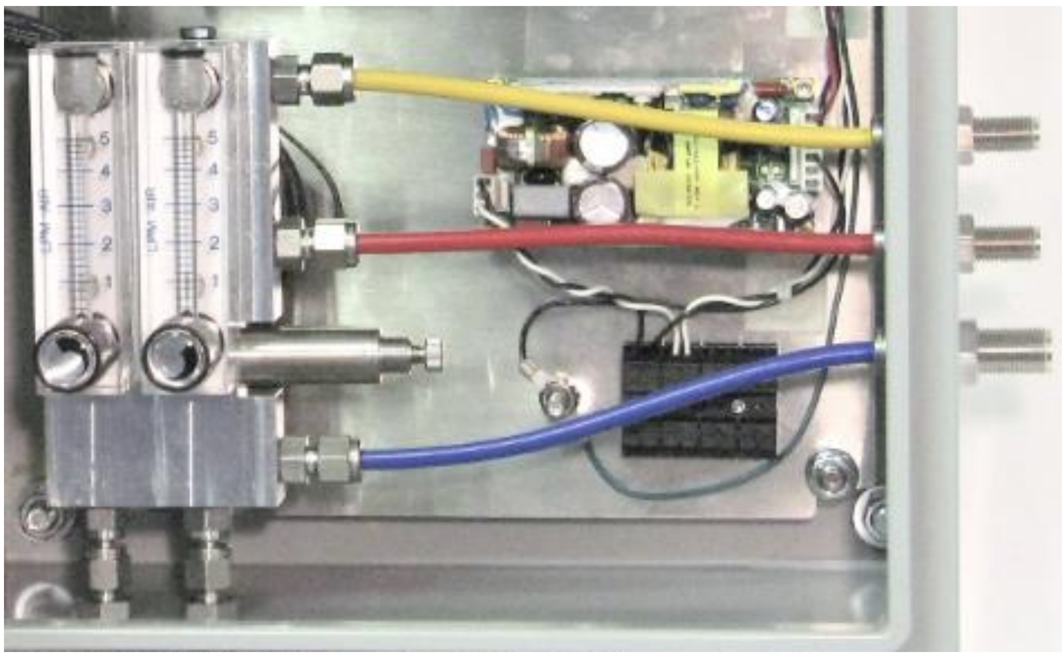
*****Make sure letters on stinger are right side up before proceeding to next step.***



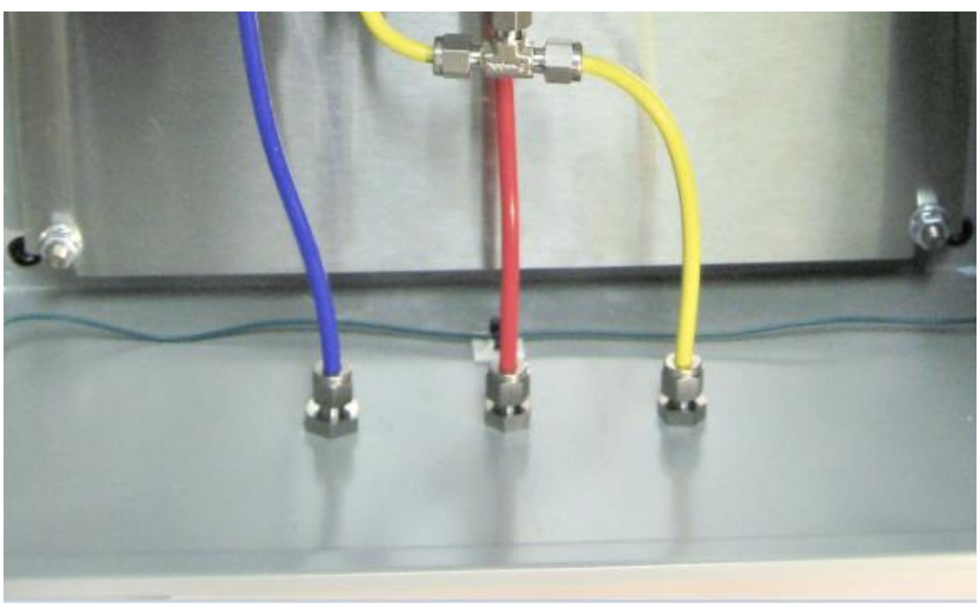


3. *Connect the Interconnect Pneumatic Lines between the Controller Enclosure and Probe Enclosure*

1. Connect the ¼ Red Calibration line, ¼ Yellow Dilution Air line, and Blue Air driven pump line into each of their associated bulkheads as shown below.



Controller Enclosure (above) Probe Enclosure (below)

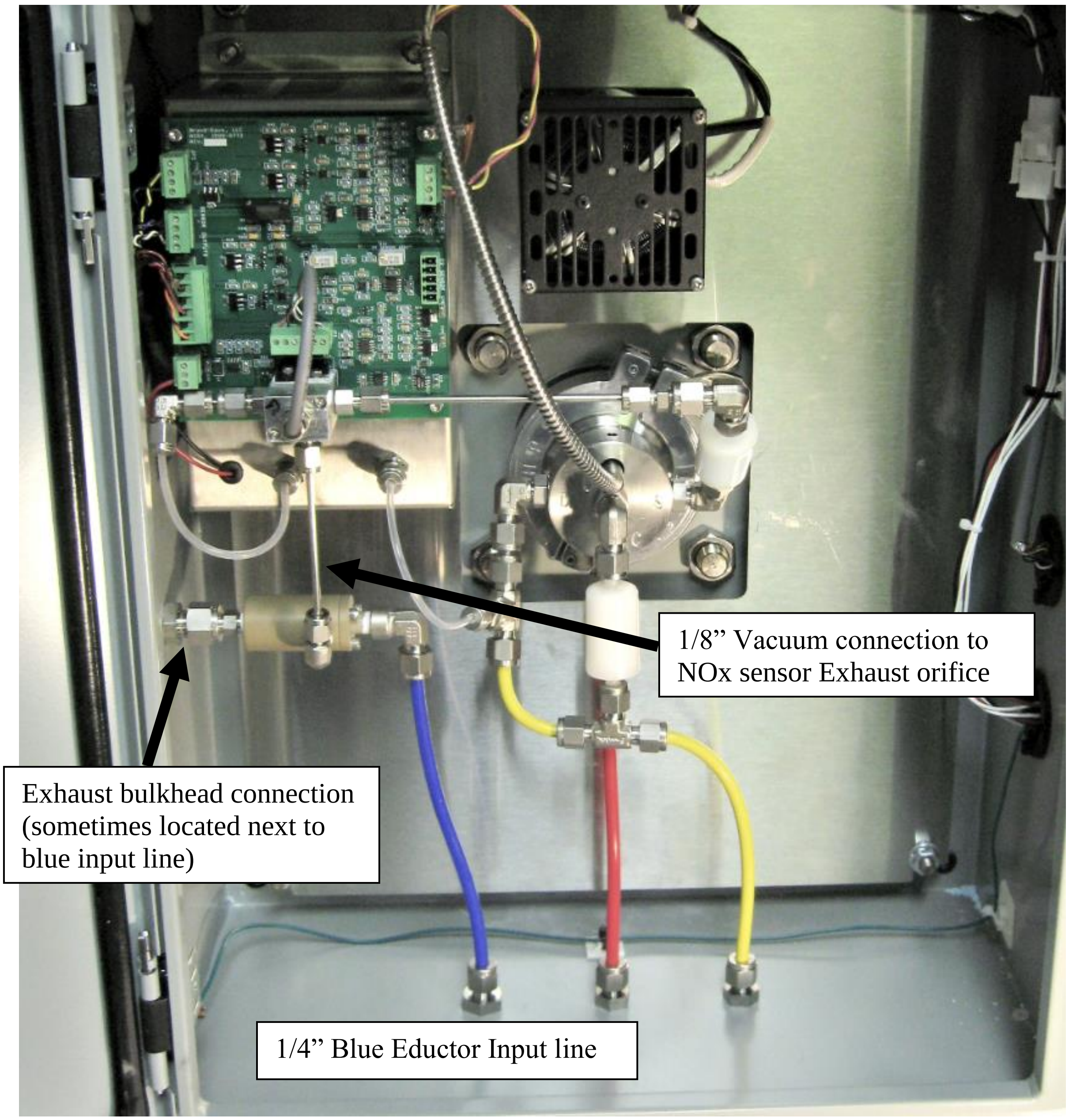


4. Connect the Interconnect Signal and Power Cable between the Controller Enclosure and Probe Enclosure

1. Cables will only fit into their associated bulkheads. Each connector contains a specific number of internal pins. See below.

5. Install the Inner Pneumatic Lines of the Probe Enclosure

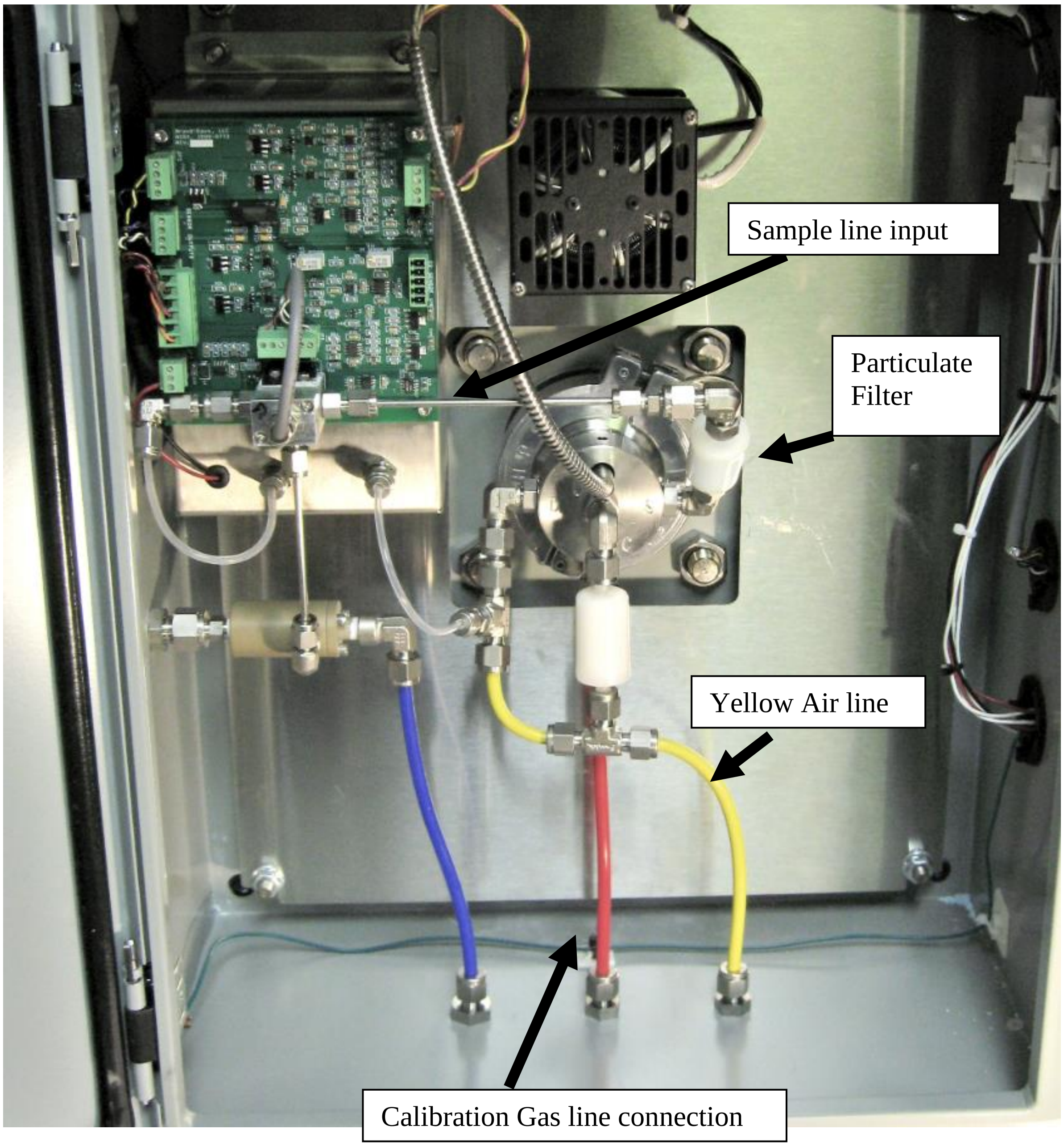
1. After connecting all the interconnect cabling it is now time to install the Air Driven Pump as shown below. This component is located in the Probe Enclosure.



2. Connect the in-line filter and ammonia scrubber (not shown) assembly into the NOx Sensor sample line input.

3. Connect the Red Calibration Line into the Probe Stinger

4. Connect the Yellow Dilution Air Line.

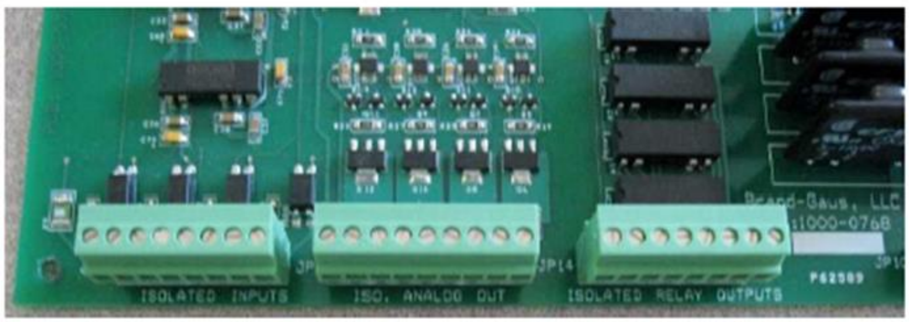


6. Connect the Inner Controller wires

1. Connect analog and digital output (see below or circuit board layout section for pin locations)

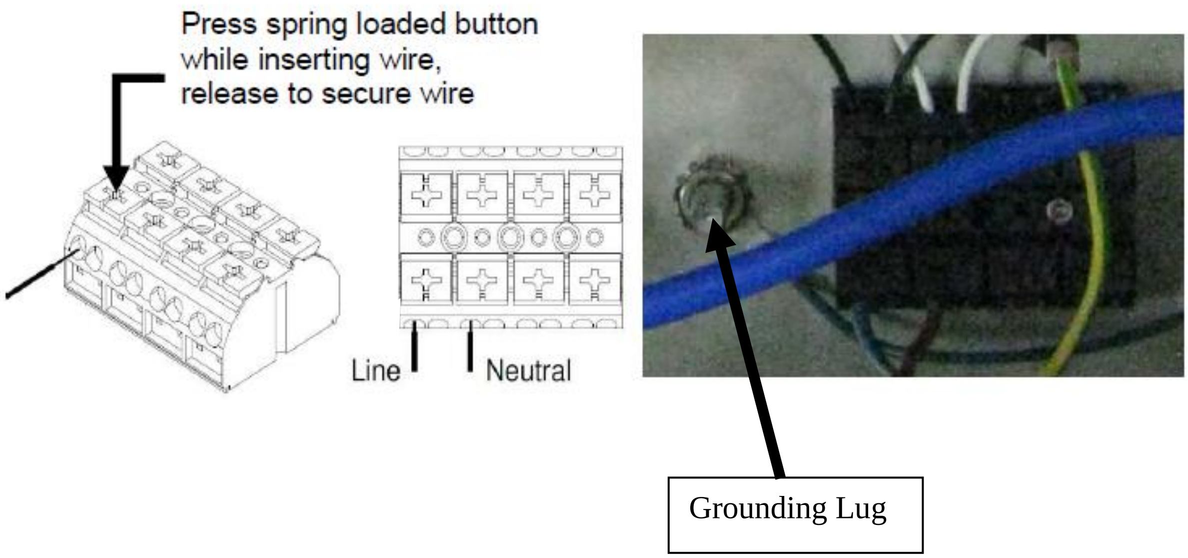
Facility I/O Connections

Connect facility signal I/O wires to the instrument via screw terminal plugs that mate with receptacles located along the lower left edge of the Interface Module system board. LED's indicate when relay outputs are active (closed). Relay outputs are dry contact. Isolated inputs have +24V supplied at the higher pin number.



Plug	Pin#	Value
Isolated Relay Outputs*	1,2	Reserved
Isolated Relay Outputs*	3,4	In Maintenance
Isolated Relay Outputs*	5,6	Cal Valve Open
Isolated Relay Outputs*	7,8	Instrument OK
Isolated Analog Out	1	N/C
Isolated Analog Out	2,3	Reserved
Isolated Analog Out (4-20mA)	4,5	Gas 3, Analog out: high, low
Isolated Analog Out (4-20mA)	6,7	Gas 2, Analog out: high, low
Isolated Analog Out (4-20mA)	8,9	Gas 1, Analog out: high, low
Isolated Inputs (wet, 24V+ at pin 2)	1,2	Start on-demand cal-check
Isolated Inputs (wet, 24V+ at pin 4)	3,4	Auto-capture during on demand cal-chek
Isolated Inputs (wet, 24V+ at pin 6)	5,6	Remote Zero valve control
Isolated Inputs (wet, 24V+ at pin 8)	7,8	Remote Span valve control
For each plug, numbering starts with Pin 1 at the leftmost position. *Dry, max switching 500mA at 200 VDC		

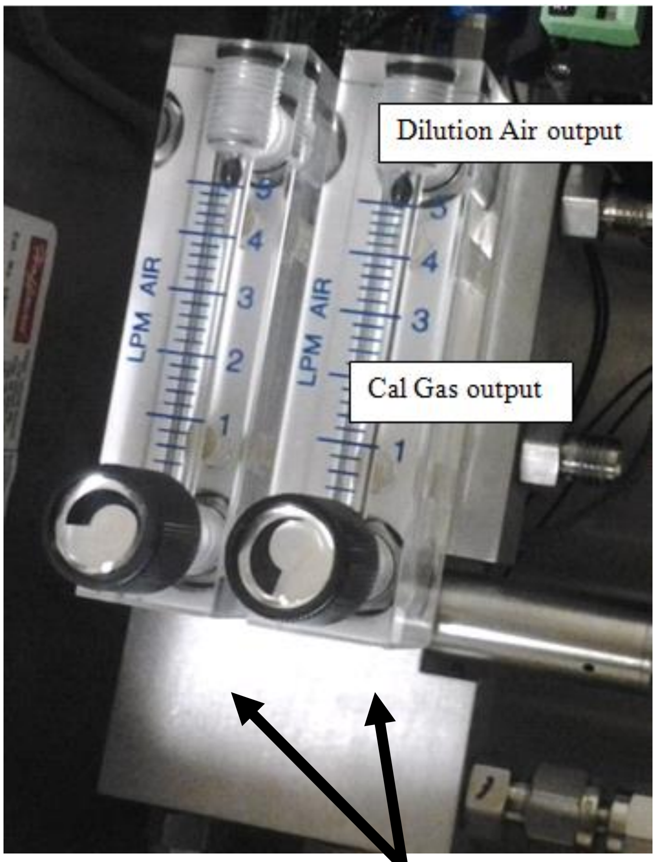
2. Connect the 120 VAC power supply input (from customer) through the other ¾" conduit labeled AC IN. As well properly ground the input to the controller where the lug is located (see below).



NOTE: at this point during the analyzer configuration **DO NOT** yet apply power to the system!

7. Apply power, Instrument air, and Cal gas to the Controller

1. Next apply the instrument/dilution air to the controller and set the flow through the right flow meter (furthest from controller wall) to 3 SLPM.
2. Apply calibration gas to the analyzer and set the left sample-flow meter (closest to controller wall) to approximately 3SLPM.
3. If either flow is out of range, adjust their *Flow Balance* regulator to get the desired flows (shown below).

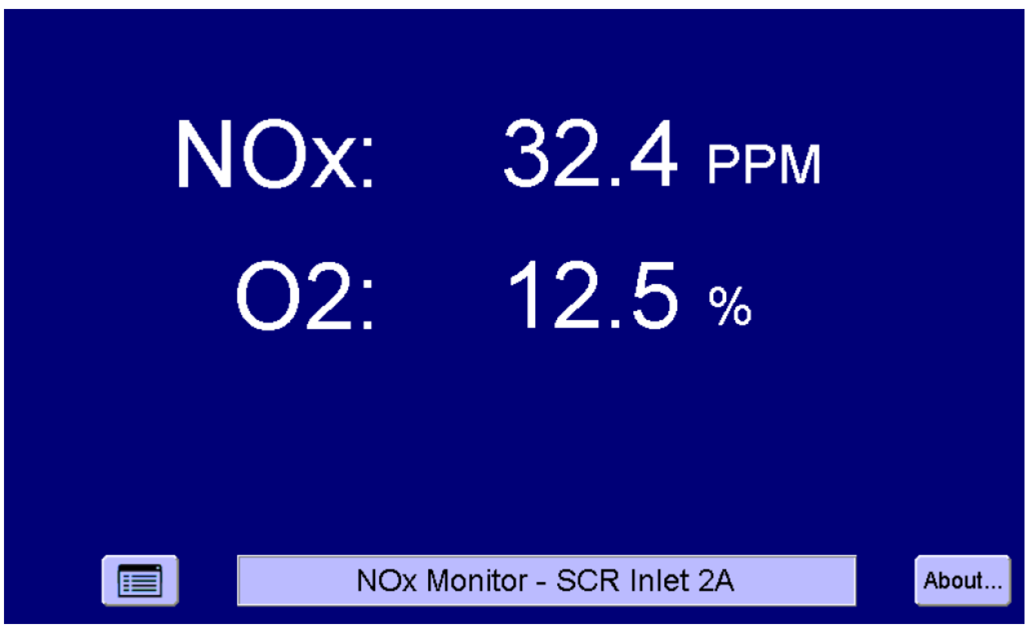


Caution: When working on the analyzer probe care should be taken. The exterior surface of the converter heater and tubes will rise to nearly 100°C if operated without the cover in place. Serious burns can result if the proper precautions are not taken.

4. Apply power to the system by either flipping the circuit breaker or plugging the external power supply in.

- Screen that should be displayed when power is turned on.

5. After a few seconds the NO_x and gas channel concentrations will be shown.



- Screen that should be seen once analyzer has gone through initial power up procedure.

6. Let the temperatures for each heating system rise and steady out (should allow about 30 minutes). The system temperature menu screen will indicate if power is being applied to the heated components. Here you will find other information regarding the heating elements of the analyzer (See touch screen menu navigation section to navigate there). Adjust the temperature limits and set points accordingly in terms of your analyzer's application.

Note: If set point temperatures are changed, check/adjust flow balance regulators and recalibrate all analyzer gas channels.

7. Set the Full-scale values of the analyzer

   Full-scale values for each gas channel can be set at any integer value between 1 and 2000 ppm. To adjust the output scaling, navigate to the Full-Scale Output menu via the touch screen and set to the appropriate values.

Note: The analog output is scaled to the gas channels full-scale value set. For example, if the full-scale of the gas channel is set to 50 ppm, then 20 mA will represent 50ppm.

   Full-scale for the O_2 channel can be set at any value between 5.0% and 25.0%. To adjust the output scaling, navigate to the Full-Scale Output menu via the touch screen and set to the appropriate values.

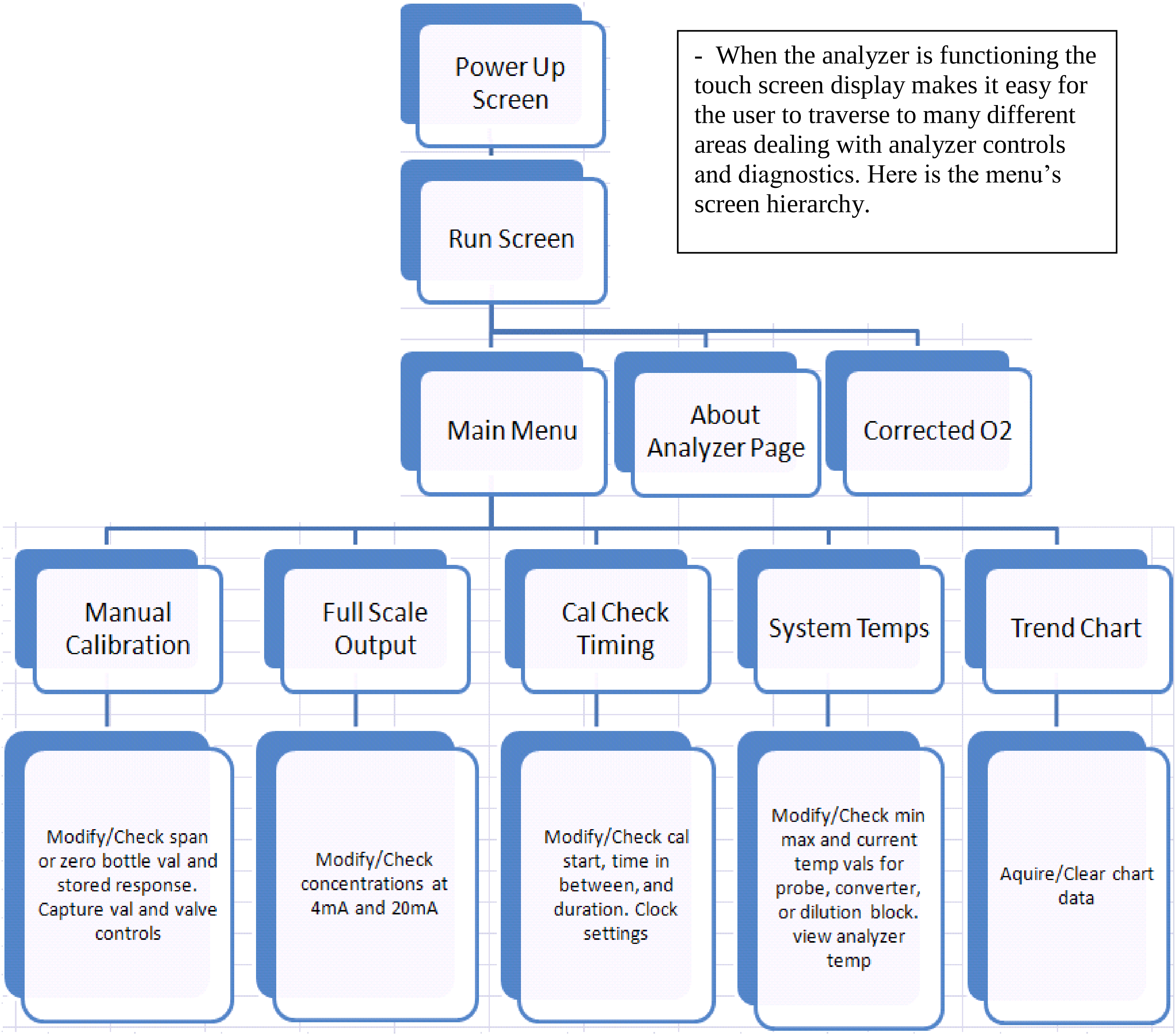
Note: The O_2 analog output is scaled to the O_2 full scale of the analyzer. For example, if the full scale of the analyzer is set to 25%, then 20 mA will represent 25% on the O_2 analog output.

8. Calibrate the analyzer

   After installation and at least a 1-hour warm up period, each gas channel can each be calibrated via following the procedures located in the "calibrating the analyzer" section (2.4)

2.3- Touch Screen Menu Navigation

- When the analyzer is functioning the touch screen display makes it easy for the user to traverse to many different areas dealing with analyzer controls and diagnostics. Here is the menu's screen hierarchy.



2.4- Calibration

After installation and at least a 1-hour warm up period, the gas channels can be calibrated via the Calibration Procedure as listed below:

Initial Calibration:

1) Follow the Calibration procedure outlined below, executed from the Manual Calibration screen.

2) By utilizing the Trend Chart found from the main menu, the response time for zero and span gases can be timed, which will assist in setting the calibration time.

3) It may be necessary to do a second calibration to stabilize the analyzer

Calibration Checks:

1) Set up the calibration check executed through the Cal Check Timing screen found in section 2.5

2) The time between checks is dependent on application, typically once per week should be good for process monitoring. For better feedback numbers change timing to every 24-48 hours or as required

3) When calibration check values are outside the required accuracy for the application, then a manual calibration should be performed

Notes on Calibration Frequency

* For normal process applications following the maintenance procedures in 2.6 will provide a level of accuracy acceptable for process monitoring

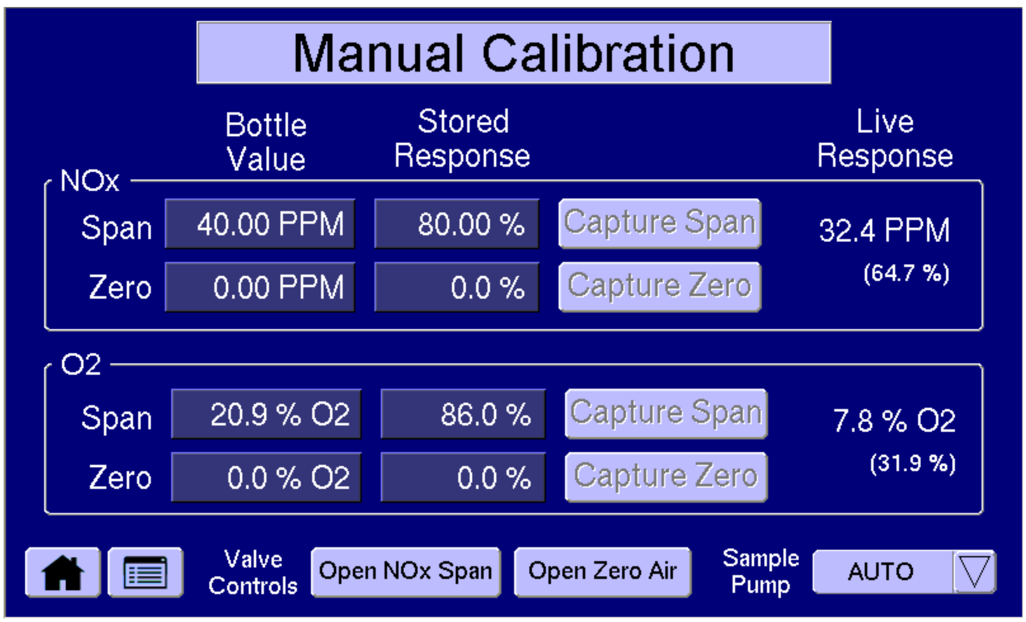
* For applications where a gas channel value is being used as a feedback number for SCR control then calibrating on a weekly basis is recommended

* For applications whereby gas channel numbers are being utilized as a means of proving the process system's ability to meet the permitted limits (without the requirement for certification) calibration drift of the analyzer should be monitored- When readings obtained are outside the acceptable limits, a recalibration should be performed

**** The analyzer can be set to do a calibration check on a daily basis. By tracking these calibration check figures and comparing them to the calibration gas bottle concentration being used, it is possible to determine the daily drift of the analyzer. ***It is recommended that if the drift is greater than 2.5ppm then a manual recalibration be performed ******

Calibration Procedure

In order to calibrate the analyzer's zero and span values the user must navigate to the manual calibration segment (see section 2.5, modifying/checking calibration values).



NOTE!

* Before calibration of the analyzer ensure that the Calibration Gas bottle values saved are correct

* Make sure that the associated bottle value is within the range of the full-scale output values set

The screen displayed on the previous page shows the following:

- The calibration gas values for both zero and span
- The analyzer stored response values, which are shown and saved within the instrument as the sensor response percent
- The live response which is the current analyzer reading that is shown as both the PPM and the sensor response percent

In order to perform a manual calibration, follow the procedure below starting with manually calibrating the zero gas, followed by performing a calibration with the span gas.

1. Open the zero or span valve to initiate either the zero or span calibration of the analyzer (only open one valve at a time)

2. Once the live response has settled you may select capture span/zero. This will change a setting stored in the analyzer that calculates the live response of the current sample gas

NOTE! Record the time it takes for the value to settle, as these will be used to set the automatic calibration sequence. (See Cal Check Timing in Section 2.5)

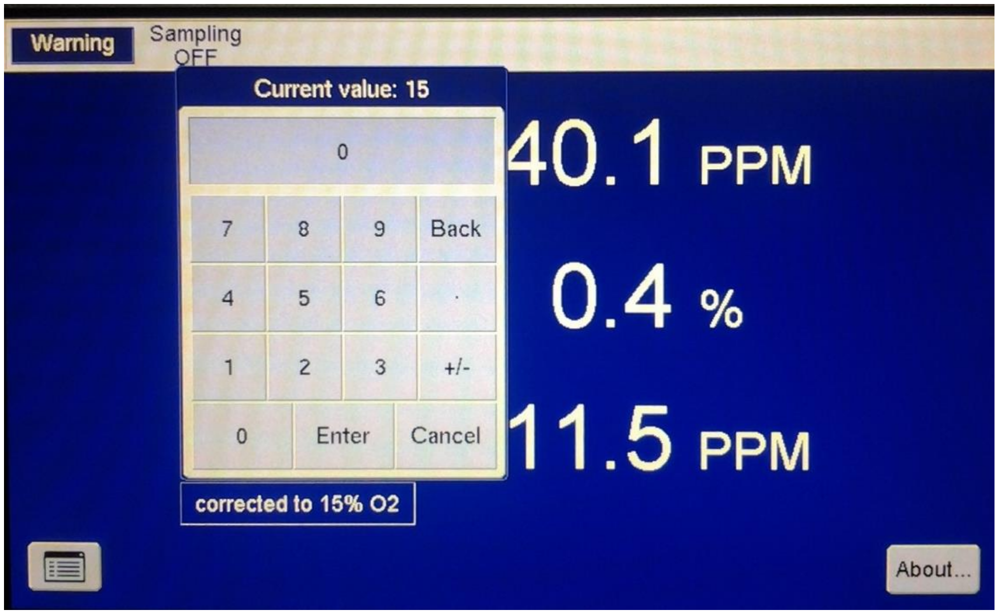
3. After completing the calibration of the analyzer close the calibration gas valves and check to ensure sample pump is on.

NOTE! For the most accurate readings calibrate the zero and span of a gas back to back

2.5- Modifying/Checking Analyzer Diagnostics

Modifying/Checking the corrected O_2/CO_2 value

Run Screen → corrected O_2/CO_2 →

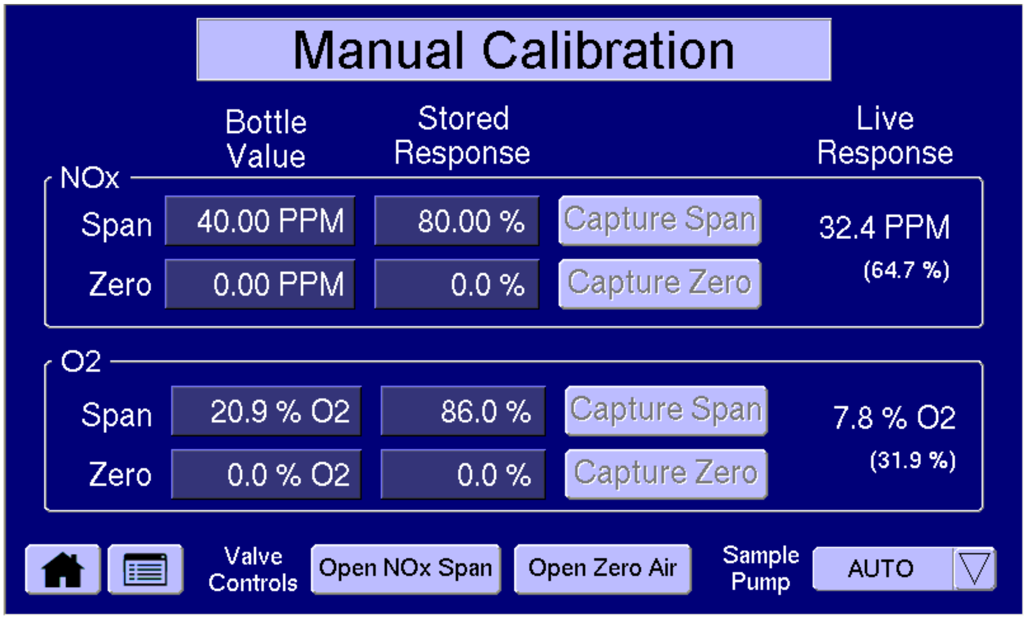


From this screen you can:

- Modify or check the current corrected gas value

Modifying/Checking Calibration values-

Run Screen → Main Menu → Manual Calibration →

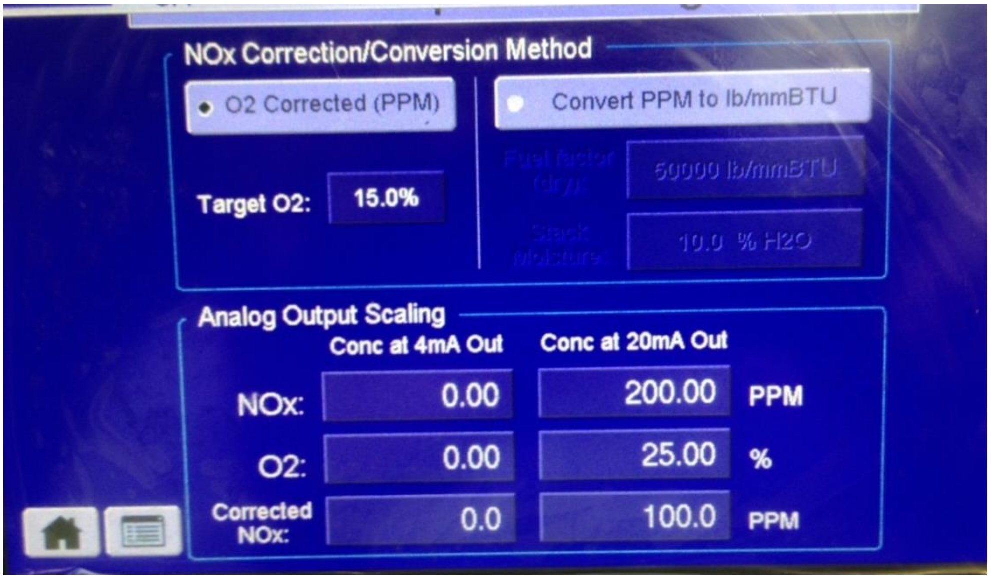


From this screen you can:

- Modify or check bottle or stored response values associated with the span and zero of the sampling gas
- Open or close the span or zero gas valves
- Modify or check the sample pump functional setting
- Capture the Span or Zero response also known as calibrating the analyzer
- View the live response readings

Modifying/Checking Full Scale Output-

Run Screen → Main Menu → Full-Scale Output →

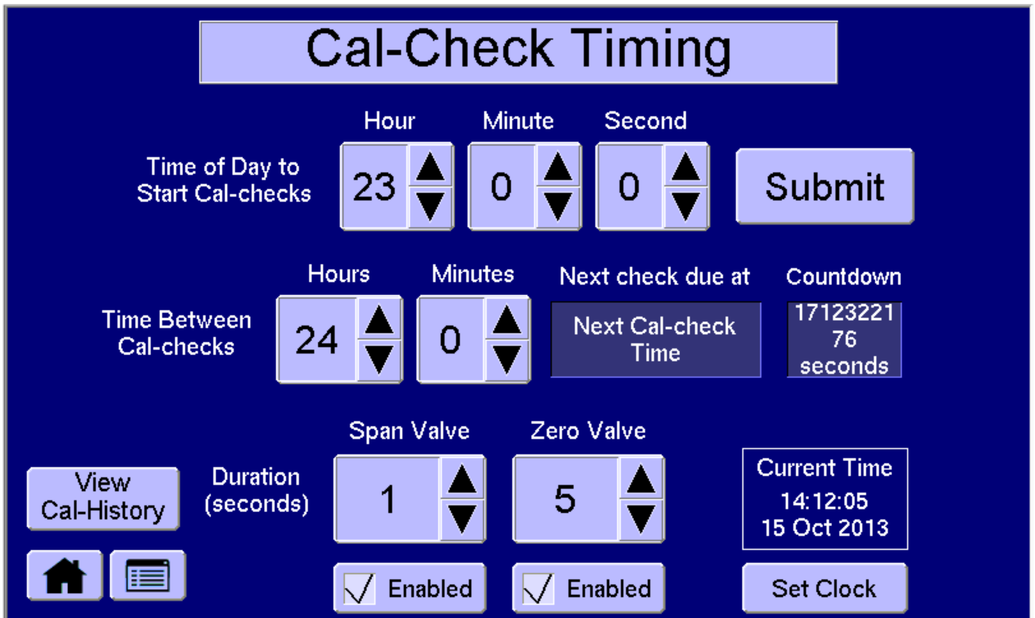


From this screen you can:

- Modify or check values associated with the concentrations at 4mA and 20mA outputs
- Modify or check NOx Correction/Conversion Methods

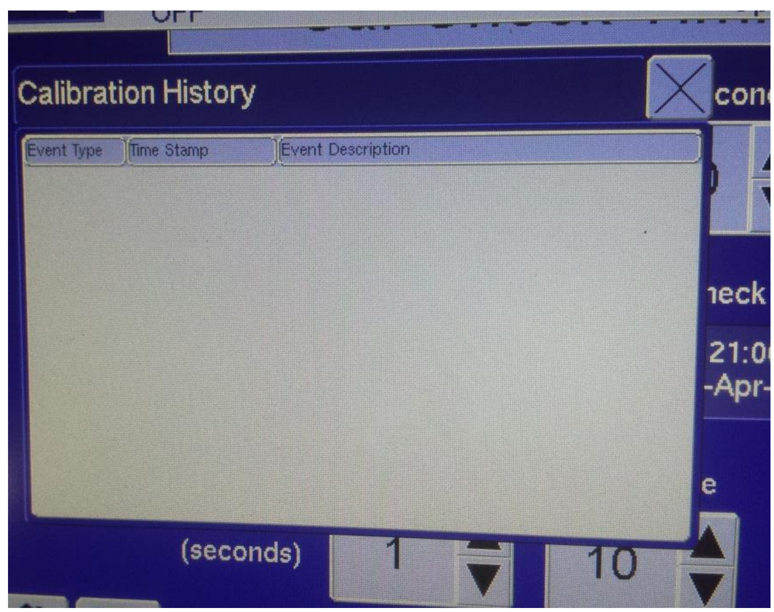
Modifying/Checking Calibration Timings

Run Screen →Main Menu →Calibration Timings →



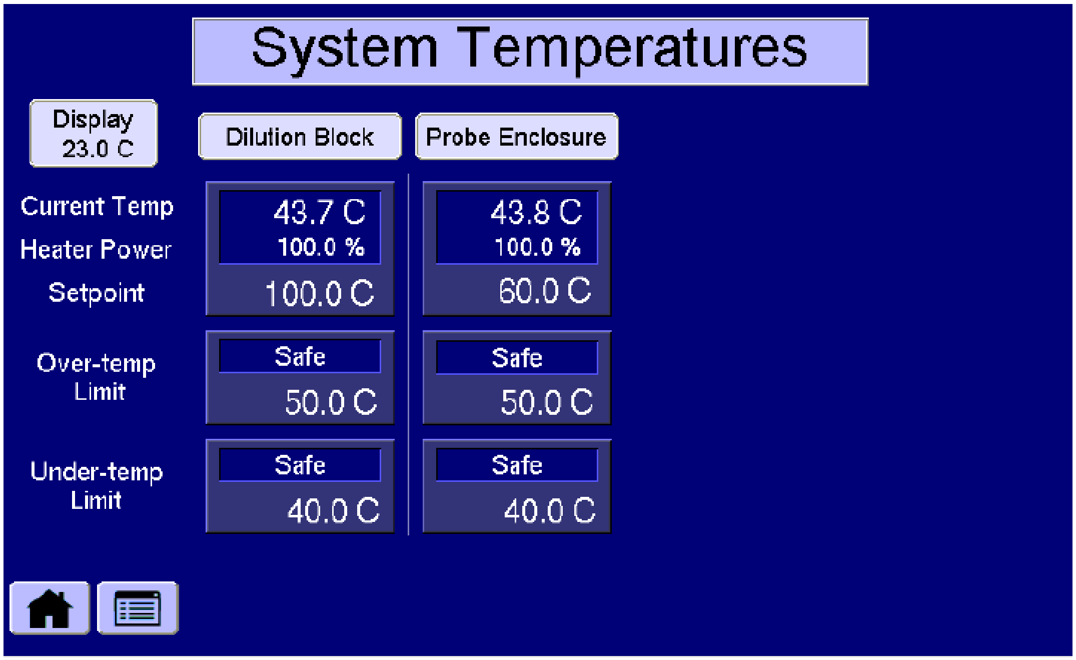
From this screen you can:

- Modify or check the time of day to start Cal-checks
- Modify or check the time between Cal-checks
- Check the time and date in which the next check is due at
- Check how many seconds there are until the next Cal-check and Cal History
- Modify or check the Duration in seconds that the span and zero valves will be open
- Enable or Disable the span and zero automated Daily Cal Checks
- Modify or check the current time and date



Modifying/Checking System Temperatures

Run Screen → Main Menu → System Temperatures →

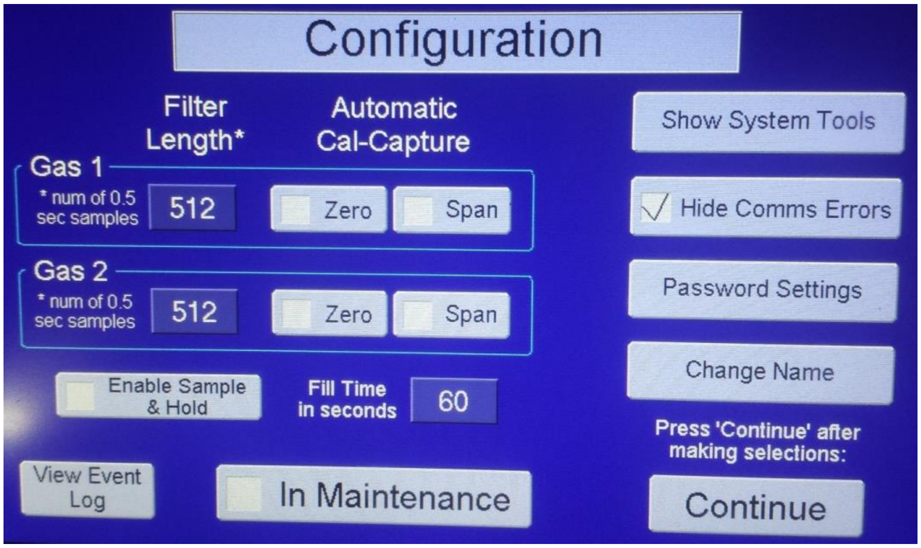


From this screen you can:

- Modify or check the over or under values of each component's temperature limits
- Check the current temperature and power being supplied to the heater of each component
- Check the controller's temperature

Configuration Screen

Run Screen → Main Menu → Configuration →

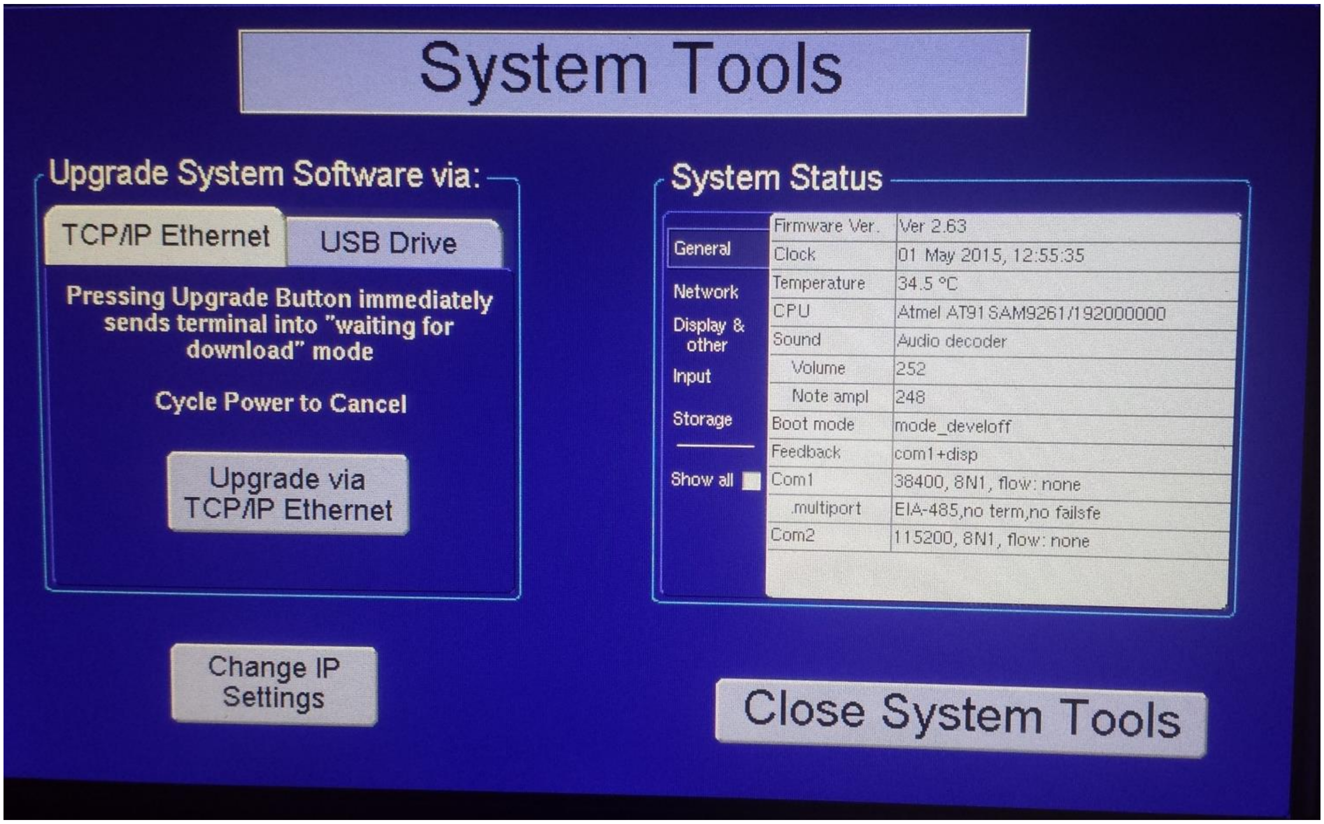


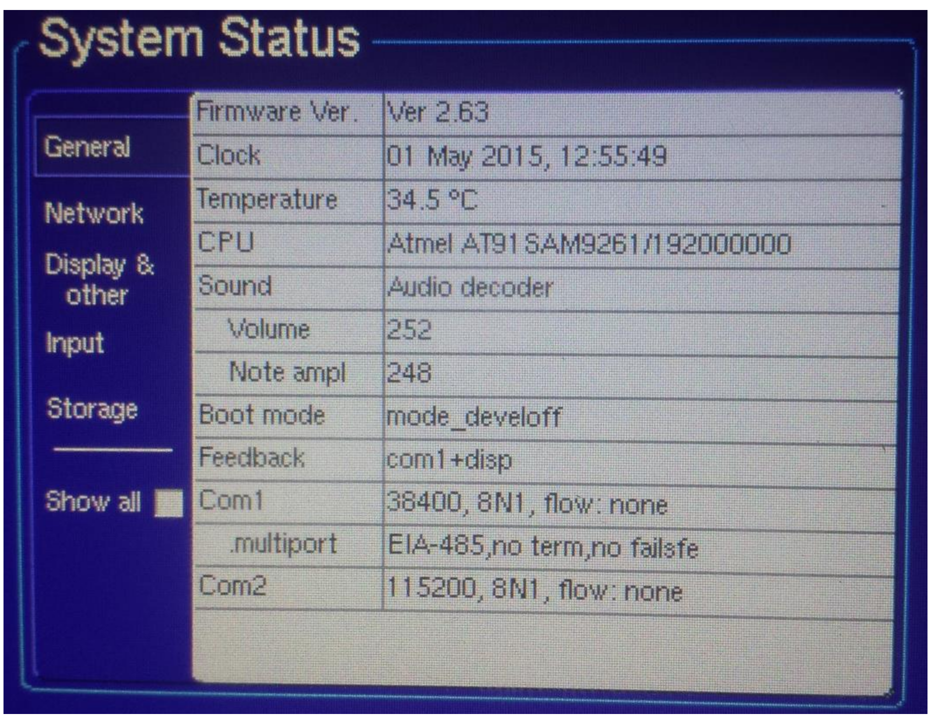
From this screen you can:

- Modify or check gas filter length coefficients
- Enable or Disable each gas channel's Automatic Cal-Capture
- Enable the Sample and Hold function and its Fill time
- Place system in Maintenance
- Navigate to the System Tools screen
- Show or Hide Comms Errors
- Make unit password accessible
- Change Units name (see below)
- View Event Log

System Tools Screen

Run Screen → Main Menu → Configuration → System Tools





From this screen you can:

- Upgrade system software
- Check various system status information
- Change IP settings (see appendix for further description)

2.6- Preventative Maintenance

Once the analyzer is correctly configured and functioning as intended, it is crucial to implement periodic checks to avoid problems causing analyzer down time.

The type and amount of maintenance required varies upon application. It is dependent on the concentration of the measured gas, particulate loading, moisture, and other sorts of relevant flue gas constituents.

Yearly basis:

- Check/Clean/Replace as necessary the Probe Stinger
- Check Linearity of each integrated gas sensor by running a mid-range gas value after a calibration procedure is performed. –Contact CEMTEK if sensor linearity procedure must be done
- Check/Replace lines for contamination
- Check/Clean/Replace each sensor's components and Ozonator module

Quarterly basis:

- Check the amount of air/gas flow while instrument air/cal gas is flowing through the analyzer. Adjust the flow balance regulators as necessary
- Check/Replace the Filter Assembly consisting of the ammonia scrubber and in-line filter
- Check/Clean the Exhaust orifice at the probe enclosure
- Check/Clean Eductor Pump parts

Monthly/weekly basis (application dependent):

- Check for alarms and system abnormalities
- Check Air and Calibration gas system pressures
- Run analyzer calibration check
- Manually recalibrate the analyzer if necessary

** Here are acceptable log sheets that can be used to carry out monthly/weekly, quarterly, and yearly preventative maintenance checks as described on the previous page.

8000 NOX-O2 PROBE MONTHLY/WEEKLY CHECKS

Alarms?		YES	NO

Plant inlet air pressure(psi)	*70 - 90 psi*	psi	OK
Air cleanup panel psi(exit)	*60 - 80 psi*	psi	OK
Calibration Gas Bottle pressure	*>150psi*	psi	OK

***must recalibrate analyzer if pressures and/or flows are changed.**

NOx zero air check value (PPM)	*0*		**Pass/Fail**
NOx zero stored % value		%	
O2 span check value (%)	*20.90%*		**Pass/Fail**
O2 span stored % value		%	

NOx span gas check	*see bottle*		**Pass/Fail**
NOx span gas stored % value		%	
O2 zero check	*0*		**Pass/Fail**
O2 zero stored % value		%	

8000 NOX-O2 PROBE QUARTERLY CHECKS

RUNNING NOx SPAN GAS:

NOx span gas flow	*3 LPM*	lpm	OK
NOx span gas dilution air flow	*3 LPM*	lpm	OK

RUNNING NOx ZERO GAS:

NOx zero gas flow	*3 LPM*	lpm	OK
NOx zero gas dilution air flow	*3 LPM*	lpm	OK

ANALYZING SAMPLE GAS:

Calibration gas flow	*0 LPM*	lpm	OK
sample dilution air flow	*3 LPM*	lpm	OK

Probe Temperature	*see set point*	C˚	OK
Converter Temperature	*see set point*	C˚	OK
Enclosure Temperature	*see set point*	C˚	OK

Check/Replace Filter Assembly and pre O2 sensor filters	OK
Check/Clean Eductor Pump	OK
Check/Clean Exhaust orifice	OK

***must recalibrate analyzer if flows, parts, or temperatures are altered.**

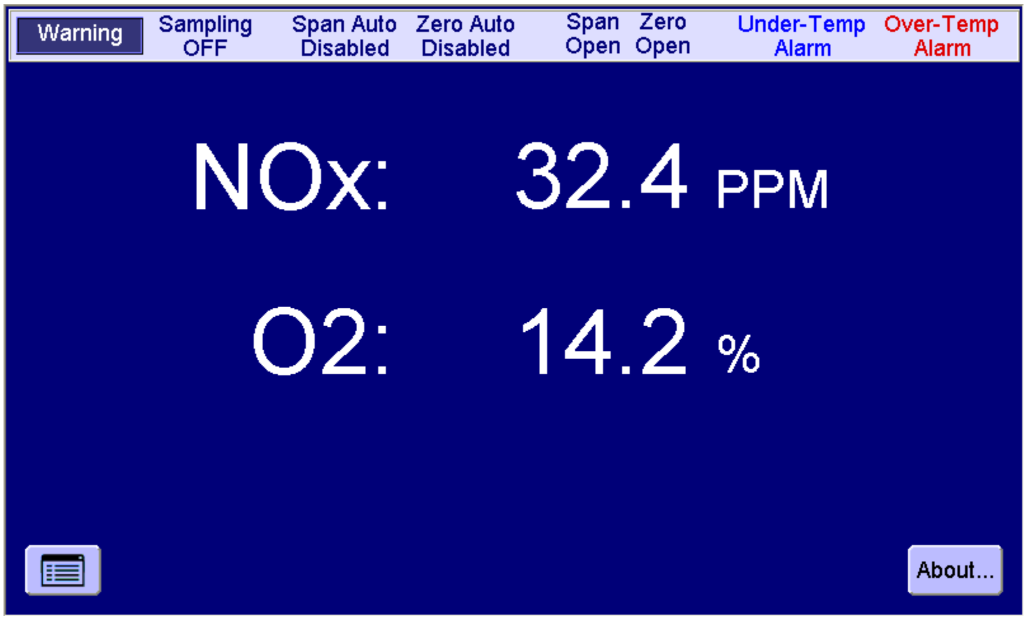
8000 NOX-O2 PROBE YEARLY CHECKS

Check/Clean all lines for contamination		OK
Check/Clean NOx reaction cell		OK
Check/Clean as necessary the Probe Stinger		OK
Check Linearity of NOx/O2 sensors by running a mid-range gas value of NOx and O2 after a calibration procedure is performed. – Contact CEMTEK if sensor linearity procedure must be done		OK

***must recalibrate analyzer if sensor parts or lines are cleaned.**

3.1- Warnings/Alarms

- Warnings and Alarms are displayed atop the Run Screen (as shown below).



Sampling OFF-There is no sample being drawn through the analyzer. This may be due to a manual or auto calibration taking place. Otherwise this warning is most likely caused by a blockage in the sample line or sample pump disengagement or malfunction.

Span Auto Disabled-States that the calibration check of the span value for the analyzer is disabled. See touch screen menu navigation section to enable auto span calibration.

Zero Auto Disabled-States that the calibration check of the zero value for the analyzer is disabled. See touch screen menu navigation section to enable auto zero calibration.

Span Open- States that the Span gas valve is open, should be seen during manual and automatic calibration of the analyzer's span value. See touch screen menu navigation section to close and open this valve.

Zero Open- States that the zero gas valve is open, should be seen during manual and automatic calibration of the analyzer's zero value. See touch screen menu navigation section to close/open this valve.

Under-Temp Alarm- Alarm displayed when a probe, converter, or dilution block temperature is under a specified limit set in the system temperature segment. See touch screen menu navigation section to view alarm details. Many need to troubleshoot.

Over-Temp Alarm-Alarm displayed when a probe, converter, or dilution block temperature is over a specified limit set in the system temperature segment. See touch screen menu navigation section to view alarm details. Many need to troubleshoot.

3.2- Troubleshooting

Once the analyzer has been set up correctly through the Initial Setup Procedure and has been functioning acceptably beyond start up issues, situations in which the analyzer is not functioning properly may arise. Below are descriptions of possible issues that may be experienced and the correct steps to take in troubleshooting them.

Analyzer Touch screen not powering on:

Blank Touch screen

- Check wiring to analyzer and into back of HMI display

- Check analyzer circuit breaker switch

- Replace screen

Ozonator not functioning properly:

If there is not a steady response while the analyzer is experiencing span gas or sample, check Ozonator function. –you should also be able to smell Ozone when Controller Enclosure is opened, if not this a sign that the Ozonator is not functioning properly

- Check wiring from Main Circuit Board into Ozonator

- Check input and output tube connections

- Replace Ozonator

Unresponsive NO_x, SO_2, or CO_2 reading:

When a change in a gas's ppm value should be seen (such as when switching from zero to span gas during a calibration check)

- Check flow scheme for leaks and loose fittings

- Make sure there is some type of range between the stored % response of the zero and span calibration values on the manual calibration page

- Validate proper calibration gas input conditions as specified in the initial set up section

- Check that the pneumatic block solenoid valves are all functioning correctly

  a. While monitoring the flow meters, manually open/close the span and zero valves and eductor pump via the touch screen on the calibration page

- Check vacuum pressure of sensor's exhaust line on eductor pump component

  a. May have to clean eductor pump fittings

- Check state of filters in filter assembly

-Check eductor exhaust flow at probe

  a. If there is not sufficient air flow out of the eductor there may be a problem with your pneumatic block or a clogged exhaust line (within sample line or up at probe). Blow out all exhaust lines

-Check/Clean sensor optics

-Check/Clean NOx sensor

a. Unplug the NOx sensor connector from Main Circuit Board
b. Unscrew both Alan screws holding the top part of the sensor block into the main sensor block
c. With caution, remove top of sensor block containing sensor optics.
d. Check for particulate build up on sensor window. Clean with appropriate optic wipes.
e. Check/Clean exhaust orifice, sample orifice and ozonator orifice for particulate build up- must unscrew orifices from mounted sensor block with wrench. Be careful not to damage O-rings– replace O rings if necessary

- May need to replace gas sensor if all other options have been exhausted

Unresponsive O2 reading:

When a change in O2 value should be seen (such as when switching from zero to span gas during a Calibration Check)

- Check O2 wire connection into Main Circuit Board and at sensor connection up at probe.

- Make sure there is some type of range between the stored % response of the zero and span calibration values on the manual calibration page

- Check flow scheme for leaks

- Check eductor vacuum on ¼” fitting

- Check pre-O2 filter for contamination up at probe

- Disassemble and check for contamination inside O2 sensor assembly

- Replace O2 cell

Over/Under Temperature Alarm:

Will be seen atop the main screen

- Go to system temperature page and confirm set points for alarms and regulating points are correct

- Check Sample line to main board wiring connections

- Check heater wiring connections

- Check Probe Enclosure wiring connections

Analyzer Software Update:

When a software update must be manually carried out

- Power system down

- Upon powering system up, hold finger in upper right corner to bring up the system diagnostics menu

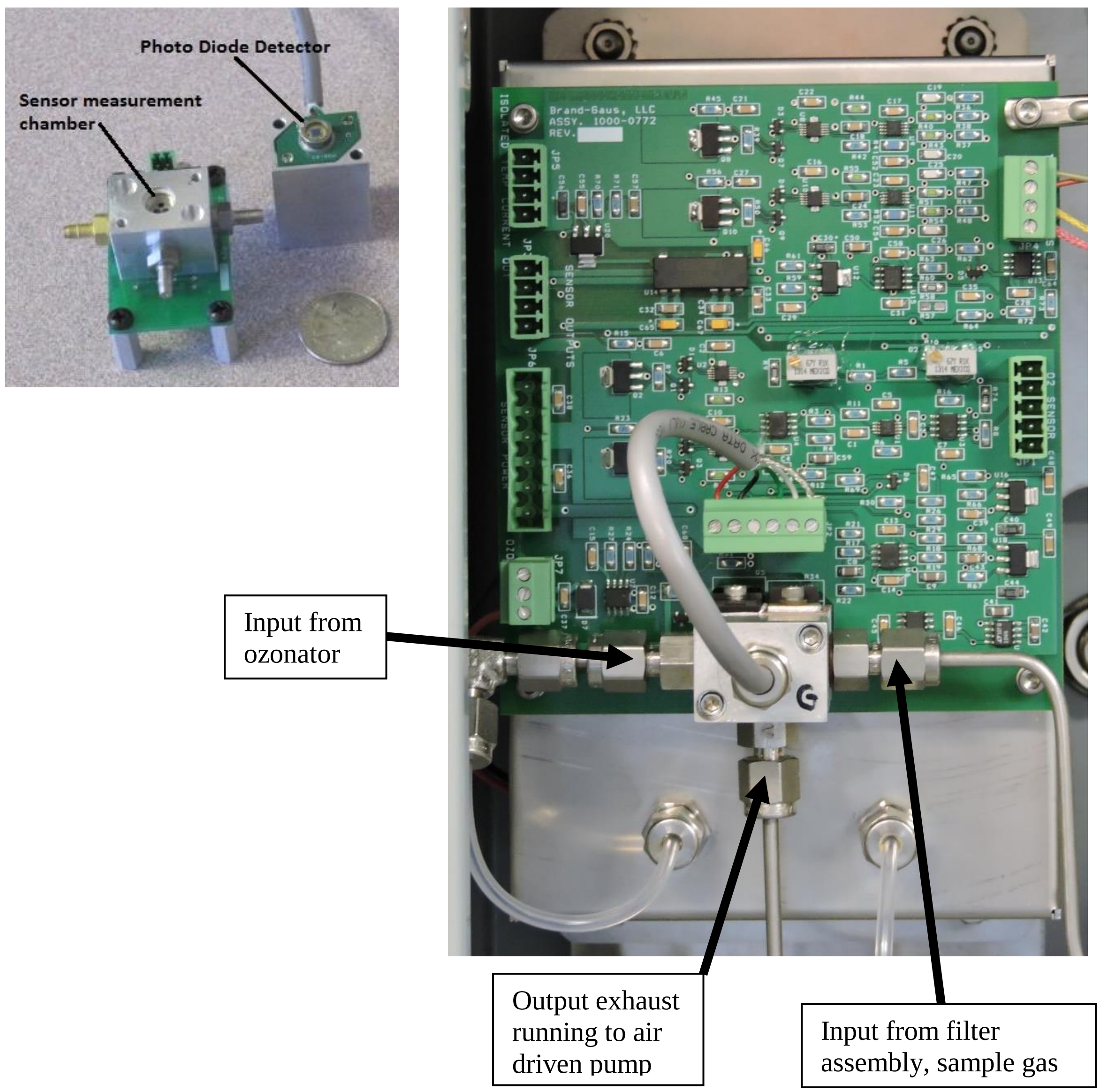
-Navigate thru diagnostics menu to accordingly update necessary software patches

- May need to hook up Ethernet cable or flash drive into back of touch screen panel

3.3- Important System Components

NOx Sensor

Sensor (shown below, covered in insulating foam) that measures the PPM of NOx in the given sample, located in Probe enclosure on Main Board.

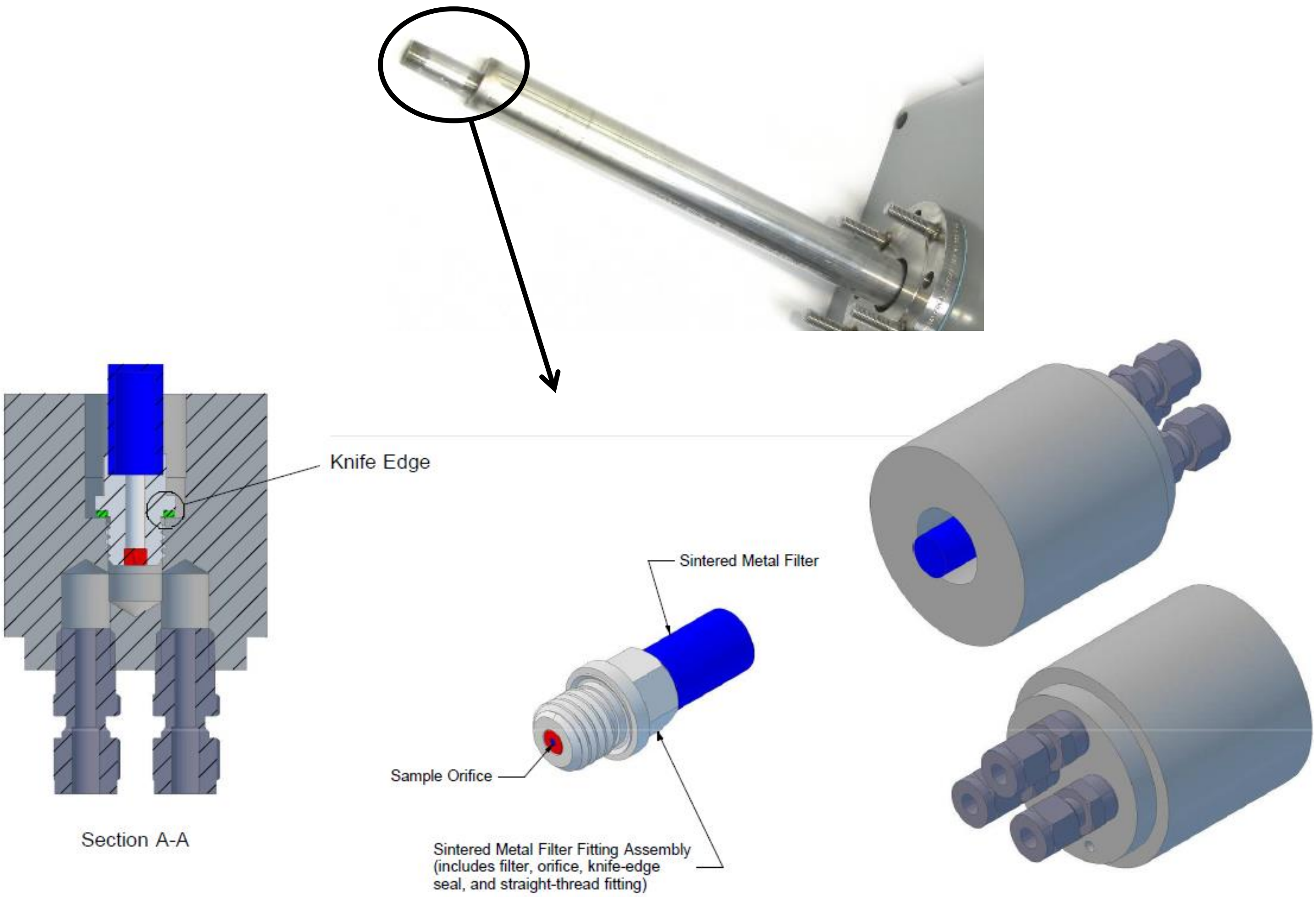


NO2 Converter

Component heater that converts NO_2 to NO, located in probe tip as optional add-on pending on application specific process.

Probe Stinger Assembly

Component connected via flange protruding out into the gas stream that the certain analyzer is sampling. Component consists of sample orifice, sintered metal filter, dilution orifice, dilution block, and knife edge seal.

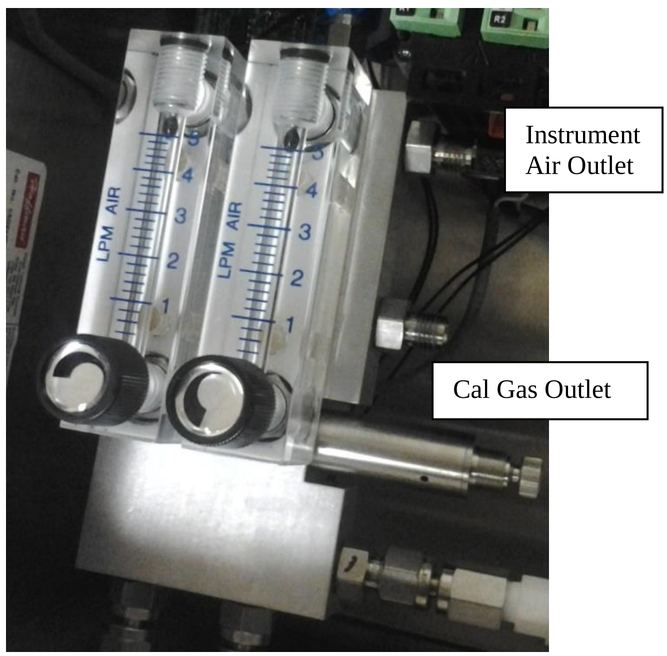


Ozonator

Component that creates O_3 from instrument air, located in the probe enclosure. Found mounted to the DIN rail, to the left of the Watlow Heater Controller, located above the Pneumatic Block. Make sure to install the Pneumatic Block after the Ozonator is installed

Pneumatic Block

The assembly that consists of the flow balance rotometers and educator plumbing, it regulates all the system's flows. The two flow balance rotometers control the flow of either the calibration gas or instrument air supply to the NOx sensor. While the educator plumbing feeds the air supply needed to power the air driven pump.



Air Driven Pump

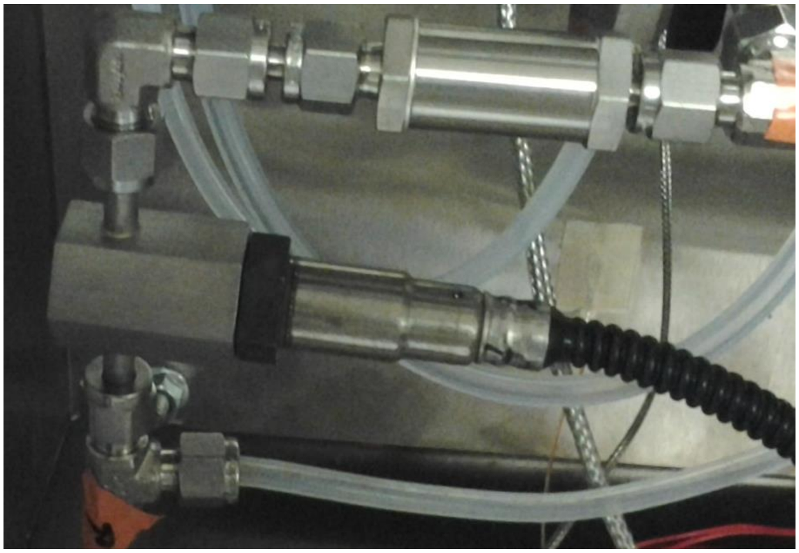
This component creates a vacuum and pressurizes the entire analyzer through eduction. It's located in the probe enclosure.

Inline Sample Filter

The ammonia scrubber removes NH3 from the sample gas. As the in-line filter conditions the sample gas prior to the NOx cell. The assembly is located before the NOx cell now in the probe enclosure. (Heavy Duty Assembly shown)

O2 cell

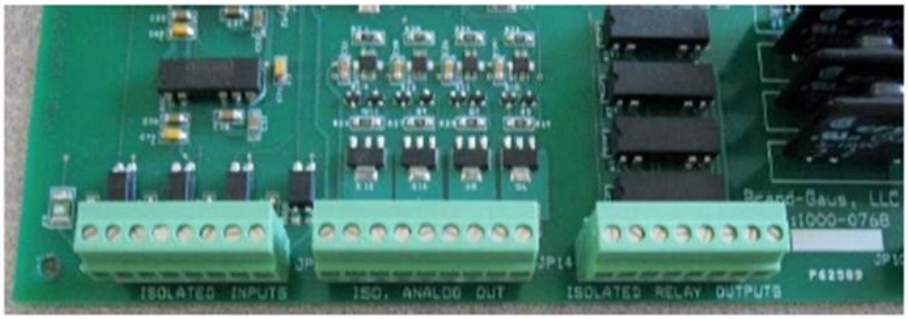
Sensor that measures the percent O2 in a given sample then sends readings back to controller. It's located in the probe enclosure.



CO2 Sensor Module

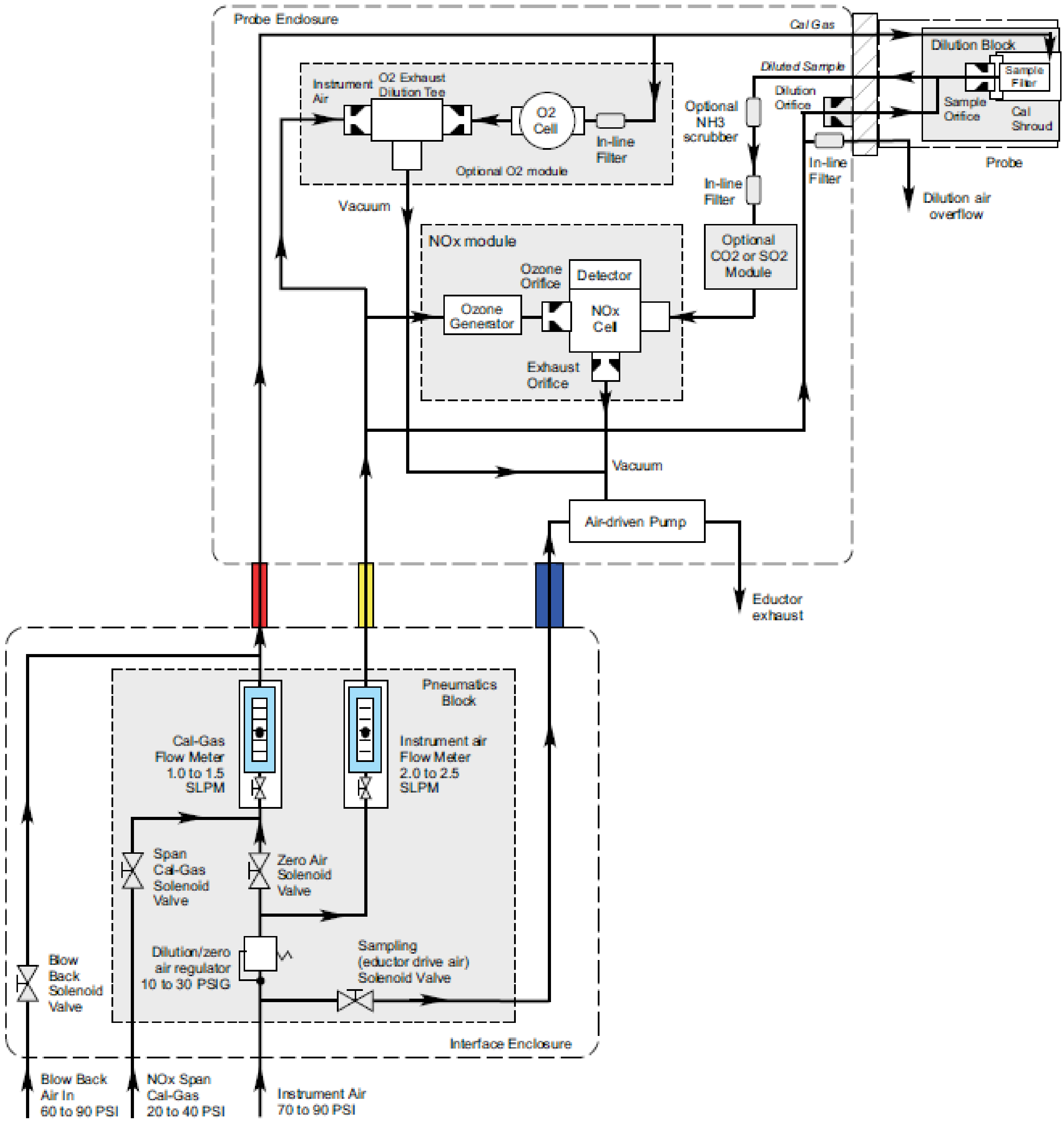
Sensor that measures the percent CO2 in a given sample then sends readings back to controller. It's located in the probe enclosure upstream of the NOx sensor.

3.4- Customer I/O Connections and Flow Scheme



Plug	Pin#	Value
Isolated Relay Outputs*	1,2	Reserved
Isolated Relay Outputs*	3,4	In Maintenance
Isolated Relay Outputs*	5,6	Cal Valve Open
Isolated Relay Outputs*	7,8	Instrument OK
Isolated Analog Out	1	N/C
Isolated Analog Out	2,3	Reserved
Isolated Analog Out (4-20mA)	4,5	Gas 3, Analog out: high, low
Isolated Analog Out (4-20mA)	6,7	Gas 2, Analog out: high, low
Isolated Analog Out (4-20mA)	8,9	Gas 1, Analog out: high, low
Isolated Inputs (wet, 24V+ at pin 2)	1,2	Start on-demand cal-check
Isolated Inputs (wet, 24V+ at pin 4)	3,4	Auto-capture during on demand cal-chek
Isolated Inputs (wet, 24V+ at pin 6)	5,6	Remote Zero valve control
Isolated Inputs (wet, 24V+ at pin 8)	7,8	Remote Span valve control
For each plug, numbering starts with Pin 1 at the leftmost position. *Dry, max switching 500mA at 200 VDC		

Analyzer Flow Schematic



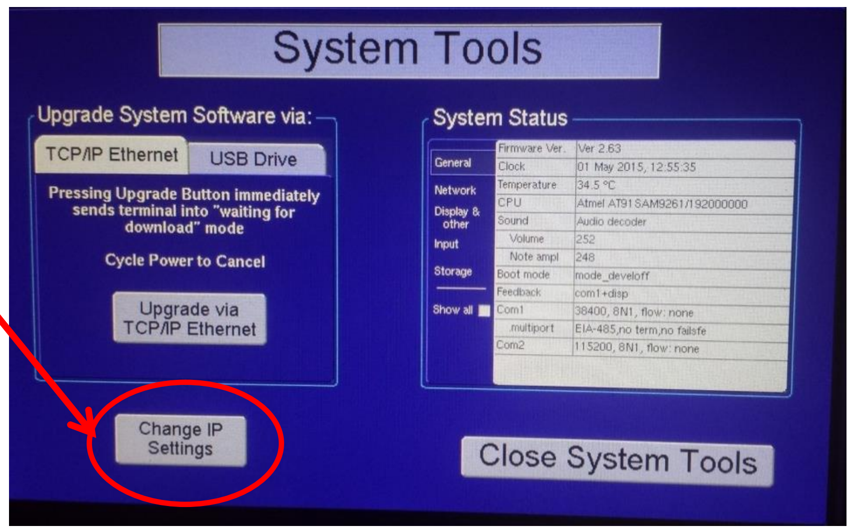
APPENDIX

TC/IPC Set Up

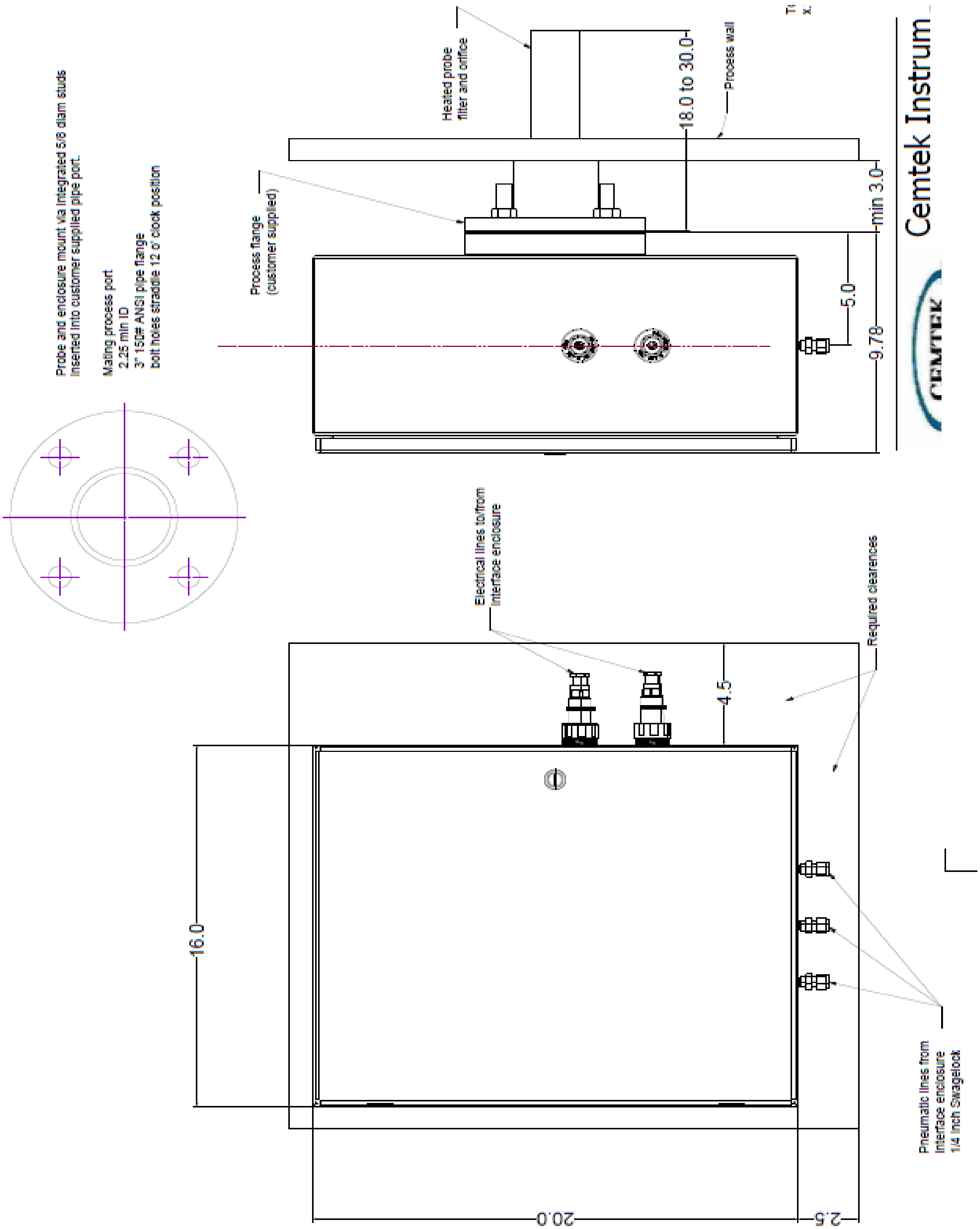
1) Ensure Ethernet cable is plugged into back of Display

2) From the System Tools Menu Screen click on the Change IP settings

3) Correctly Program TP/IPC addresses into settings registers based on application specific operating system



Probe Dimensions and Flange specifications



Controller Layout with Dimensions

*shown without Blowback option

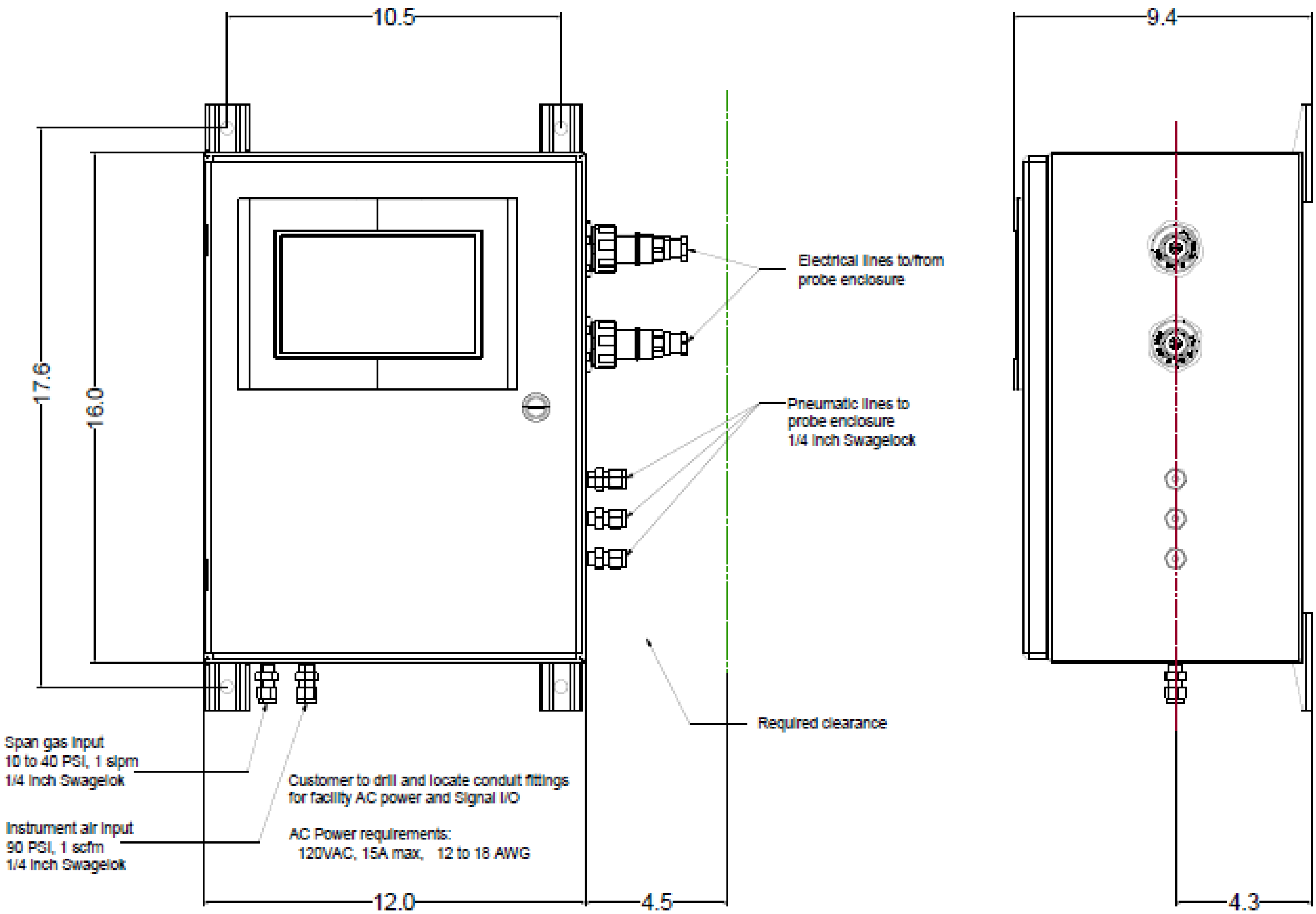
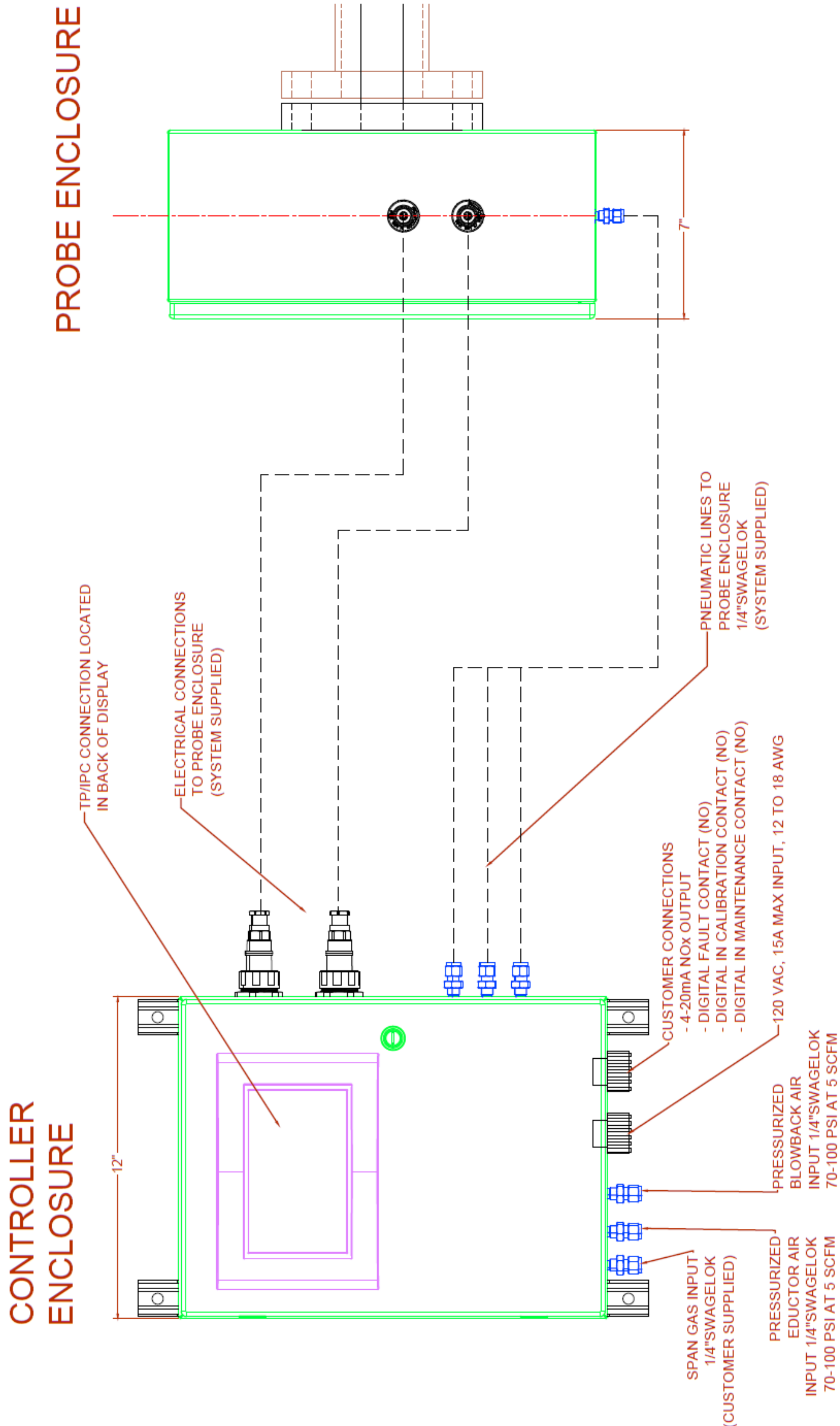
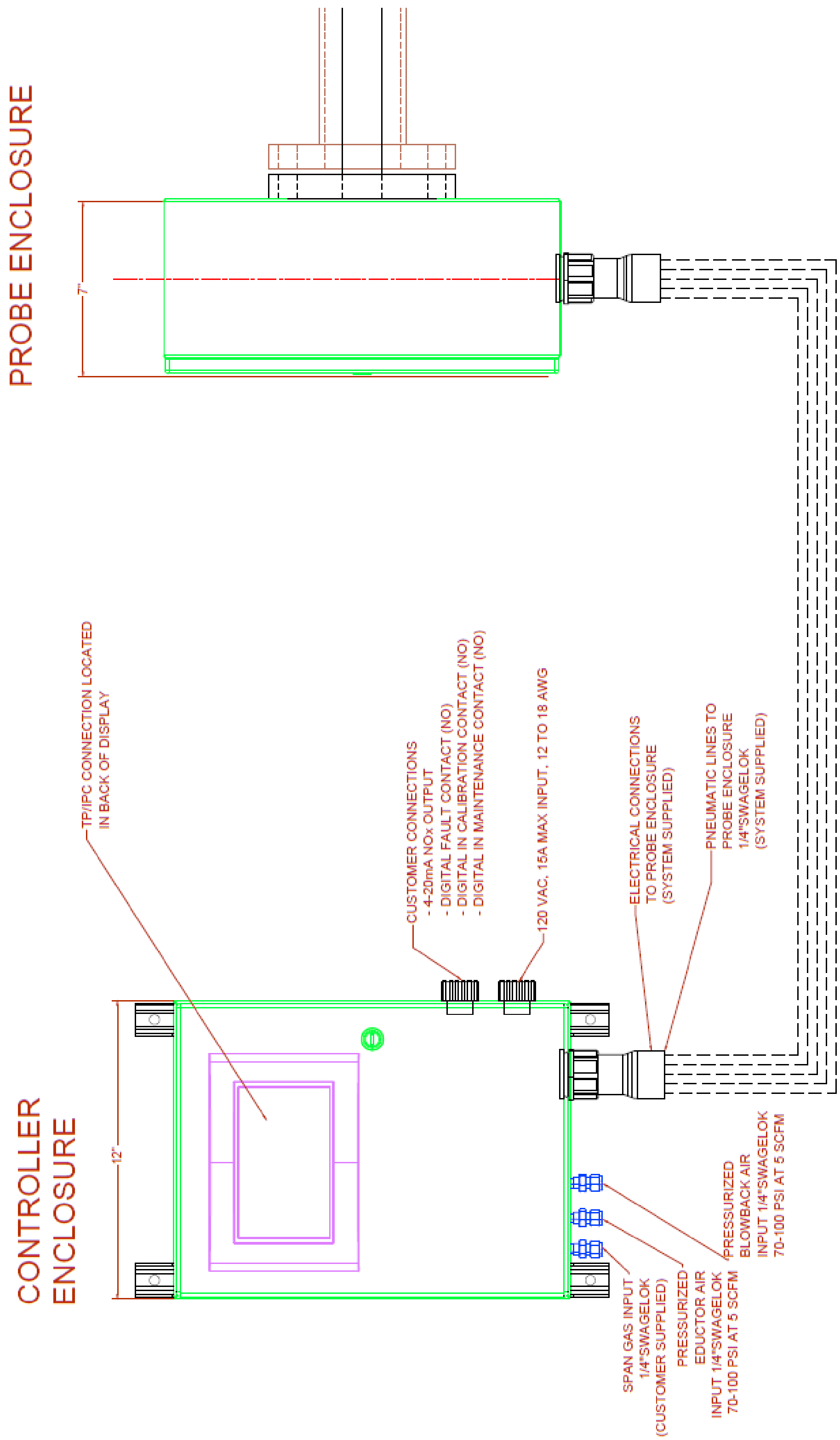


Figure iv- Flange and Probe Specifications.

System description with dimensions – Umbilical A



System description with dimensions – Umbilical B



Parts List

Level A Spares: (Consumables -recommended)

Particulate Filter
Ammonia Scrubber
Ozone Orifice
Exhaust Orifice
Eductor
Solenoid Valve, manifold mount
Moly recharge for NOx convertor
Oxygen Sensor
Filter assembly, sintered metal, sample orifice included
Inline Particulate Filter for Oxygen sensor
Inline Filter Element
Oxygen Sensor Extraction Tee

Level B Spares (Critical spares, recommend stocking for multiple unit applications)

Pneumatics block
NOx optical detector
Ozonator
Nox Converter
Heater assembly, dilution block
Temperature sensor, dilution block
CO2 optical detector
SO2 optical detector

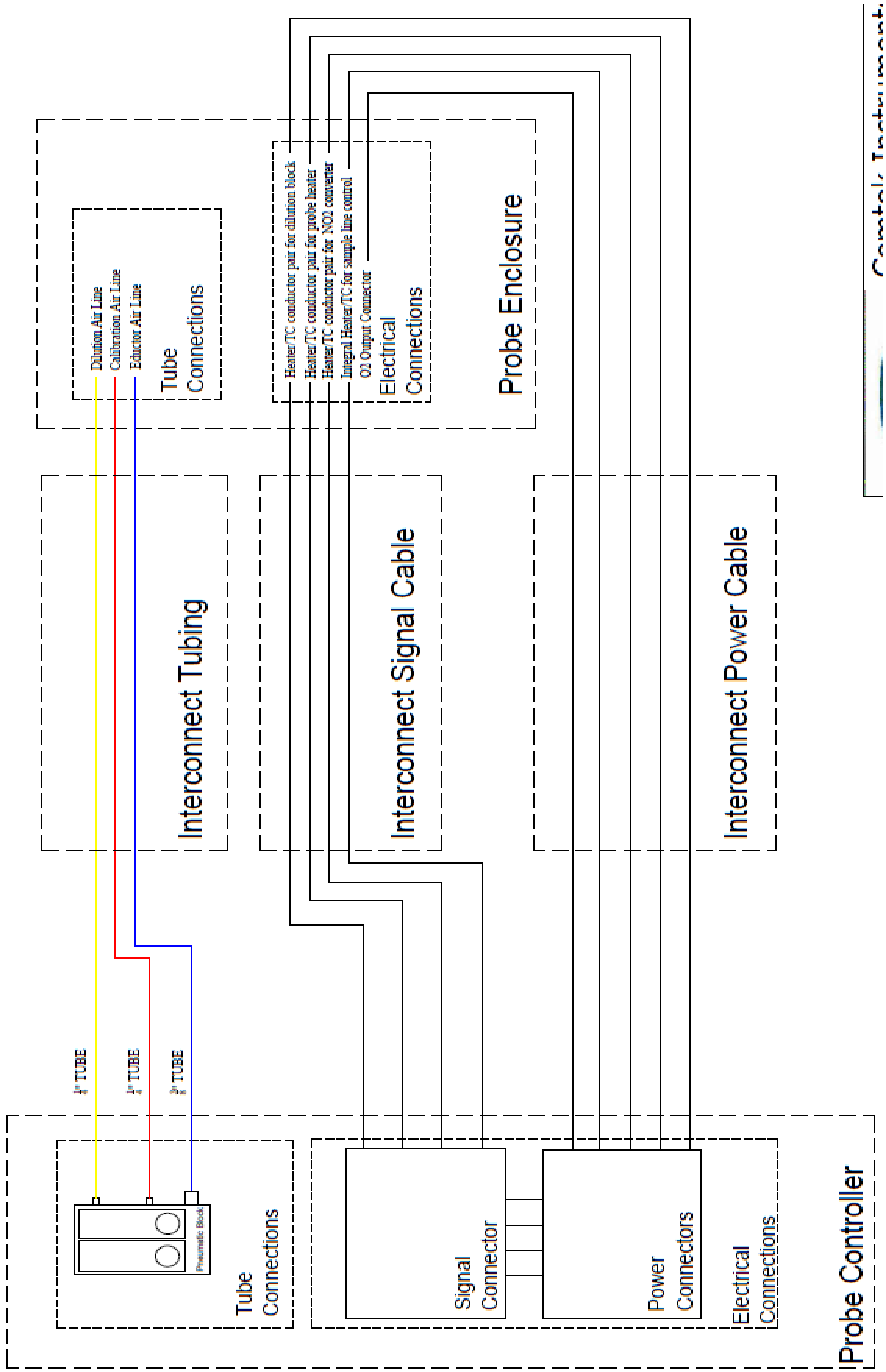
Level C Spares: Not Required for Stock

NOx analyzer board
CO2 analyzer board
SO2 analyzer board
Probe Enclosure Heater
Controller Heater / Fan assembly
PLC Module
Display Module
24V DC Module
Temperature Control Module
Temperature sensor, probe enclosure
Heated assembly, sample line per ft
Umbilical line per ft
Dilution Block Assembly
Hastelloy Dilution Block Assembly

Commercial Notes:

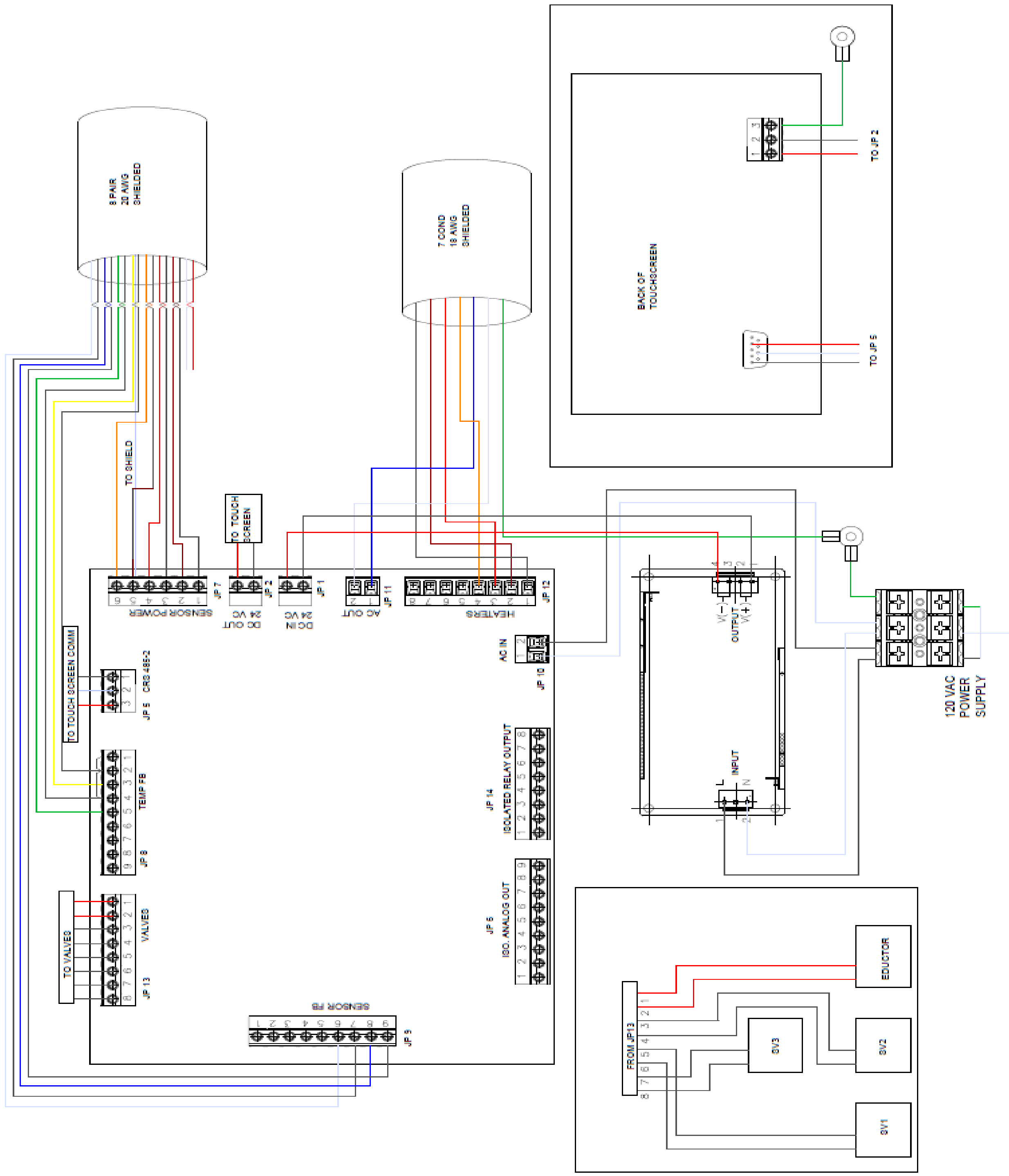
Delivery schedule: Equipment: Level A & B @ 3-4 weeks ARO, Level C @ 4-6 weeks ARO.

Connection Diagrams/Layouts



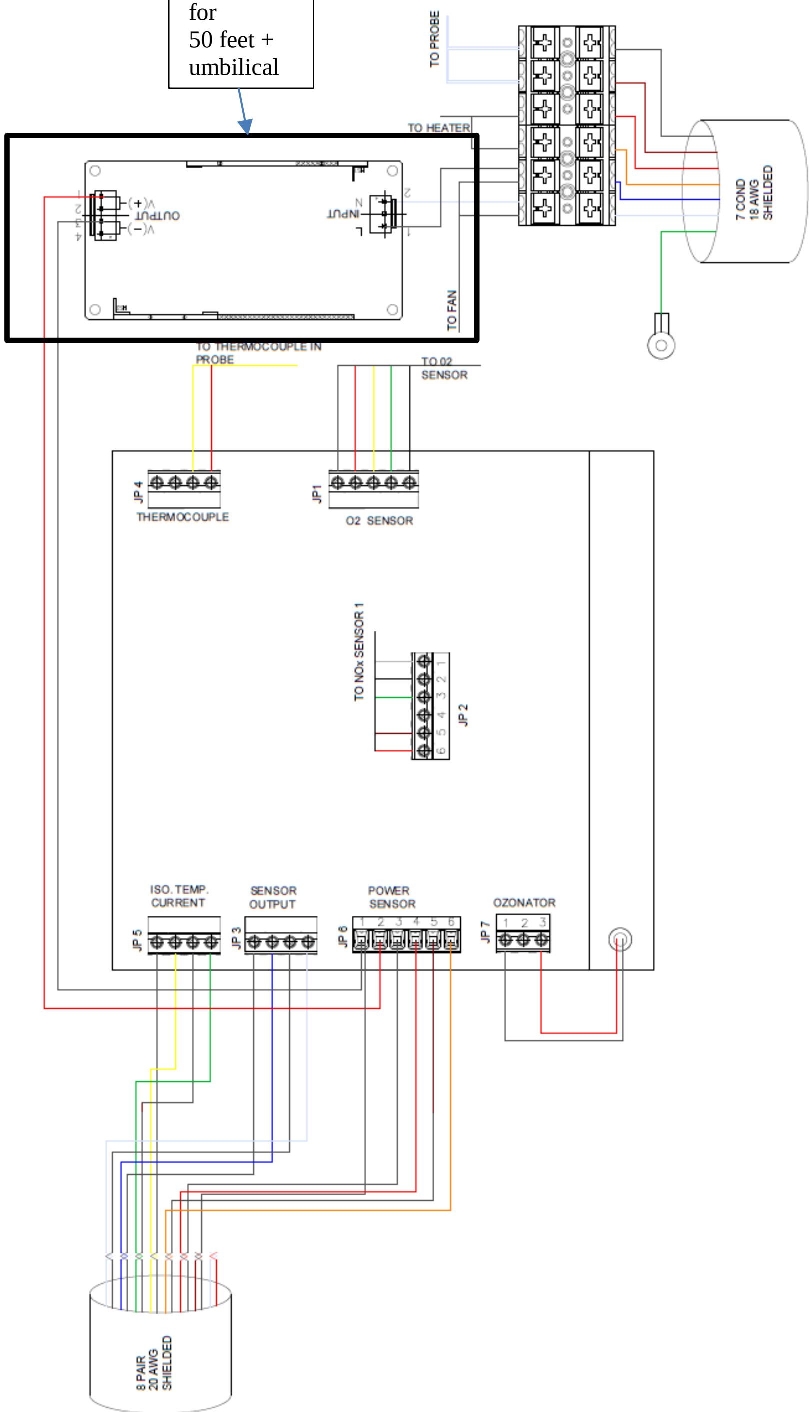
Controller and Probe Wiring

Controller



Probe

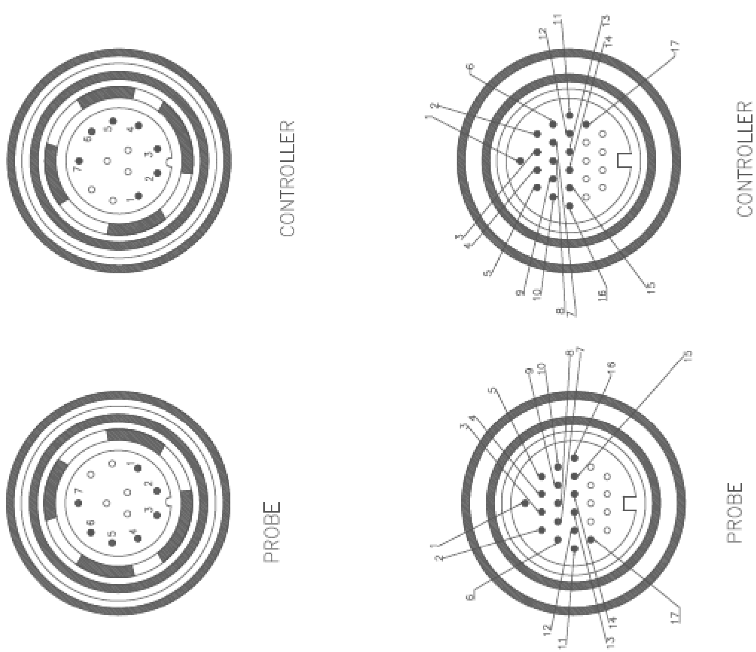
Required for 50 feet + umbilical



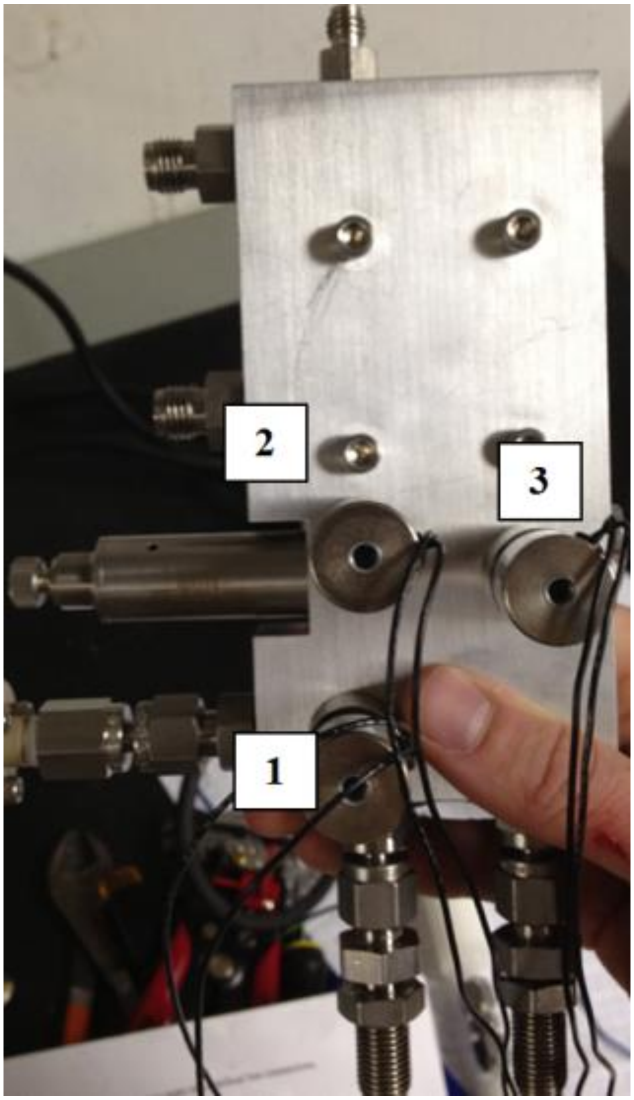
Pins

7 COND 18 AWG – NUMBER TO COLOR		
NUMBER	COLOR	SIGNAL
1	GREEN	NEUTRAL
2	WHITE	AC OUT
3	BLUE	AC OUT
4	ORANGE	HEATER IN ENCLOSURE
5	RED	HEATER IN ENCLOSURE
6	BROWN	HEATER IN PROBE
7	BLACK	HEATER IN PROBE

8 PAIR 20 AWG – NUMBER TO COLOR		
NUMBER	COLOR	SIGNAL
1	BLACK	SENSOR POWER
2	BROWN	SENSOR POWER
3	BLACK	SENSOR POWER
4	RED	SENSOR POWER
5	BLACK	SENSOR POWER
6	ORANGE	SENSOR POWER
7	BLACK	TEMP. FEED BACK – ISO. TEMP. CURRENT
8	YELLOW	TEMP. FEED BACK – ISO. TEMP. CURRENT
9	BLACK	TEMP. FEED BACK – ISO. TEMP. CURRENT
10	GREEN	TEMP. FEED BACK – ISO. TEMP. CURRENT
11	BLACK	SENSOR FEED BACK – SENSOR OUTPUT
12	BLUE	SENSOR FEED BACK – SENSOR OUTPUT
13	BLACK	SENSOR FEED BACK – SENSOR OUTPUT
14	WHITE	SENSOR FEED BACK – SENSOR OUTPUT
15	WIRE FROM SHIELD	SENSOR POWER
16	WHITE	UNUSED
17	RED	UNUSED



Pneumatic Block Installation



Shown to the right is the back of the pneumatic block that connects into the bottom left area in the controller enclosure.

Shown below is the bottom row of the main circuit board, located inside the controller.

1. Connect the solenoid valves that control the various functions carried out by the analyzer.

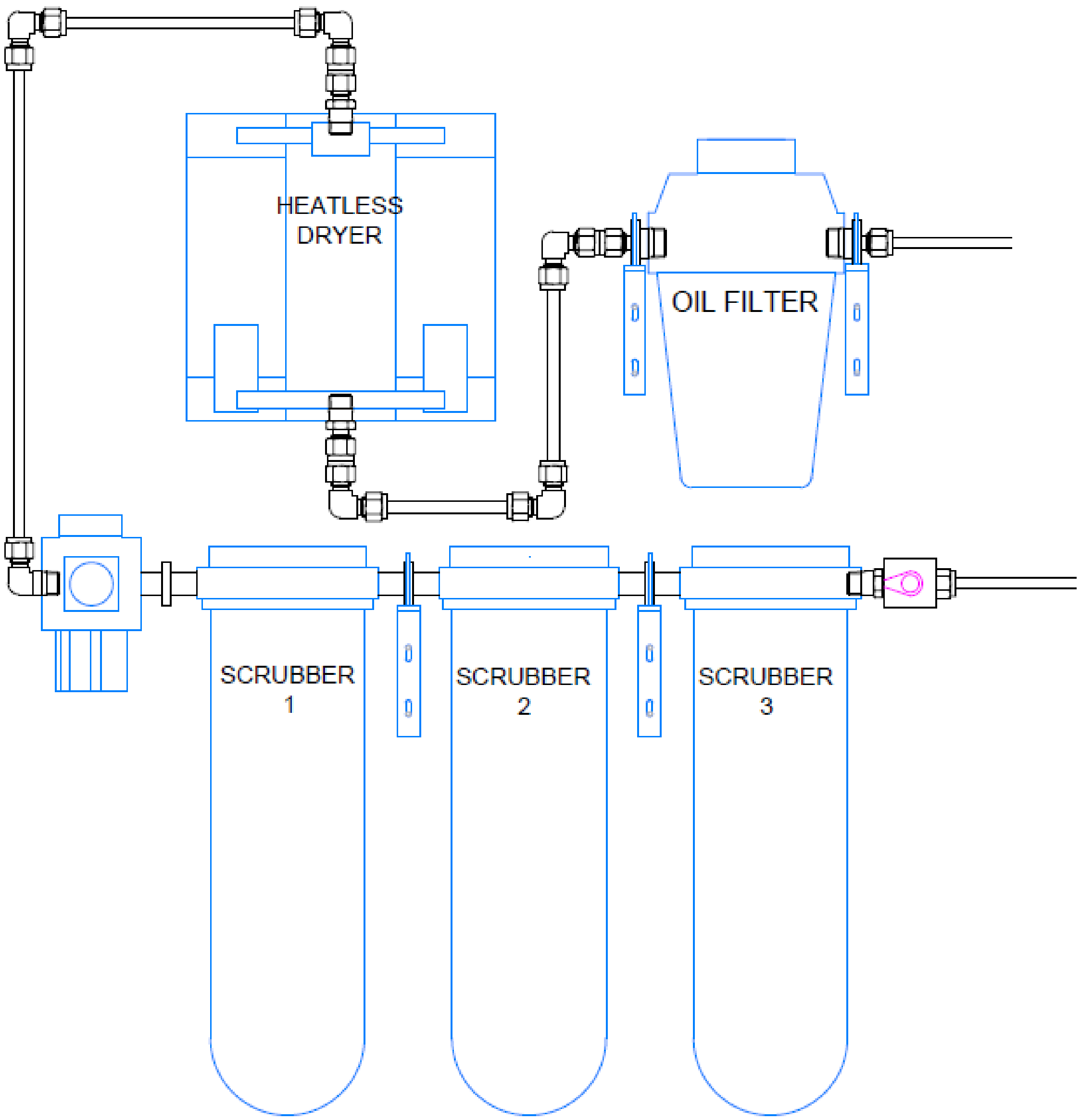
Valve 1 (Eductor Flow) **-** connects to **JP13** pins 3 and 4 on main board. -100 PSI rated solenoid valve

Valve 2 (Zero Air) **-** connects to **JP13** pins 7 and 8 on main board. -70 PSI rated solenoid valve

Valve 3 (Span Air) **-** connects to **JP13** pins 5 and 6 on main board. -70 PSI rated solenoid valve

Valve 4 (Blowback Air) **-** not shown, located in controller enclosure. -100 PSI rated solenoid Connects to **JP13** pins 1 and 2.

Cemtek Air Clean Up System (with heatless dryer)



Air Clean Up System Information

Scrubber 1- Activated Carbon (black)
Scrubber 2- Activated Aluminum (white)
Scrubber 3- Purafil Media (purple)

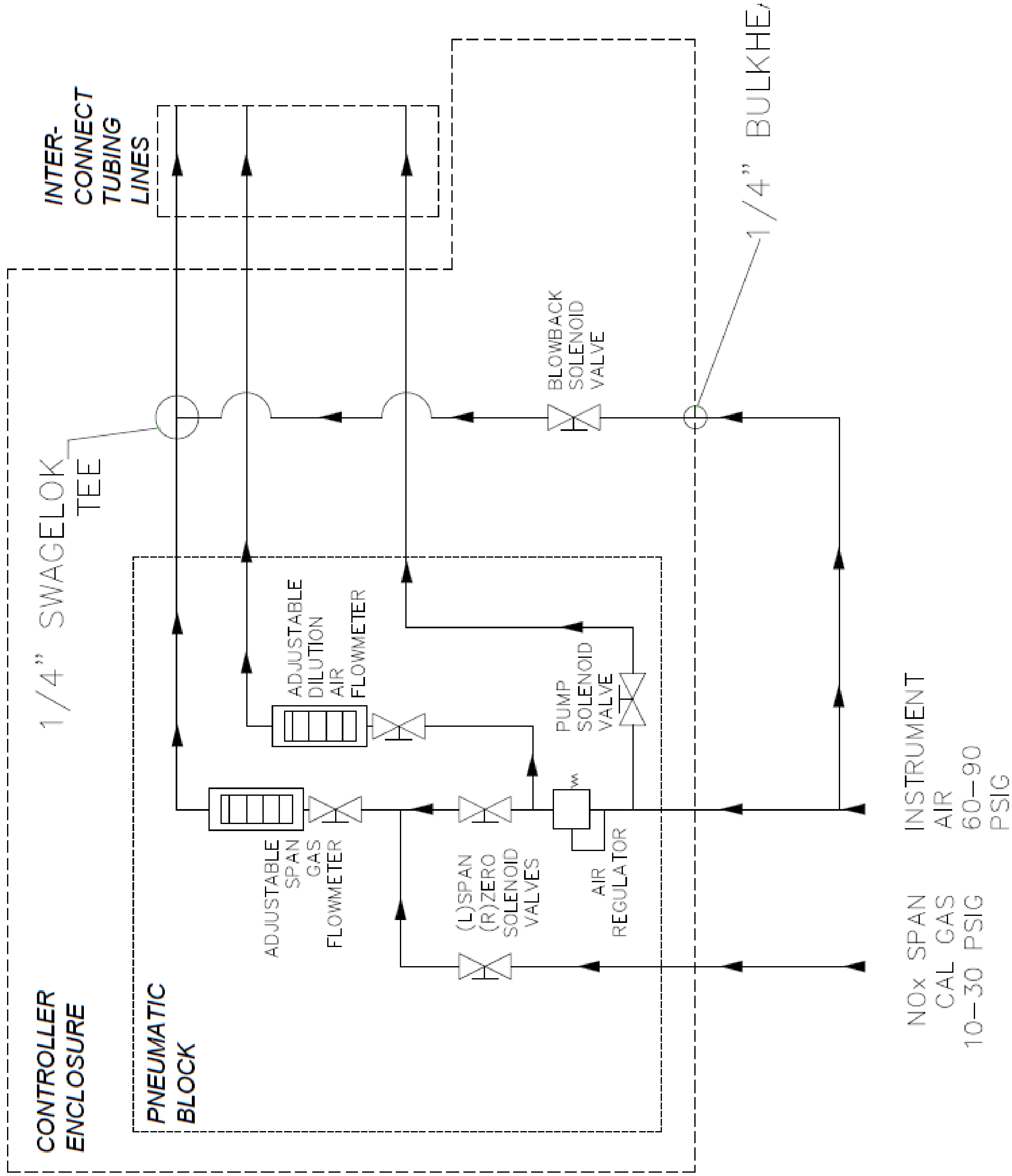
See Supplied Material Safety Data Sheets for more information on these substances.

- 1.8 LB canisters contain each of these media
- May need to be changed out due to the quality of the compressor plant air used (input air should be clean and dry).
- Based on each specific application; media and air clean up components should be monitored accordingly.

Blowback Upgrade Layout

Model 8000 NOx Automated

-Optional feature, for high particulate applications



Contact Information:

CEMTEK INSTRUMENTS
www.cemtekinstruments.com
Telephone: (908) 474-9630
24 hr. Emergency Service: 888-400-0201