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NORTH CAROLINA
Environmental Quality

Ozone Monitoring Standard Operating Procedures Thermo Scientific Model 49*i* Ozone Monitoring System
DAQ-10-001.1: Electronics and Calibration Branch Responsibilities
Revision: 7.3
March 15, 2022

NORTH CAROLINA
Department of Environmental Quality

Approval Sign Off Sheet

I have read and approve of the contents of this revision to the Ozone Monitoring Electronics and Calibration Branch Responsibilities QA Plan (Version 7.3) with an effective Date of March 15, 2022.

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This document, and any revision hereto, is intended as a reference guide to assist technicians in the setup, calibration, maintenance, operation, and data collection as related to the NC DAQ Ozone Monitoring Program. It is intended as a supplement for training in addition to other NC DAQ Reference Manuals, QAPP's, and EPA Guidance. It is not a substitute for the extensive training and experience required for the efficient operation of ambient air monitoring equipment needed for scientifically valid data.

Contents

Section 0   Scope, Purpose, and ECB Responsibilities

The Electronics and Calibration Branch (ECB) of the Ambient Monitoring Section of the North Carolina Division of Air Quality (DAQ) is responsible for supporting all DAQ ozone monitoring efforts and monitoring sites statewide. This includes the evaluation and procurement of approved ambient air ozone monitoring equipment; installation of monitoring instrumentation and support equipment at all ozone monitoring sites; evaluation of the on-going performance of all ozone monitoring systems; and scheduled and unscheduled system maintenance. The ECB shall maintain a sufficient inventory of ozone monitoring system instrumentation, support equipment, and replacement parts to minimize the loss of ambient air ozone monitoring data. The ECB is responsible for maintaining a dedicated laboratory; the required protective storage areas for instrumentation, equipment, and performance records; and necessary efficient workspace to perform all required activities in support ambient air ozone monitoring activities in North Carolina. The ECB is responsible for maintaining all property records in accordance with established state procedures for all DAQ equipment and instrumentation employed to measure ambient air ozone concentrations.

The ECB is responsible for procuring and maintaining the North Carolina Standard Ozone Photometers. The North Carolina Standard Ozone Photometers (NCSOP) provide a direct link to a national ozone standard and serve as the foundation for the collection of the highest quality ambient air ozone data possible in accordance with current procedures and existing Federal Regulations and Guidelines. The NCSOP is compared to a national ozone standard yearly prior to the start of the Federally Mandated Ozone Monitoring season in accordance with approved procedures. The ECB maintains permanent records for each NCSOP certification, performance, and maintenance.

The ECB is responsible for procuring, maintaining, and certifying the Site Primary Ozone Standards with the NCSOP each year prior to the start of the yearly ozone monitoring season. The Site Primary Ozone Standard yearly certification is valid for 1-year. The ECB is responsible for providing, installing, and maintaining a Certified Site Primary Ozone Standard for each DAQ Ozone Monitoring Sites and designated support effort. The Site Primary Ozone Standard provides the direct link between the ozone monitor to the NCSOP and thus the national ozone standard. The ECB maintains permanent records for each Site Primary Ozone Standard yearly certification, performance, maintenance, and site assignment.

The ECB is responsible for procuring, maintaining, and certifying the Primary Standard Audit Devices used to perform Ozone Monitoring site Performance Audits. The certification of the Primary Standard Audit Devices must be performed prior to the start of the Ozone monitoring season. The Primary Standard Audit Devices Yearly Certification is to be verified in July each year. These Audit Standards provide an independent evaluation of monitoring equipment performance and site operator adherence to approved operating procedures. The ECB is responsible for the performance of the Audits at each ozone monitoring site throughout the ozone monitoring season. The ECB maintains permanent records for each Primary Standard Audit Devices certification, performance, maintenance, and the results of each ozone performance audit conducted.

The ECB is responsible for procuring, maintaining, and certifying the Site Zero Air Supply with the NCSOP each year prior to the start of the yearly ozone monitoring season. The yearly Site Zero Air Supply certification is valid for 1-year. The ECB is responsible for providing, installing, and maintaining a Certified Site Zero Air Supply for each DAQ Ozone Monitoring Site and designated support effort. The ECB maintains permanent records for each Site Zero Air Supply certification, performance, maintenance, and site assignment.

The ECB is responsible for procuring and maintaining all approved auxiliary equipment and supplies for the efficient monitoring of ambient air ozone concentrations for all DAQ operated monitoring sites and support efforts. This includes but is not limited to computers, modems, power supplies, surge protection, computer cables, monitoring shelters, air compressors, air conditioners, heaters, particulate filters, Teflon tubing, manifolds, fittings, pumps, silica gel, tools, and vehicles for use at the ECB.

The ECB is also responsible for evaluating, developing, and recommending changes in equipment and operating parameters to improve the quality of data collected and procedures used in the collection of the data

Section 1   Equipment Selection and Procurement

The North Carolina Ambient Air Ozone Monitoring System must meet or exceed the Reference and Equivalent Method requirements in 40CFR53.1. The NC ambient air ozone monitoring system is compliant with these requirements. The EPA Designated Equivalent Method Number is EQOA-0880-047, August 27, 1980 (Thermo 49i analyzer; Range:0.05-1.00 ppm, Avg. time: 10-300 sec, UV O3 Photometer, S/N 102434-00). The NC ambient air ozone monitoring system consist of the following:

1.   North Carolina Standard Ozone Photometer (UV O3 Photometer, S/N 102434-00)
2.   Thermo Environmental Model 49i-PS Primary Standard
3.   Thermo Environmental Model 49i -PS Primary Standard Audit Devices
4.   Thermo Environmental Model 49i Ozone Monitor.
5.   Regenerative Zero Air Supply
6.   Teflon Sampling Line
7.   Data Communication System
8.   Temperature Controlled Monitoring Shelter

Note: minor components are not specified but included by reference.

The ECB is responsible for ensuring that all components are compatible with the measurement of ambient levels of atmospheric ozone in accordance with EPA and NC approved procedures. The

ECB is responsible for the performance of complete system evaluation prior to the field installation and that the system is fully functional at the completion of the installation. On an ongoing basis, as needed, the ECB provides equipment and instrumentation maintenance and operational support to maximize the collection of the highest quality ambient air pollution data in accordance with accepted and approved procedures.

Section 1.1 North Carolina Standard Ozone Photometer Reference Study

The ECB maintains two (2) North Carolina Standard Ozone Photometers (NCSOP). The primary NCSOP is the reference photometer that establishes the basis for all ambient ozone measurements made throughout the State operated ozone monitoring network each year. Both NCSOP's are TEI Model 49i-PS with the ozone generation capabilities eliminated. These reference photometers are never used to sample raw ambient air. The second NCSOP is kept onsite and serves as a 'backup' SOP in the event of a failure of the primary NCSOP.

The ECB is responsible for establishing the direct link yearly between the NCSOP and a National Institute of Standards and Technology (NIST) Standard Reference Photometer (SRP). The EPA operates multiple NIST provided SRP(s). The EPA operated NIST SRPs are verified with the SRP maintained by NIST and serve as the National Standards for all ambient air ozone measurements nationwide.

Each year, during the 4th quarter (i.e. before the next monitoring season), the ECB is required to perform a comparative study between an EPA operated NIST SRP and the NCSOP (both units, primary and backup---**see Appendix A for EPA Procedure**). The results of this yearly direct comparison establishes the "True Value" for all ozone measurements made yearly in North Carolina. Each year during this comparative study, NC should obtain a copy of the most recent verification versus the NIST Standard Photometer for the EPA SRP used to establish the "Truth" of the NCSOP. During this comparative study, the NCSOP is directly compared to the measured ozone concentration as determined by the EPA operated SRP. At the completion of this yearly study a copy of the comparative results are kept by NCDEQ in a secured area as well as a backup stored digitally. The Level 2 Verification Report(s) (hard copy) are also attached to the primary and secondary NCSOP units and maintained throughout the season.

The standard EPA Certification/Verification procedure for state operated ozone primary standards and standard photometers is performed over the approximate concentration range of 0.000 to 0.500 ppm. The NC DAQ ozone monitor calibration range is from 0.000 to 0.225 ppm ozone. The EPA SRP and NCSOP comparative study described below only utilizes the ozone concentration points from 0.000 to 0.250 ppm ozone.

This comparative study is performed in 2 stages. During the first stage of the study NCSOP and the EPA SRP are compared and if necessary the NCSOP is adjusted to more closely duplicate the EPA SRP within set limits. During the second stage consecutive multiple comparative analyses are performed with the EPA SRP and the NCSOP on various ozone concentrations in the range

of 0.000 to 0.500 ppm ozone to build a data set from which a formula is developed with confidence to report "True" ozone concentrations with the NCSOP.

Upon the completion of the yearly NCSOP & EPA SRP comparative study the ECB submits the results for analysis to the Projects and Procedures Branch for verification and approval prior to application of study results to the Certification of Site Primary Standards.

The primary calibrator is a Model 49 i-PS S/N#1170480015, EQ:46, and the Backup is S/N#1170480017, EQ:48

Section 1.2   EPA Standard Reference Photometer (SRP) and NC Standard Ozone Photometer (NCSOP) Direct Comparison Study (EPA RTP Procedure) see Appendix A

describes the procedure utilized by US EPA to certify the NCSOP (standard)

Section 1.3 Certified Site Primary Ozone Standards

The Site Primary Ozone Standard is used to calibrate and evaluate the ongoing performance of the ozone monitors at each site. With the establishment of a NCSOP, the ECB is able to transfer the authority obtained through the comparative study with the EPASRP directly to each of the TEI Model 49 i-PS used as a Site Primary Ozone Standard of known certified concentration. The ECB performs response adjustments to the Site Primary Ozone Standard to duplicate the concentration readings of the NCSOP as part of this Certification process.

The Certified Site Primary Ozone **Standard** TEI **49 i-PS (**calibrator**)** is the source of known concentration of ozone enabling the calibration of the ambient air ozone monitor. The ambient air ozone monitor is adjusted to duplicate the concentration of ozone produced by the Site Primary Ozone Standard. Following the procedure below. All data including instrument parameters are recorded in the specific TEI 49i-PS logbook.

The Thermo-Environmental Model 49 i-PS operational parameters and acceptable range of operation are as follows:

Analytical Range	**0.000 – 0.250 ppm** Ozone
Averaging Time	**20 Seconds**
Temperature Correction	**ON**
Pressure Correction	**ON**
DC Power Supplies	**+5 (+1) Volt, +15 (+1) Volt**
Chamber Pressure	**200 mm Hg-1000 mm Hg**
Bench Lamp Temperature	**50 – 60 ° C**
Ozone Lamp Temperature	**60 – 80 ° C**
Bench Temperature	**15 – 40 ° C**
Individual Cell Flow	**0.4 – 1.4 LPM**
Intensities	**45 – 150 KHZ**

The ECB is responsible for setting the operational parameters of each TEI 49 i-PS as listed above. Yearly, prior to installation at the monitoring site, the ECB must evaluate the condition and performance of each TEI 49 i-PS to include the following. The results of the evaluation, findings, and all adjustments are entered into the Certification workbook (Excel), dated, and initialed. The Pass/Fail results are recorded in the Specified Equipment logbook(s). In addition, the site where the Site Primary Ozone Standard is installed each year is entered into the logbook.

1. Perform any scheduled approved preventative maintenance procedures and or system enhancements.
2. Visually inspect both cells for contamination and clean if necessary. If cells are dirty investigate causes of contamination and correct per manufacturer's recommendations.
3. Connect the Primary Standard 49 i-PS to zero air supply and the State Ozone Primary Photometer.
    a. Connect the Zero Air supply output to the 49i-PS input port labelled 'Zero Air' (see pg. 2-4 of Model 49i Primary Standard manual and pg. 3-3 of Model 701 Zero Air Generator Operators manual).
4. Turn on the Zero air supply.
5. Power up The Primary Standard TEI49 i-PS, and allow to warm up for a minimum of 1 hour.
    Note: The NCSOP remains on with the ZAP off and the ZAP turns on automatically when you initiate the Calibration Program through Envidas.
6. Verify and adjust, if necessary, the Model 49 i-PS operational parameters. If system fails to achieve required operational parameters investigate causes and correct per manufacturer's recommendations.
7. Activate the Zero (0.000 ppm) event on the Site Primary Ozone Standard and allow the readings to stabilize on both the State Ozone Primary Photometer and the Site Primary Ozone Standard. Adjust the Site Primary Standard to agree with the readings with the State Ozone Primary Photometer. Record Ozone Background Coefficient.
8. Allow readings to stabilize for 10 minutes and record 5 x 1 minute averages for the zero event.
9. Activate the High Span (0.225 ppm) event on the Site Primary Ozone Standard and allow the readings to stabilize on both the State Ozone Primary Photometer and the Site Primary Ozone Standard. Adjust the Site Primary Standard to agree with the readings with the State Ozone Primary Photometer. Record the Ozone Span Coefficient.
10. Allow readings to stabilize for 10 minutes and record 5 x 1 minute averages for the High Span Event.
11. Sequentially activate the calibration program in Envidas to include the following: (0.000 ppm, 0.225, 0.120, 0.065, and 0.050 ppm). Allow readings to stabilize for 10 minutes and record 5 x 1 minute averages for each of the level points.
12. Compare the average readings with the Acceptance Criteria for each Site Primary Ozone Standard Certification concentration level:

0.000 ppm	± 0.002
0.050 ppm	± 0.002
0.065 ppm	± 0.002
0.120 ppm	± 0.002
0.225 ppm	± 0.002

If acceptance criteria are not satisfied repeat steps 1-12. If Acceptance criteria are met proceed to step 13.

13. Determine the slope, intercept, and the correlation coefficient of the Primary Standard Calibration Curve. The **Slope** must be in the range of **0.98 – 1.02**, the **Intercept** must be **<+2.0**, and the **Correlation coefficient** must be **>0.999**.

14. If the above acceptance testing is passed the Site Primary Ozone Standard is considered Certified. This certification is valid for a period of **1 year**. The following label is attached to the front panel of the TEI 49 i-PS Site Primary Ozone Standard:

Unit #:
Certification Date:
Performed By:

This evaluation and certification must be performed again prior to the redeployment of any Site Primary Standard that has been returned for any reason from the field throughout the yearly ozone monitoring season.

Section 1.4.   Certified Primary Standard Audit Devices

The ECB shall maintain two (2) Primary Ozone Standard Audit Devices that are dedicated to conduct performance audits at all the ozone monitoring sites. The Certified Primary Ozone Standard Audit Devices are identical to the Site Primary Ozone Standards and are certified following the same procedures in Section 1.3 Site Primary Standards above. The North Carolina ozone monitoring season is from March 1st through October 31st. The Primary Standard Audit Devices must be certified prior to the start of the ozone monitoring season and the certification must be verified versus the NCSOP in July.

Section 2   Description of the Thermo Model 49i Ozone Analyzer (from Manual)

The Thermo Model 49i Ozone Analyzer is designated by the US Environmental Protection Agency as an Equivalent Method (EQOA-0880-047) for measurement of ambient Ozone per CFR 40, Part 53 of the Federal Register. The monitor operates on the principle that Ozone absorbs UV light at a wavelength of 254 nm. An ambient sample is pulled via vacuum through the instrument and split into two air streams; one flows through a scrubber to become the reference gas and the other is sent via air stream as the ambient sample gas. The gas is carried via a solenoid into cells A and B which alternate every 10 seconds and so (i.e. 10 sec sample gas

in cell A and sample in B and alternates back and so on). The intensities of each gas are measured continuously as UV light and the 49i then calculates the concentration in each cell and outputs an average on the display panel and makes the collective data available via Ethernet connections. The minute and hourly data are stored via Envidas (Envista system) and reviewed by operators, technicians, and regional staff.

Section 2.1   Site Ozone Monitor

The Site Primary Ozone Standard is used to calibrate the TEI Model 49i Ozone Monitor at each site. Thus via the calibration of the ozone monitor (regional staff) at each site with the Site Primary Standard, the ozone concentration data reported at each site is directly traceable to the NCSOP and thus the EPA SRP.

The Thermo-Environmental **Model 49i** (analyzer) operational parameters and acceptable range of operation are as follows: (Check Ozone SOP for these ranges)

Analytical Range	**0.000 – 0.250 ppm** Ozone
Averaging Time	**20 Seconds**
Temperature Correction	**ON**
Pressure Correction	**ON**
Chamber Pressure	**200 mm Hg-1000mm Hg**
DC Power Supplies	**+5 (+1) Volt, +15 (+1) Volt**
Bench Lamp Temperature	**50 – 60 ° C**
Bench Temperature	**15 – 40 ° C**
Individual Cell Flow	**0.4 – 1.4 LPM**
Intensities	**45 – 150 KHZ**

The ECB is responsible for setting the operational parameters of each TEI 49i ozone monitor as listed above. Monitor operation outside of these settings and limits will display an alarm and is non-compliant with the NC QAPP for ambient air ozone monitoring and the data will be invalidated.

Yearly, prior to installation at the monitoring site, the ECB must evaluate the condition and performance of each TEI 49i Ozone Monitor to include the following. The results of the evaluation, findings, and all adjustments are entered into the monitor specific logbook, dated, and initialed. In addition the site where the Ozone Monitor is installed each year is entered into the logbook.

1. Perform any scheduled approved preventative maintenance procedures and or system enhancements.
2. Visually inspect both cells for contamination and clean if necessary. If cells are dirty investigate causes of contamination and correct per manufacturer's recommendations.
3. Connect the monitor, power up, and allow to warm up for 1 hour.

4. Perform a leak test. If the leak test fails investigate causes and correct per manufacturer's recommendations.

5. Verify and adjust, if necessary, the Model 49i operational parameters. If system fails to achieve required operational parameters investigate causes and correct per manufacturer's recommendations.

6. Condition a new particulate filter.
   a. With the 49i running, remove the filter holder by loosening the 2 knurled threads (Teflon nuts)
   b. Using the 2 filter (spanner) wrenches, loosen the 2-piece filter housing and open
   c. Carefully remove the old (used) filter with tweezers and dispose of it
   d. Carefully place the new filter in between the 2-piece housing, taking care not to touch the face of the filter or allow debris or moisture to contaminate it
   e. Position the two pieces of the housing together and tighten with the two filter (spanner) wrenches until snug (do not over tighten)
   f. Place the filter housing with the flow arrow(s) pointing IN to the port of the instrument
   g. Follow Step 7 and allow to stabilize at 220 for at least 5 minutes and then perform the zero and span as listed below

7. Perform an Adjusted 2-point Calibration for the Zero (0.000 ppm) point and the High Span (0.225 ppm) Point Span using a certified Site Primary Standard allowing monitor readings to stabilize prior to adjusting the calibration.

8. Verify that the Span coefficient is ≥ 0.095 and ≤ 1.05 and the Zero Point is $\leq$ +/- 0.003 ppm. Record these values in the monitor specific logbook. If outside of these limits perform troubleshooting per manufacturer's recommendations. Repeat step # 7.

9. Run the Precision Point (0.065 ppm) to verify linearity of the monitor. The precision point must be + 0.003 ppm of the true value as displayed on the site primary standard. If precision point does not meet this criteria, troubleshoot per manufacturer recommendations and repeat steps 7 through 9.

This evaluation must be performed again prior to the redeployment of any monitor that has been returned for any reason from the field throughout the yearly ozone monitoring season

Section 3   Description and Operation of the Thermo Model 49i-PS Calibrator (from Manual)
The Thermo Model 49iPS calibrator operates in a very similar manner to the 49i Monitor and uses absorbed UV light at 254 nm. The zero air is supplied to the zero air bulkhead and split into two streams via a pressure regulator to the reference solenoid valve to become the reference gas, and the second stream flows through a pressure regulator and then an ozonator and a manifold to become the sample gas. Ozone from the manifold is then delivered to an ozone bulkhead and another solenoid alternates the two streams similar to the 49i monitor in 10 second intervals where reference and sample alternate between cells A and B. When cell A contains reference

gas then cell B will contain sample gas and vice versa. Much like the Model 49i monitor, the 49iPS detects the UV light intensities in each cell and calculates the Primary Standard values for each cell and outputs the average concentration on the display panel and also makes data available over the Ethernet connection. The 49iPS Primary Standard is programmed to run autocal Precision, Zero, Span points every 24 hrs via the network software.

Section 4   **Teledyne Model 701 Zero Air Generator (from Manual)**

The Teledyne API Model701 Zero Air Generator system is a source of clean, dry purged air. The 701 produces scrubbed air via an oil and diaphragm free pump which removes SO_2, NO, NO_2, O_3, and H_2S. Inlet air is pulled through a water trap and pre-cooler to remove moisture. The scrubbed air then passes through a Regenerative Dryer for final drying operations. Lastly, outlet air then passes through a filter to assure clean, dry, zero air with a dew point of less than -20C independent of the inlet dew point.

Section 4.1   Zero Air Supply Certification

The Zero Air Supply provides an excess of purified dried ambient air to the site Primary Ozone Standard for use in calibrating the site ozone monitor. The ambient air first passes through two molecular sieve columns to remove moisture and then through an activated charcoal column to remove NO_2, O_3, SO_2, and H_2S. Finally the air stream passes through a Purafil^{TM} column to oxidize NO to NO_2. This Zero Air Supply is essential to the accurate operation of both the Site Primary Ozone Standard and the ozone monitor. Each year, each site Zero Air Supply is Certified. This Certification is valid one year from the Certification Date.

Yearly, prior to Certification, the ECB must evaluate the condition, perform required maintenance, and determine the performance of each Zero Air Supply. Yearly prior to commencing with the Certification of the Zero Air Supply the activated charcoal and Purafil^{TM} is replaced. The results of all maintenance, evaluation, findings, and yearly certification are entered into the Zero Air Supply Unit specific logbook, dated, and initialed. In addition, the site where the Zero Air Supply is installed each year is entered into the logbook.

1.   The Zero Air Supply is connected to the NCSOP.
2.   The Zero Air Supply is activated and the NCSOP determine the reported ozone concentration.
3.   Record 30 x 1-minute average ozone readings.
4.   The average of the 30 x 1-minute ozone readings must be **<± 0.003 ppm** ozone.
5.   If the Zero Air Supply Unit meets the criteria, the following label is attached to the front of the Zero Air Supply.

Unit #:
Certification Date:
Performed By:

6.   If the above criteria are not met, the cause of the failing to meet the criteria is determined and corrected.

This evaluation must be performed again prior to the redeployment of any Zero Air Supply that has been returned for any reason from the field throughout the yearly ozone monitoring season.

Section 5   Computer and Data Acquisition System (DAS) and Modem

The ECB is responsible for providing an instrumentation and operating system compatible computer, Data Acquisition System (DAS), and a modem communication system. The operating system, data collection and storage capability, and remote communication system must be designed and acquired to maximize ease of data collection and transferring of data remotely. The entire data collection and communication system must be compatible with data retrieval programs operated by the database manager of the Ambient Monitoring Section. The ECB is encouraged to evaluate procedures, equipment, and systems to improve the data collection, data storage, and data transferring capabilities of the NC ozone monitoring system.

Section 6   Temperature Controlled Monitoring Shelter

Each ozone monitoring site shelter must be maintained in good repair. Each shelter must be temperature controlled within the EPA requirements of $5 – 40^{o}C$ with a daily fluctuation less than $\pm\ 2^{o}C$. The temperature is monitored and recorded every minute through Envidas via the Comet temperature probe/sensor. The backup temperature recording system is the HOBO temperature sensor and must be manually downloaded by site technicians at least once per month. Also, a certified mineral thermometer is kept at each site and serves as the primary standard to compare the Comet and HOBO values to assure accuracy.   At installation, the ECB verifies the temperature with a standard calibrated and certified thermometer (Omega RTD) and assures that the Comet and HOBO sensors display and agree with the standard. The site operator views hourly temperature as well as the Central Office staff and QA is confirmed daily to assure no data will be lost as a result of drifting site temperature. During the annual performance evaluation audits, the ECB staff again checks the temperature against a standard verified and certified thermometer. This is performed at season start up and again at the rotating quarterly audits. If drift or deviation occurs outside of the **5-40 deg. C,** then the data are disqualified and an error message (AE) is submitted in the daily data by the operator/reviewer to invalidate any potential erroneous equipment operation as a result of temperature drift.

In addition, the monitoring shelter must provide a secure hazard proof facility for both instrumentation and monitoring personnel.

Section 7   Initial Laboratory Startup of the Model 49i and 49i-PS

Section 7.1 Teflon Sampling Line

The Teflon sampling line is a 3/8" OD 1/4" ID virgin continuous piece of sample tubing that runs from the back of the particulate filter holder on the TEI 49i ozone monitor to the inverted funnel on the outside of the monitoring shelter. Prior to installation at a monitoring site the sampling line must be pretreated with ozone to eliminate the effect of ozone depleting substances which may be present on the interior walls of the tubing. This sampling line is replaced whenever damage or contamination is observed or every two (2) years.

Section 7.2 Site Set Up Logistics

The ECB is responsible for the installation of all State operated ambient air ozone monitoring sites across the state each year. The sites are required to be setup prior to the **March 1** start date of the EPA mandated ozone monitoring season.   There are a few exceptions to the March 1 start date, which include certain mountain sites, which are installed and operated on a shortened schedule because of difficulties, associated with inclement weather and site access. Other exceptions include sites that may operate all year.

The installation of the ozone monitoring sites includes the Certified Site Primary Ozone Standard, the Performance Tested Ozone Monitor, the Certified Zero Air Supply, the Pretreated Teflon Sampling Line, and the computer, DAS, and modem system. The monitoring site includes additional items such as the air conditioning unit, a heater, heat tape, and a temperature controller. These additional components generally remain at the site year round.

 Following the installation of all components of the ozone monitoring system the performance of all components is verified as the final step of the site installation.

Section 7.3 Maintenance Responsibilities

The ECB is responsible for all ongoing maintenance activities at the ozone monitoring sites and support laboratory facilities. The ECB shall maintain sufficient inventory of Certified Site Primary Standards, Certified Zero Air Systems, and all other ancillary equipment and equipment parts to minimize the loss of quality ambient air ozone concentration data.

Section 7.3.1 Inspection

An initial visual inspection is performed on the monitoring site to assure it is clean, safe, and free of any ambient features that could potentially invalidate the monitoring FRM and/or FEM per federal regulations and requirements.

When driving up to the site, observe the outside of the sampling building, sampling probe, looking for vandalism, security breaches, and the presence of unauthorized personnel. If there is

any evidence of vandalism contact the local law enforcement department and DAQ Central Office. Also note the activities adjacent to the sampling site such as construction, paving of highways, timbering, farming etc. and document these observations in the audit record.

Visually inspect and document the condition of the sample delivery and calibration tubing systems.

1. The probe should be turned down, an undamaged inverted funnel on the end, the Teflon screen must be in place to protect the sampling probe from insects and foreign material, and the Teflon line must be visible inside the funnel screen.

2. Ensure the sample tubing inside the monitoring building, especially at any bends, has not been kinked, crimped, cut, or a low spot or loop created which could collect moisture, particulates, or impede sample flow. If line is crimped remove crimp. If moisture or particulates are noted the sampling line should be replaced.

3. Each sampling and calibration line has multiple swage connections. Each of these connections is a potential source of leaks in the system. Each swage fitting should be "finger tight" to ensure adequate sealing. Each fitting must be checked for tightness.

Section 7.3.2 Check Zero Air Generator

Verify the outlet pressure on the compressor is reading between **20 to 30 psi**.

Section 7.4 Assembly, Modification, and Initial Verification

Section 7.4.1 Initial Laboratory Checkout

Check the intensity/flow/chart with highs and lows within acceptable range from **Owners manual** and aforementioned settings

Range setting to match **0-250 ppb** Range

Flow measurement on 49i Monitor to comply with Allicat verification on flow transducers (2 of them)

Monitor and calibrator (49iPS) ambient pressure verification---verify pressure transducer (1) with lab standard barometer to match ambient pressure.

Leak check and Calibration---verification of Precision/Zero/Span (PZS) to check for close to standards to assure they are within +/-5 before transporting and deploying in the field

Section 7.5 Certification of Transfer Standard, Zero Air Generator, Thermometers

Section 7.5.1 Certification of 49iPS Calibrator (Transfer Standard)

Compare to Bench standard and document and write up in (log sheet, ECB Certification Form, storage backup on 'P' drive)

Section 7.5.2 Certification of Zero Air Generator Model 701 Run for 30 minutes and see attached forms (below) and assure meets the **<3** criteria

Blank form

49 iPS		Certification				Date	01/00/00		
Date:		Specialist:	DEH		Point	Date	Time	Cert iPS	Site iPS
ECB Cert Bench	46	Cert Room Temp (C)	23			1/0/1900	##########		
Primary Standard EQ#:	46	Primary Cert Date:	11/20/2019			1/0/1900	##########		
Primary Std Cert Slope	1.0033	Intercept	-0.0962		0.0	1/0/1900	##########		
Primary Std O3 Bkg	0.0	Primary O3 Coeff	0.988			1/0/1900	##########		
Zero Air Supply (ZAS) EQ#:	4	ZAS Pressure (psig):	25.0			1/0/1900			
49i-PS EQ Number:	0	Instrument Range:	0-250 ppb			Average		#DIV/0!	#DIV/0!
O3 Background (found):		O3 Coeff (found):				1/0/1900	##########		
O3 Background (left):		O3 Coeff (left):				1/0/1900	##########		
					225.0	1/0/1900	##########		
Cert 49 iPS Settings	Pre A	Pre B	Post A	Post B		1/0/1900	##########		
Intensities (kHz)						1/0/1900			
Pressure						Average		#DIV/0!	#DIV/0!
Flows						1/0/1900	##########		
						1/0/1900	##########		
Site 49 iPS Settings	Pre A	Pre B	Post A	Post B	120.0	1/0/1900	##########		
Intensities (kHz)						1/0/1900	##########		
Pressure						1/0/1900			
Flows						Average		#DIV/0!	#DIV/0!
						1/0/1900	##########		
	Certification					1/0/1900	##########		
					65.0	1/0/1900	##########		
iPS Set Point	46	Primary O3 ppb Corrected (x)	0			1/0/1900	##########		
0.0	#DIV/0!	#DIV/0!	#DIV/0!			1/0/1900			
225.0	#DIV/0!	#DIV/0!	#DIV/0!			Average		#DIV/0!	#DIV/0!
120.0	#DIV/0!	#DIV/0!	#DIV/0!			1/0/1900	##########		
65.0	#DIV/0!	#DIV/0!	#DIV/0!			1/0/1900	##########		
50.0	#DIV/0!	#DIV/0!	#DIV/0!		50.0	1/0/1900	##########		
						1/0/1900	##########		
0	m=	#DIV/0!				1/0/1900			
	b=	#DIV/0!	Pass/Fail	Pass		Average		#DIV/0!	#DIV/0!
	r=	#DIV/0!							

	Comments
49iPS Certification Curve	
	Analyst
	D. House
	Date
	1/0/1900

Completed form

Date:	12/14/2018	Zero Air Supply Certification		
Specialist	Jake Eagle			
EQ #	5			

ECB Cert Bench		Primary EQ#	46	Cell A	Cell B
Cert Room Temp (C)	25	Pre-Intensity		110	97
Primary Standard EQ#:	46	Pre-Pressure		756	
Primary Cert Date:	8/6/2018	Pre-Flow		0.776	0.771
Primary Std Cert Slope	1.0073	Post-Intensity		111	97
Primary O3 Coeff	0.988	Post-Pressure		756	
Primary Std O3 Bkg	0.9999	Post-Flow		0.770	0.775

Zero Air Supply					
Zero Air Supply EQ #		5	ZAS Pressure (psi)		25.0

Cycle	Date	Time	Reading	Cycle	Date	Time	Reading
Warm up Cycle	12/14/2018	6:59	0.27	Cycle 3	12/14/2018	7:15	0.55
	12/14/2018	7:00	0.70		12/14/2018	7:16	0.67
	12/14/2018	7:01	0.65		12/14/2018	7:17	0.49
	12/14/2018	7:02	0.47		12/14/2018	7:18	0.56
	12/14/2018	7:03	0.36		12/14/2018	7:19	0.55
	Average		0.490		**Average**		0.564
Cycle 1`	12/14/2018	7:05	0.53	Cycle 4	12/14/2018	7:20	0.46
	12/14/2018	7:06	0.43		12/14/2018	7:21	0.46
	12/14/2018	7:07	0.51		12/14/2018	7:22	0.44
	12/14/2018	7:08	0.38		12/14/2018	7:23	0.53
	12/14/2018	7:09	0.49		12/14/2018	7:24	0.57
	Average		0.468		**Average**		0.492
Cycle 2	12/14/2018	7:10	0.45	Cycle 5	12/14/2018	7:25	0.69
	12/14/2018	7:11	0.36		12/14/2018	7:26	0.48
	12/14/2018	7:12	0.73		12/14/2018	7:27	0.56
	12/14/2018	7:13	0.60		12/14/2018	7:28	0.43
	12/14/2018	7:14	0.55		12/14/2018	7:29	0.51
	Average		0.538		**Average**		0.534

Acceptance Criteria	Results		Evaluation	ZAS	5
Average ≤ 2.0 ppb	Average ppb	0.52	Pass		
Maximum ≤ 2.0 ppb	Max ppb	0.73	Pass		

Comment		
	Analysts	Jake Eagle
	Date	12/14/2018

Section 7.5.3 Certification of Mineral Thermometers

Mineral (Site primary standard) and Comet (site secondary) and HOBO (site backup) thermometer(s) See **Appendix B** and assure all 3 are current, recorded and entered into ECB database.

Section 7.5.4 Standard and Service Modes Envidas Settings and Communication Settings New Computer (bare bones out of box)

Note: Disclaimer about Software version
The visual layout of Envidas may vary in each instrument based on which Version number is currently loaded in the instrument. The 'newer' version(s) will allow more options and settings to adjust than older versions. It will of course be the goal of the ECB to upload the most current 'workable' version to keep all instruments working as efficiently and 'normal' as possible with existing time and manpower constraints.

Go into Envidas **Ultimate Setup** (**Note Version #---very important!**)

Sign In with **Username** and **Password**

Install Envidas Software

Go to Envidas **Reporter** to **reports**, **columns**, etc.

Go to Envidas **Ultimate Setup**
        Note: to set it up **include Viewer**

In **Setup**, **upload** the **Configuration files**; **import** the **Site Specific files** (this will give the site a Starting point background)

Next, go to the **Communication tab**, input the **I/D address of the monitor and calibrator** (see picture below)—this will be the **TCP/IP address**
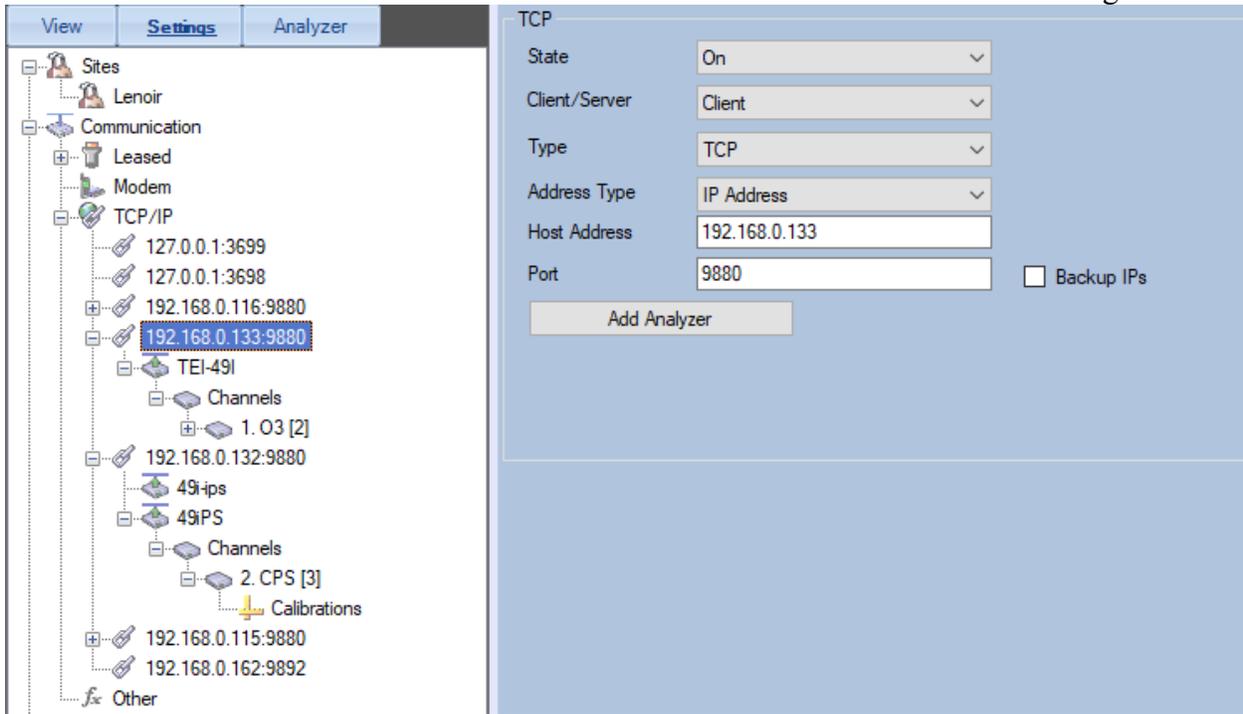
Go to '**Add Analyzer**' under the newly created IP address
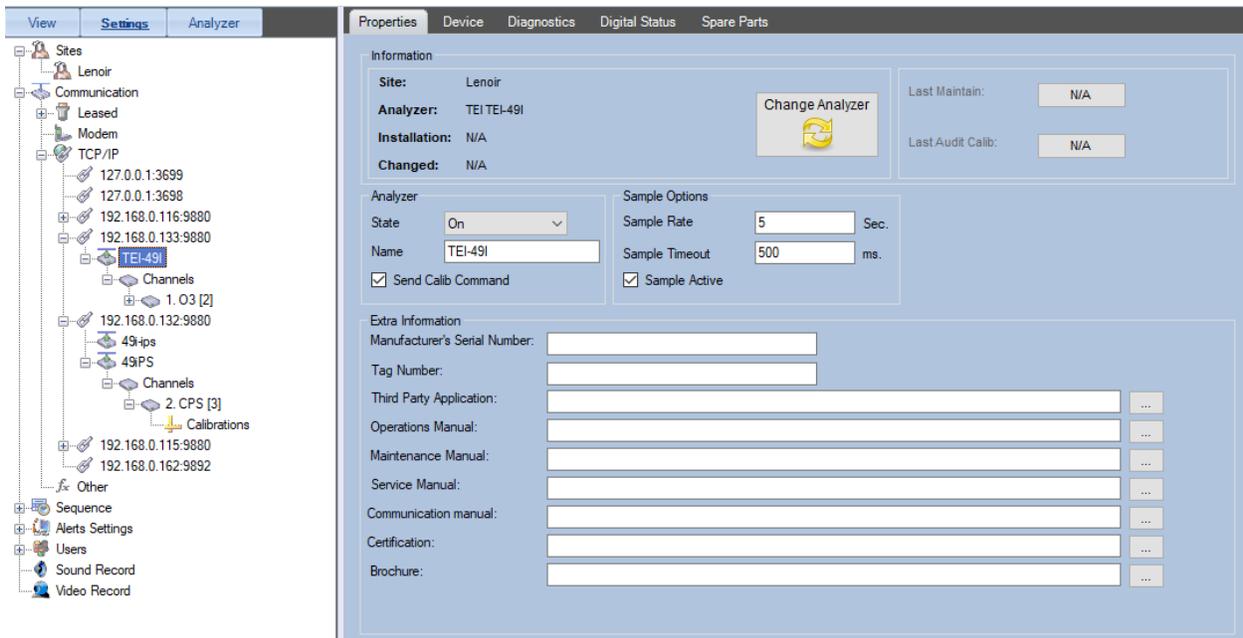
In the **Add Analyzer Tabs**, populated with pre-set specification; i.e. **Set Device properties** (see below)
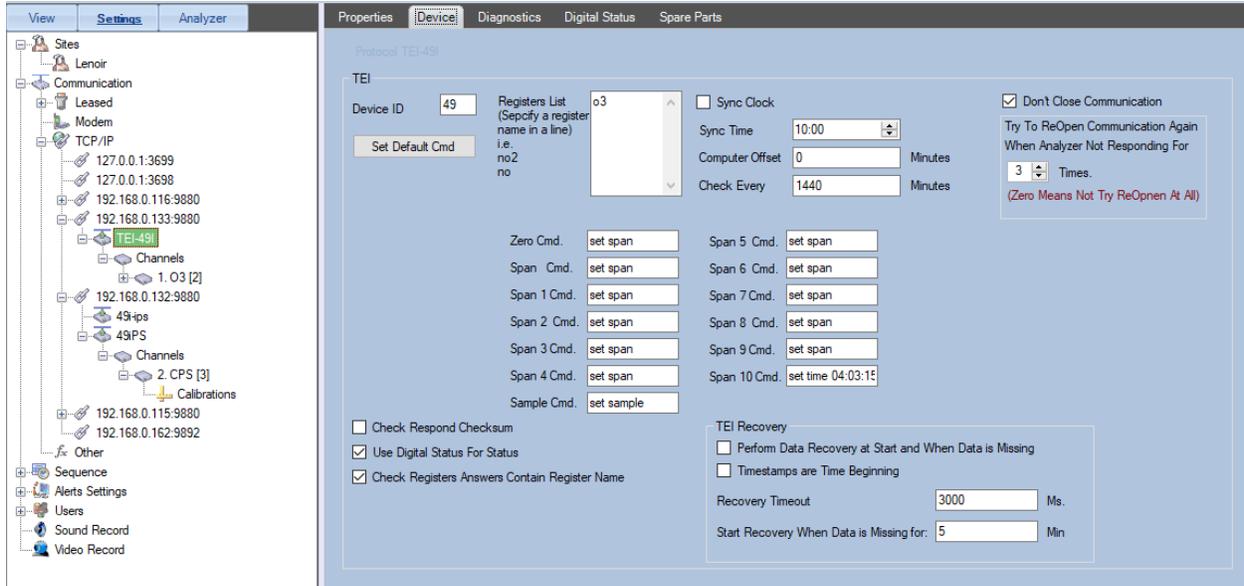
Channels
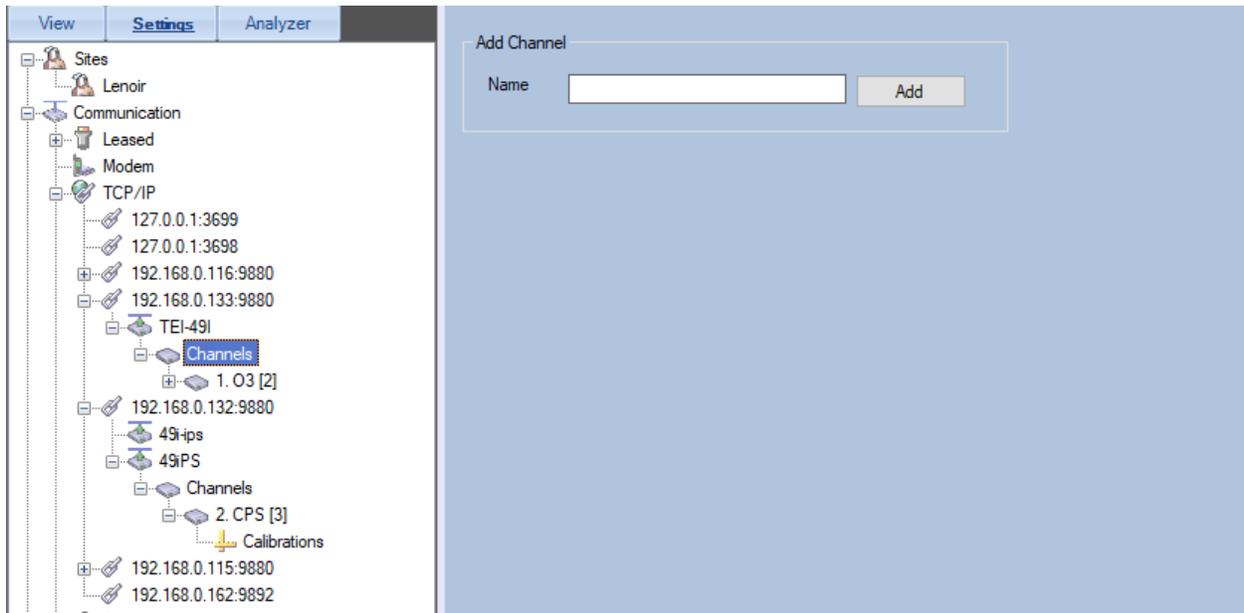
Channels
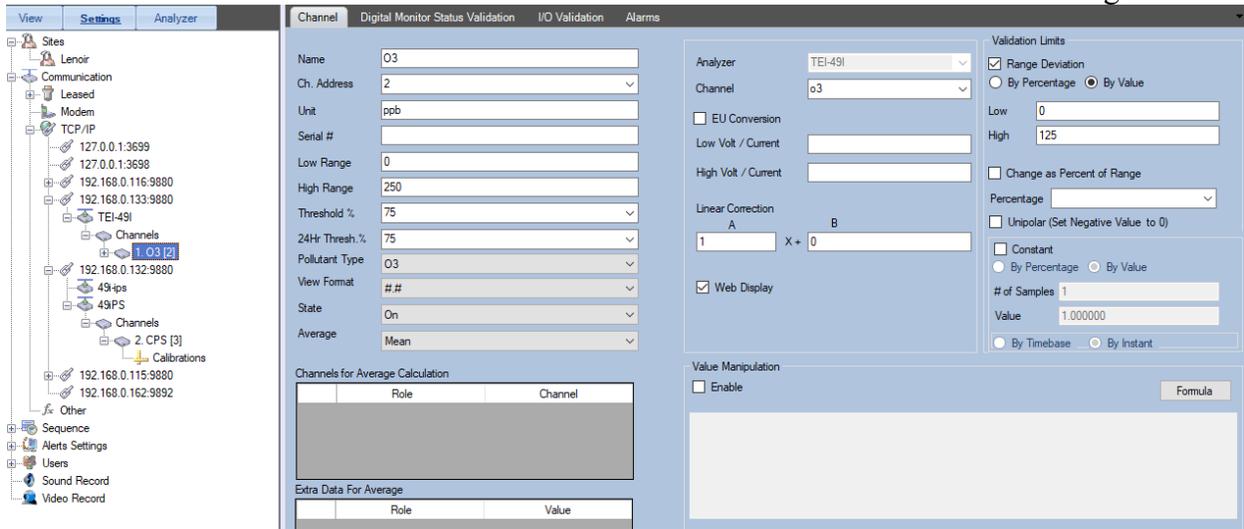
Channels
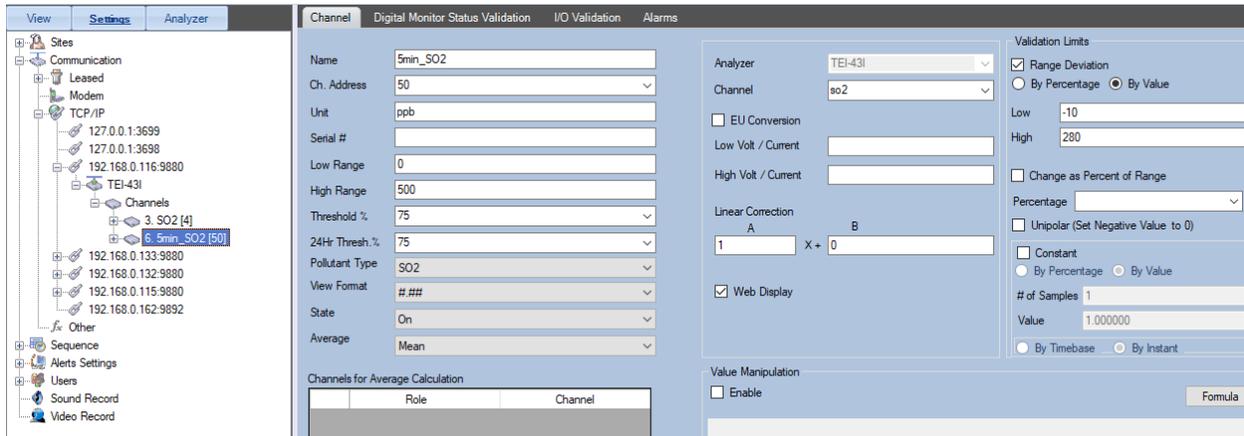
Note: the Diagnostic tab is for Trouble Shooting only!

After **identifying the Analyzer**, then **add the Channels** and **Validate the limits**
Repeat the steps above for the **Calibrator (49iPS)**; i.e. **add TCIP, Analyzer, channel, preliminary set up, set up for Autocal**

Envidas **TCP/IP** setup (**Calibrator**)
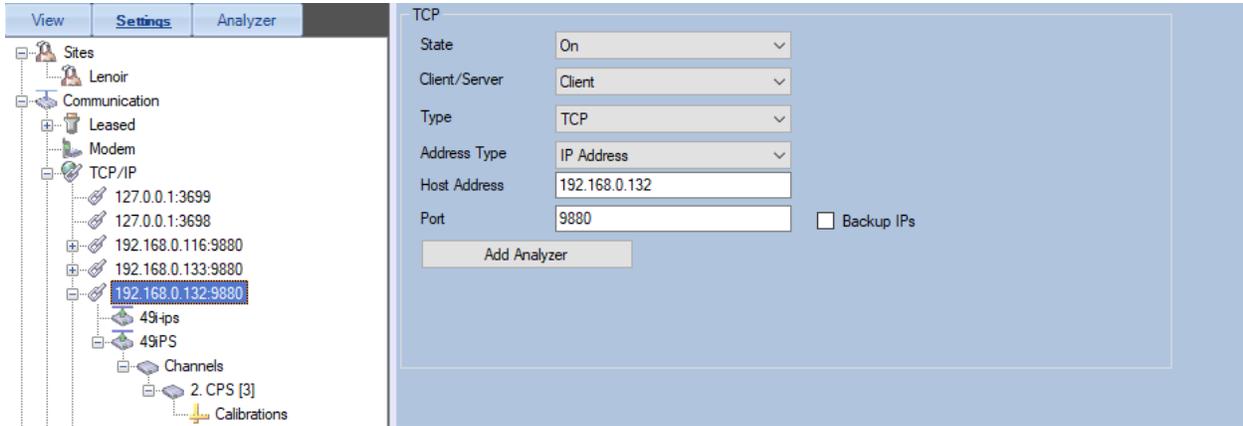
Add Analyzer (Calibrator)
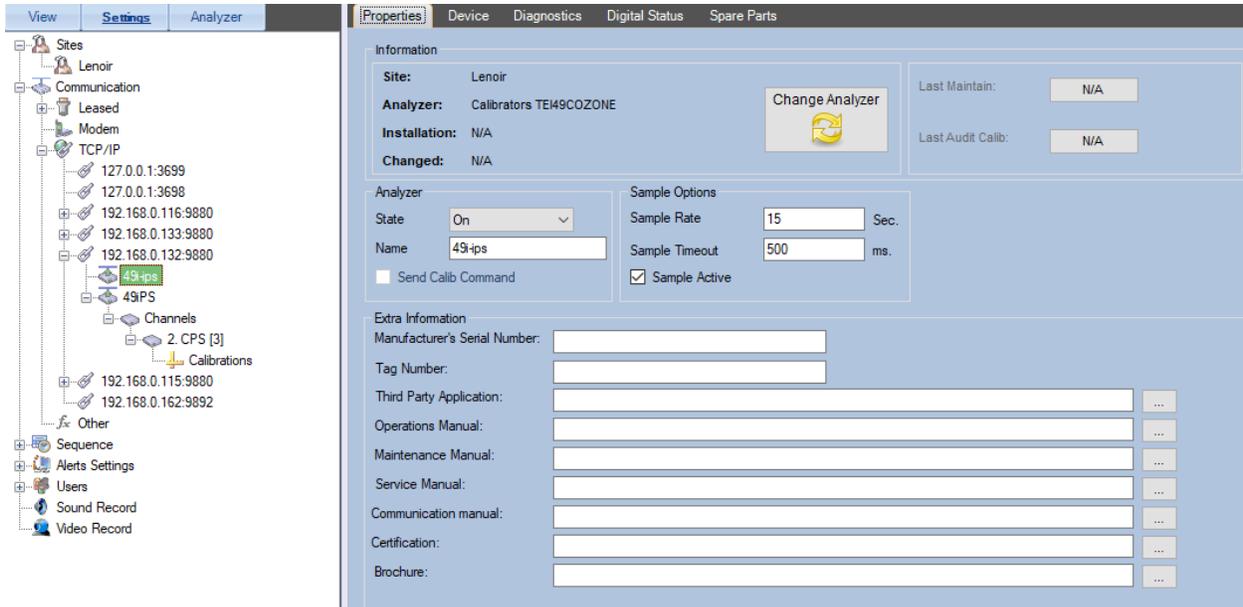
Add **Analyzer Device (Calibrator)**
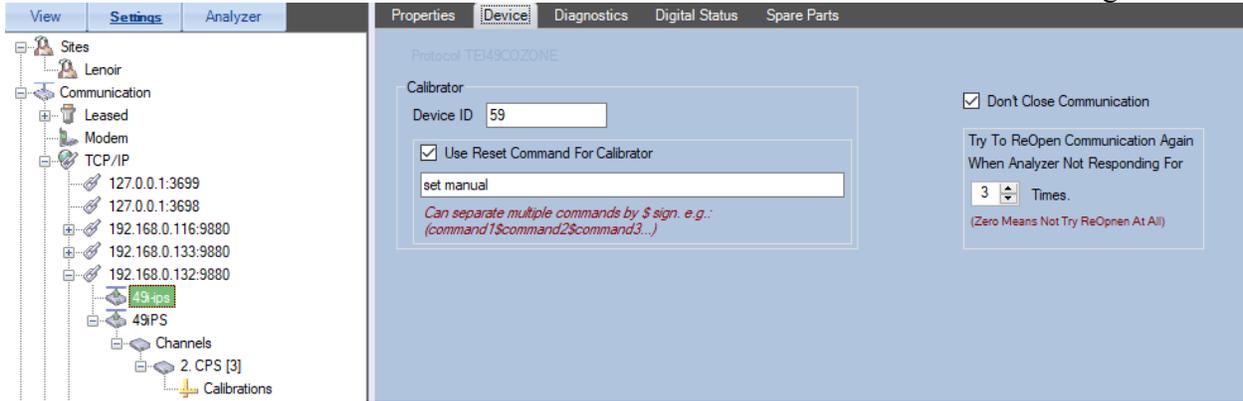
Add Analyzer (Calibrator) (2)
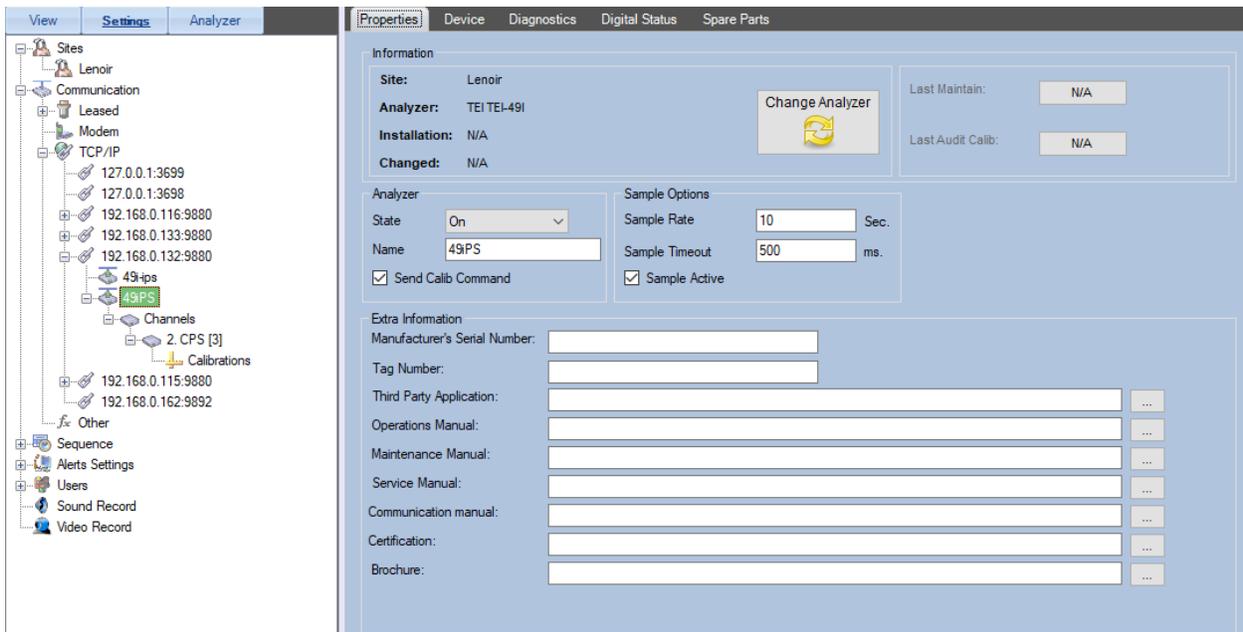
Add Analyzer Device (Calibrator) (2)
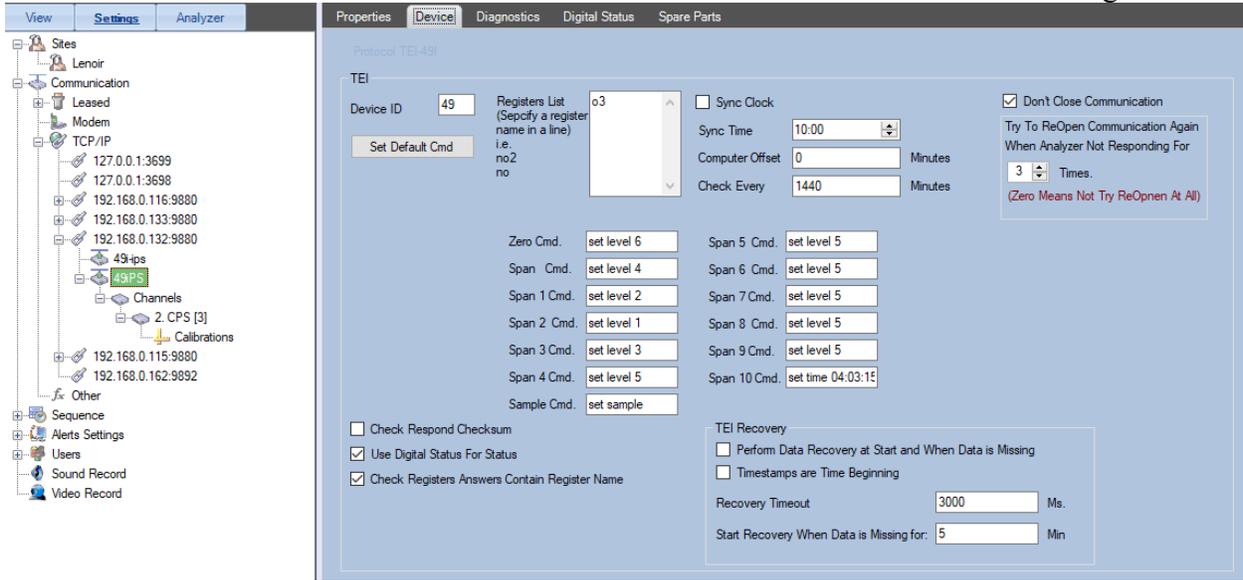
Channels (2)
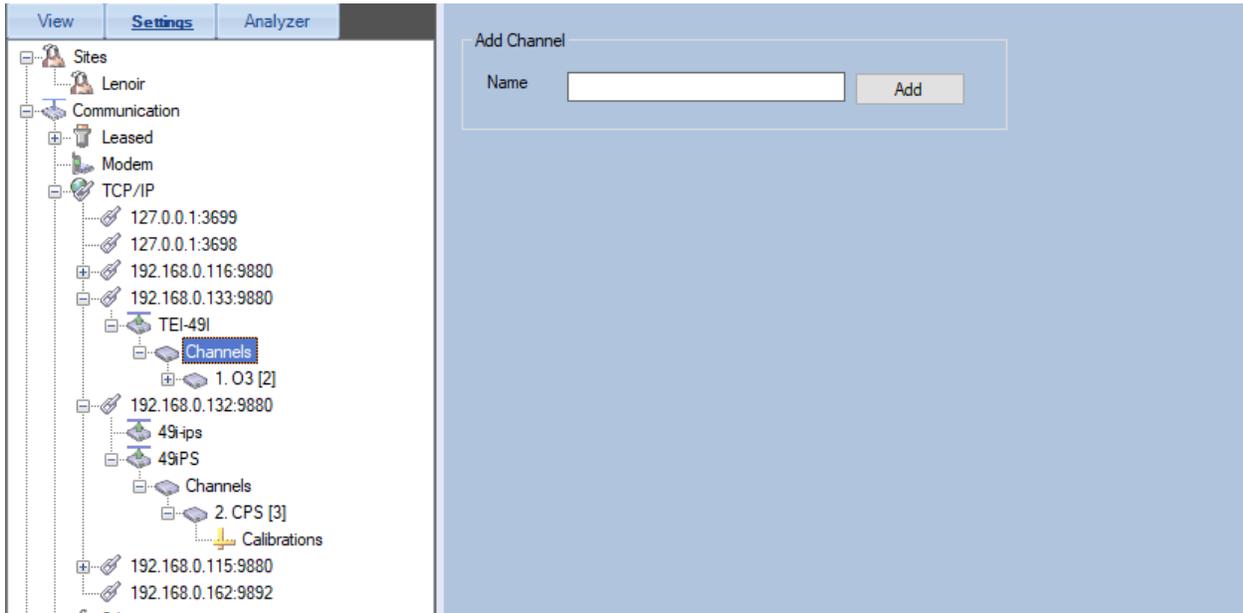
Channels (2)
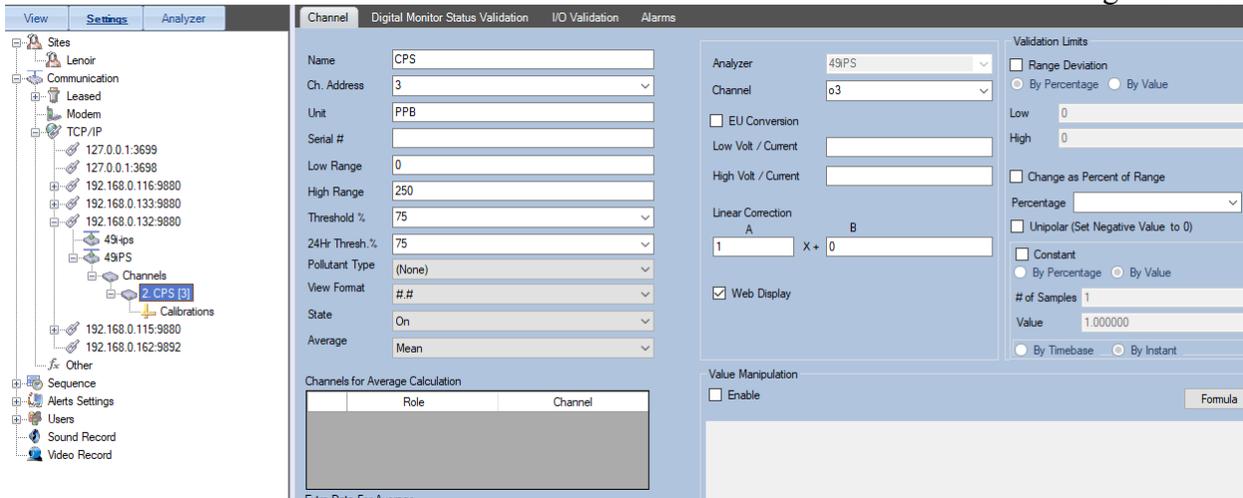
Go to **Properties:**

Sequence set up for **AutoCal**

Go to **Sequence Tab** (see Screen shot), set **Duration** of each point (Zero, Span, Precision)

On Sequence Tab

Check and Set Properties

Check Sequences

In **Sequence Tab** create a **Time Sync** in instrument to mirror computer

Note: ECB sets up Users in software (screen shot)
Save settings

Restart Services---Restart Services by ***Right clicking on the Globe icon*** located in the bottom right of windows task bar (if not showing hit the 'up arrow' at bottom right of screen to Show hidden icons and Globe is contained within) and hit **Restart Services**,

Log in again, Status bar should be Green and you are good to go

Ready to run!

Set up **Envidas Ultimate Viewer**
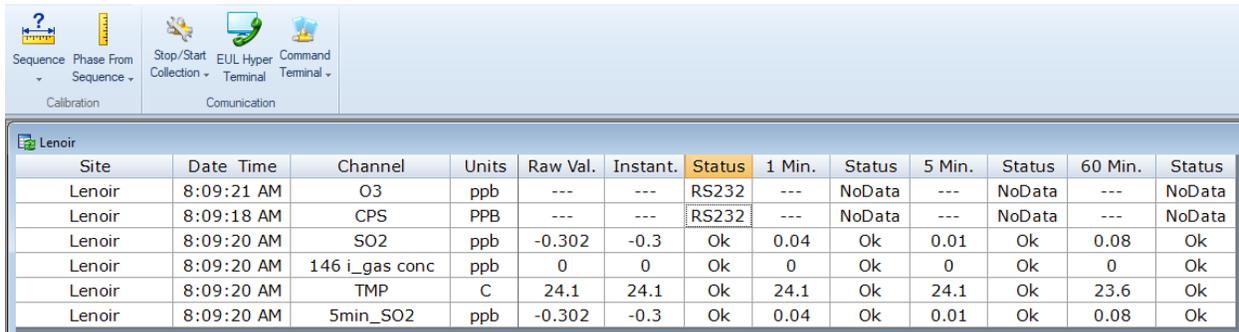
Site	Date Time	Channel	Units	Raw Val.	Instant.	Status	1 Min.	Status	5 Min.	Status	60 Min.	Status
Lenoir	8:09:21 AM	O3	ppb	---	---	RS232	---	NoData	---	NoData	---	NoData
Lenoir	8:09:18 AM	CPS	PPB	---	---	RS232	---	NoData	---	NoData	---	NoData
Lenoir	8:09:20 AM	SO2	ppb	-0.302	-0.3	Ok	0.04	Ok	0.01	Ok	0.08	Ok
Lenoir	8:09:20 AM	146 i_gas conc	ppb	0	0	Ok	0	Ok	0	Ok	0	Ok
Lenoir	8:09:20 AM	TMP	C	24.1	24.1	Ok	24.1	Ok	24.1	Ok	23.6	Ok
Lenoir	8:09:20 AM	5min_SO2	ppb	-0.302	-0.3	Ok	0.04	Ok	0.01	Ok	0.08	Ok

Log in to Envidas **Ultimate Viewer** (screen shot)
        Note: If anything other than 'OK' displays, then it is **Not** Working

Once in Viewer, activate Events by going to the **Sequence tab** and proceed to **set up Graphs**, Set the **channel flags** (i.e. for Maintenance, Calibration, Audit, etc.)

Set the **Temperature** in Envista Ultimate Set up
        Note: in HOBO: modify by resetting the pin and adding extensions And power supply

        Under Leased---add HOBO according to communication port(s) on back of computer (See HOBO directions below)

Screen shot---add **Port** (screen)---**add Analyzer**---**add channel** (screen shot)

Set up Envidas Reporter
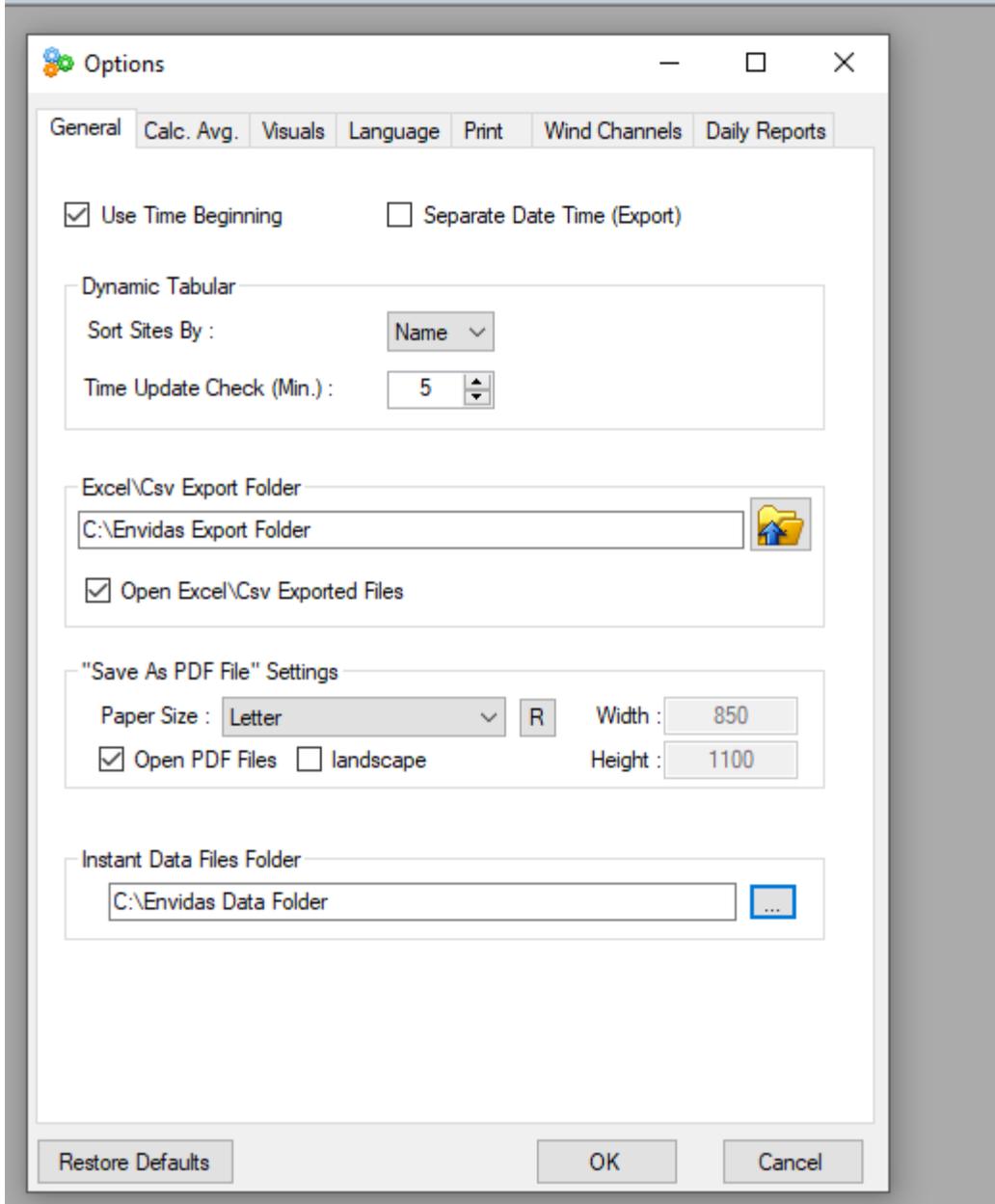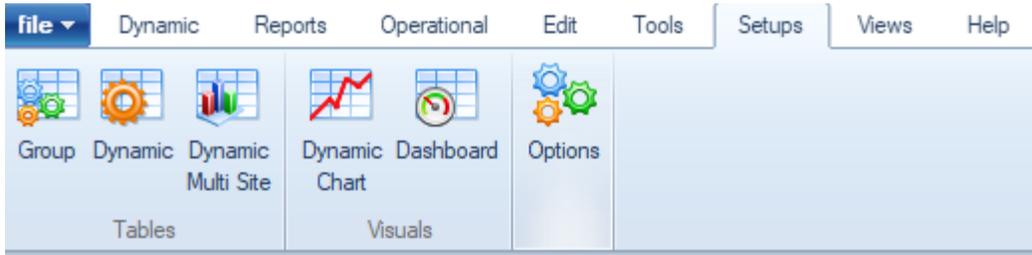
While in Envista **Reporter** proceed to **Set ups**, then **Options**
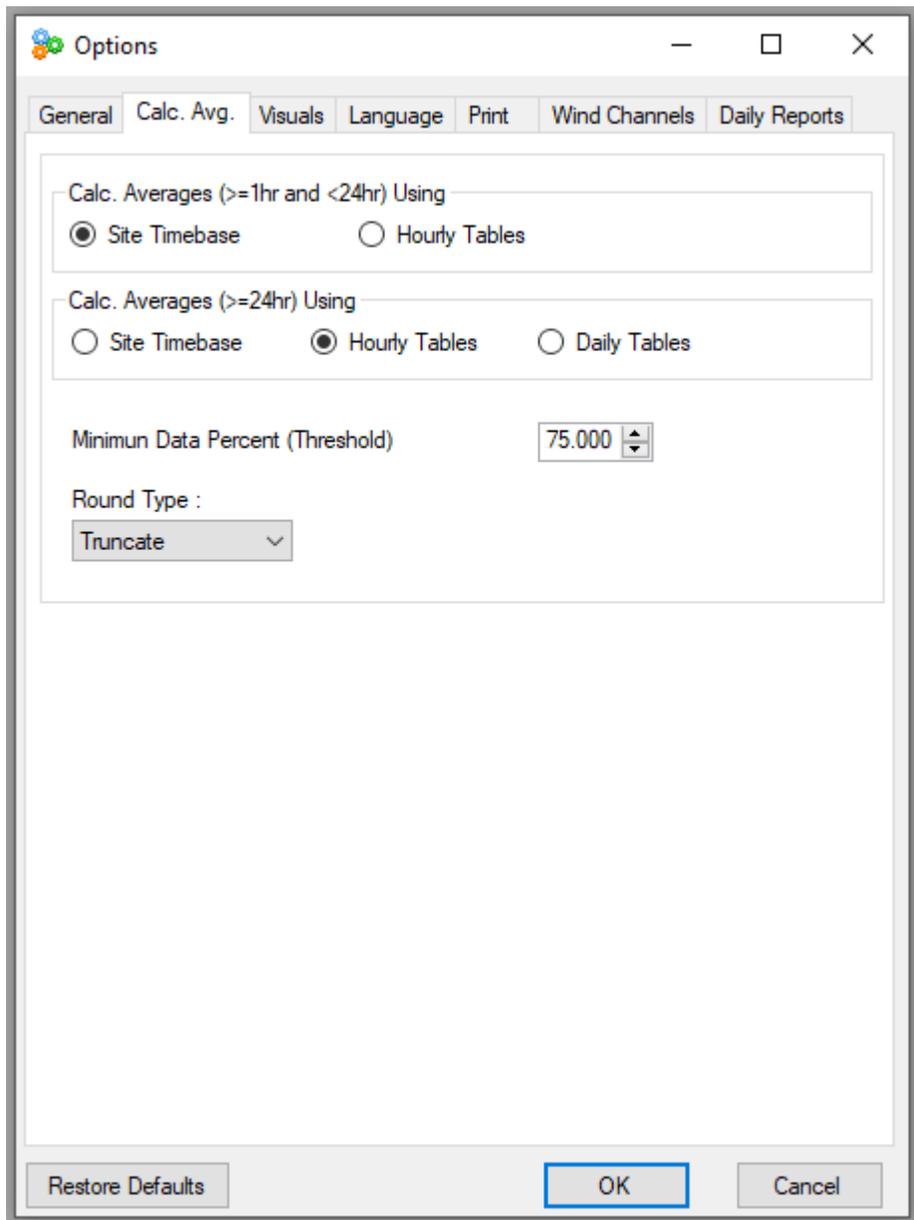
While in the General tab the C drive should display …**EADS**…folder in the C drive---
this is the Export folder (this is where the graphs are retrieved)

In the **Calculate Average** be sure to check **Truncate** (screen shot)

In the **Language** tab be sure to check **English/US**
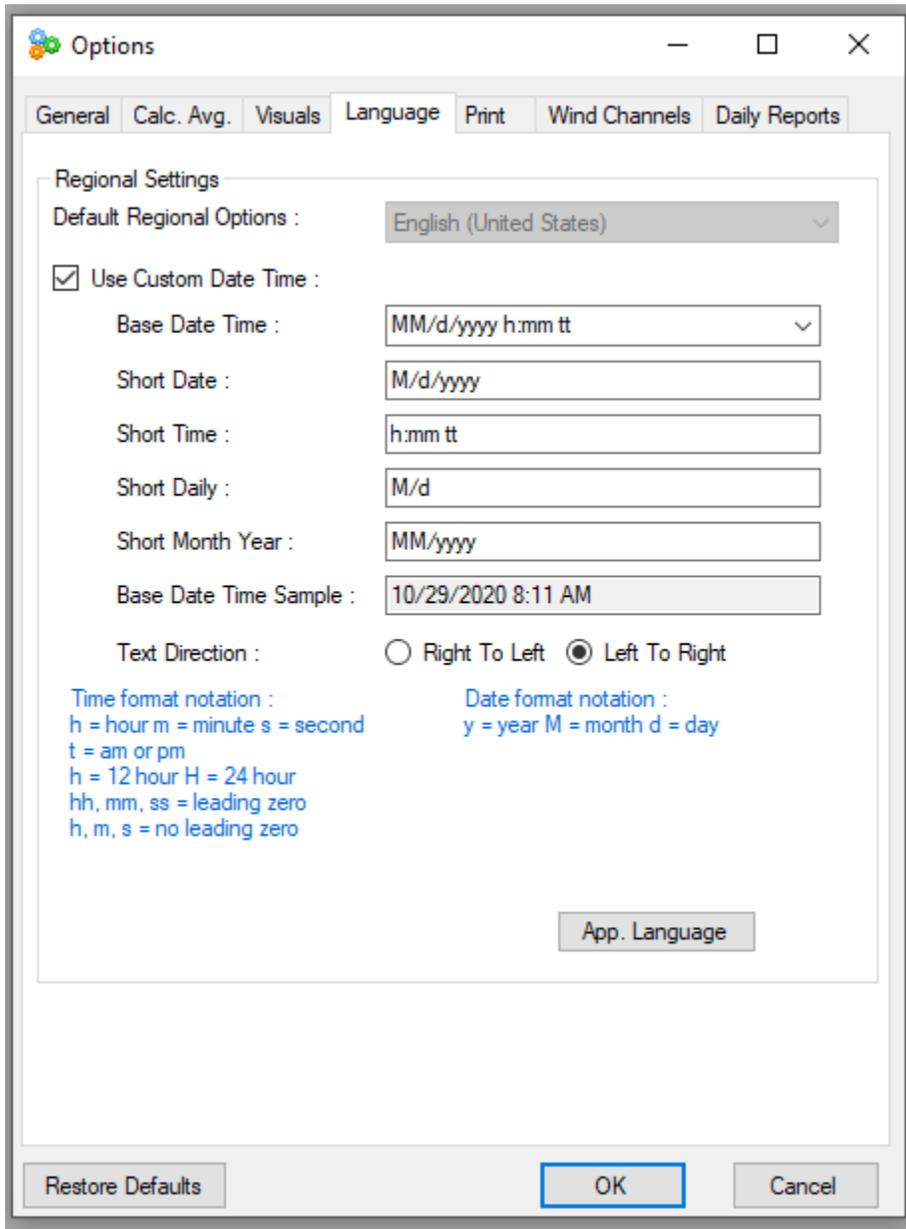
Hit **OK, enter**

Good to go!

Graph creation in Reporter

To create a graph in Reporter First go to **Set up**, proceed to **Dynamic chart** add a **new graph**, **name it**, proceed to **Edit chart**, **define the axis**(s) (auto minor and max), and **Save it**
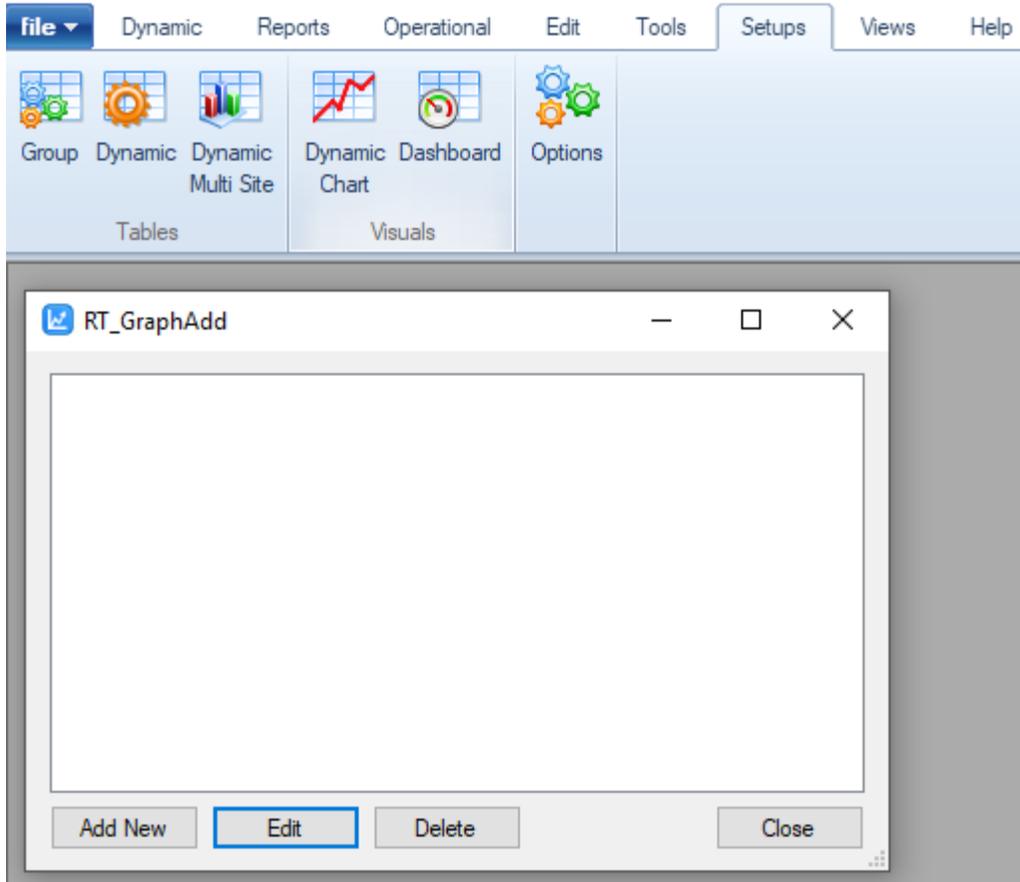
Add New (Give a name and select OK)
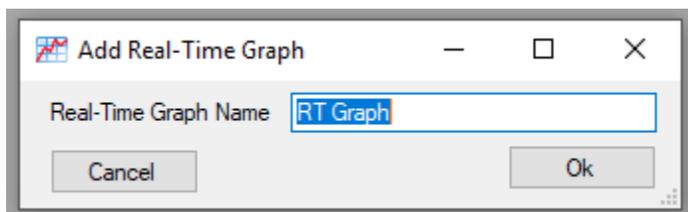
Select **graph** and select **edit**
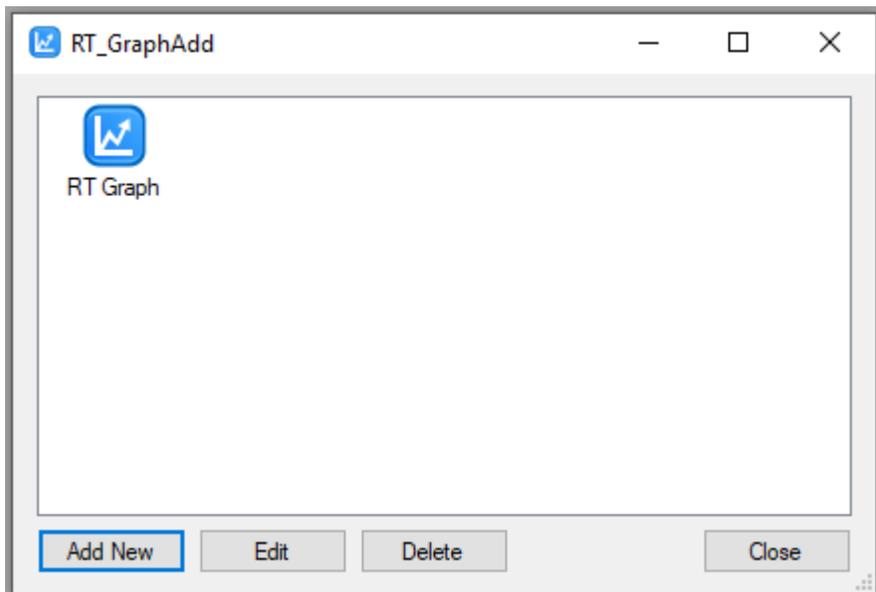
Select add monitor
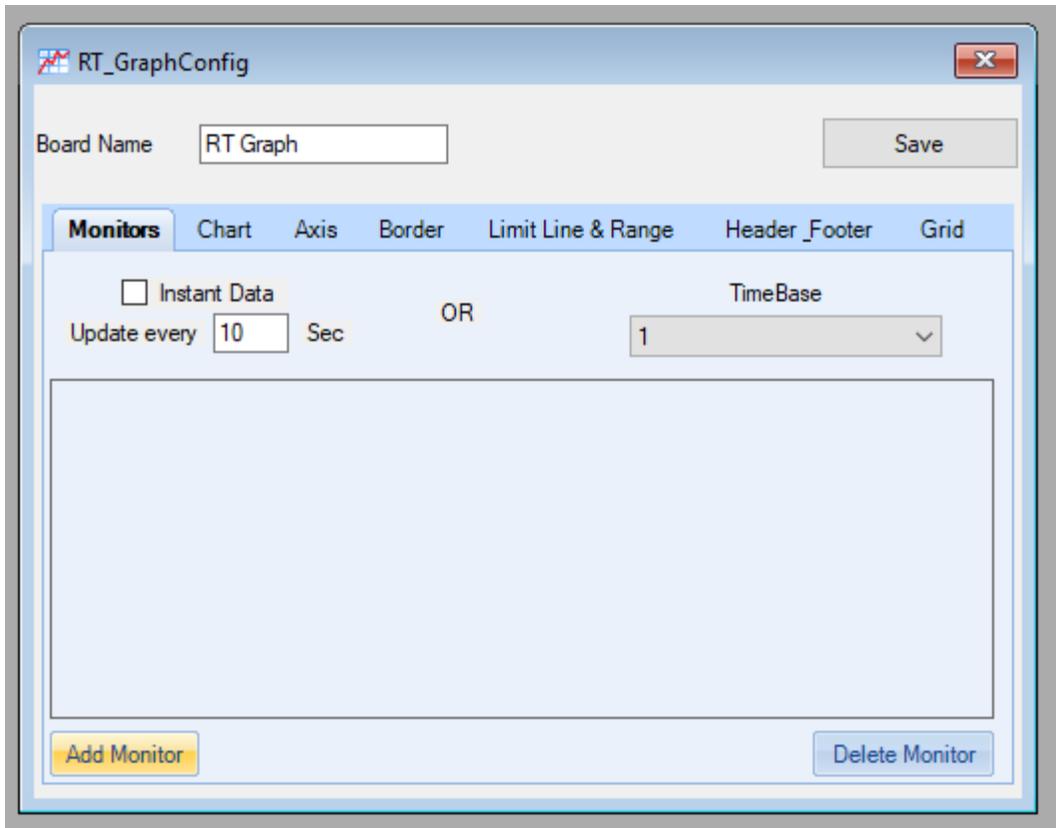
Select **monitor** and Select **OK**
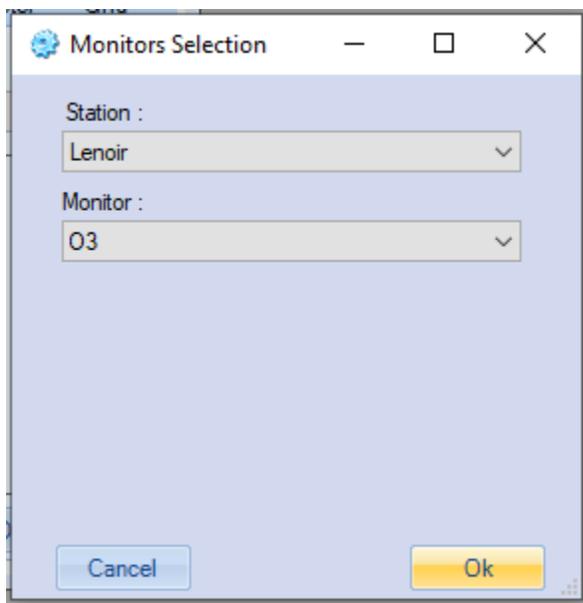
Select **Axis**
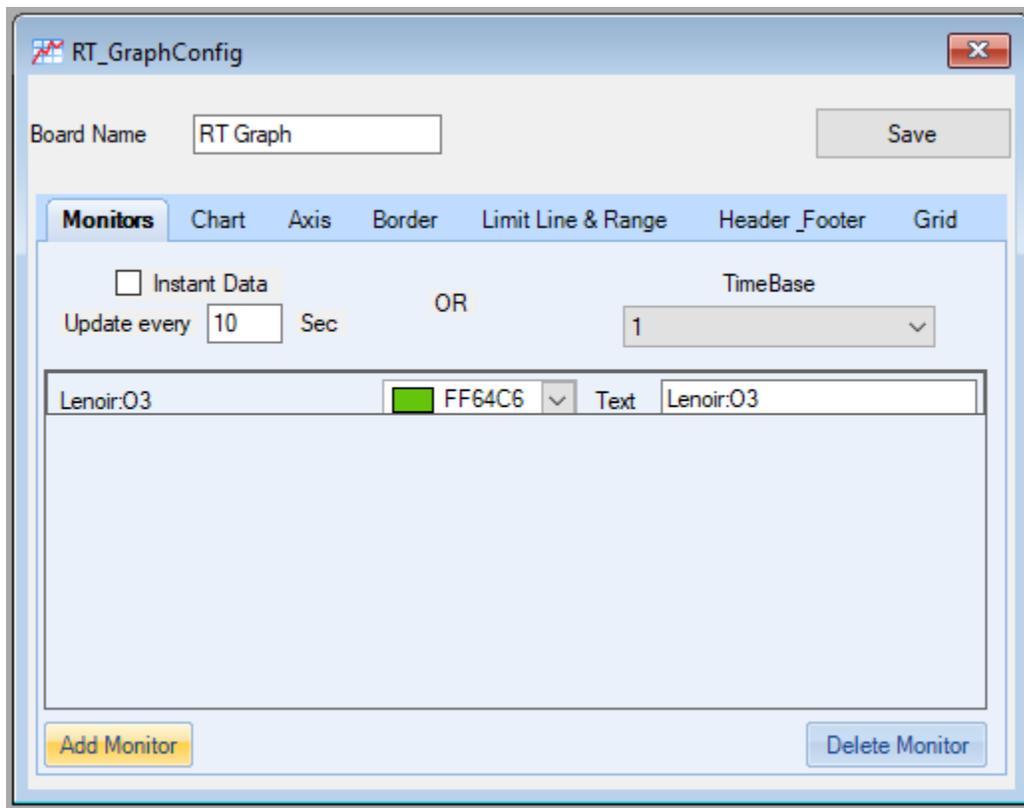
Place **check in box** (Auto Minimum Maximum)

Press **Save**

Section 7.6 On-site Installation

Install

Section 7.6.1 Instrument installation and testing—plug in/warm up until all alarms disabled and run Zero and Span and Precision at a minimum expect +/-5 ppb and Cal Factors good and proceed to next steps below

Section 7.6.2 Teflon sampling line and probe installation and/or replacement if necessary (see sections **Section 7.1** and **Section 7.3.1** above for specs)

Section 7.6.3 Temperature control and monitoring shelter specs

The specs for Ozone shelter is to be set to maintain a minimum **>5C** and a maximum **<40C**.

Section 7.6.4 Install heat tape around probe line and insulator 'Koozie' to filter housing on back of 49i Monitor (optional for moisture reduction in sample train)

Section 7.6.5 Software checklist: Make sure all events **Activate** and shows up in **Viewer**
(activate **Zero**, **Levels 1-5**, and then **deactivate**)

Section 7.7 Communications list checklist/settings/modem settings, and Connectivity

Section 7.7.1 iPort set up

Install Monitor and Calibrator and connect to iPort

Open **iPort** on Desktop

Go to **File Preferences**
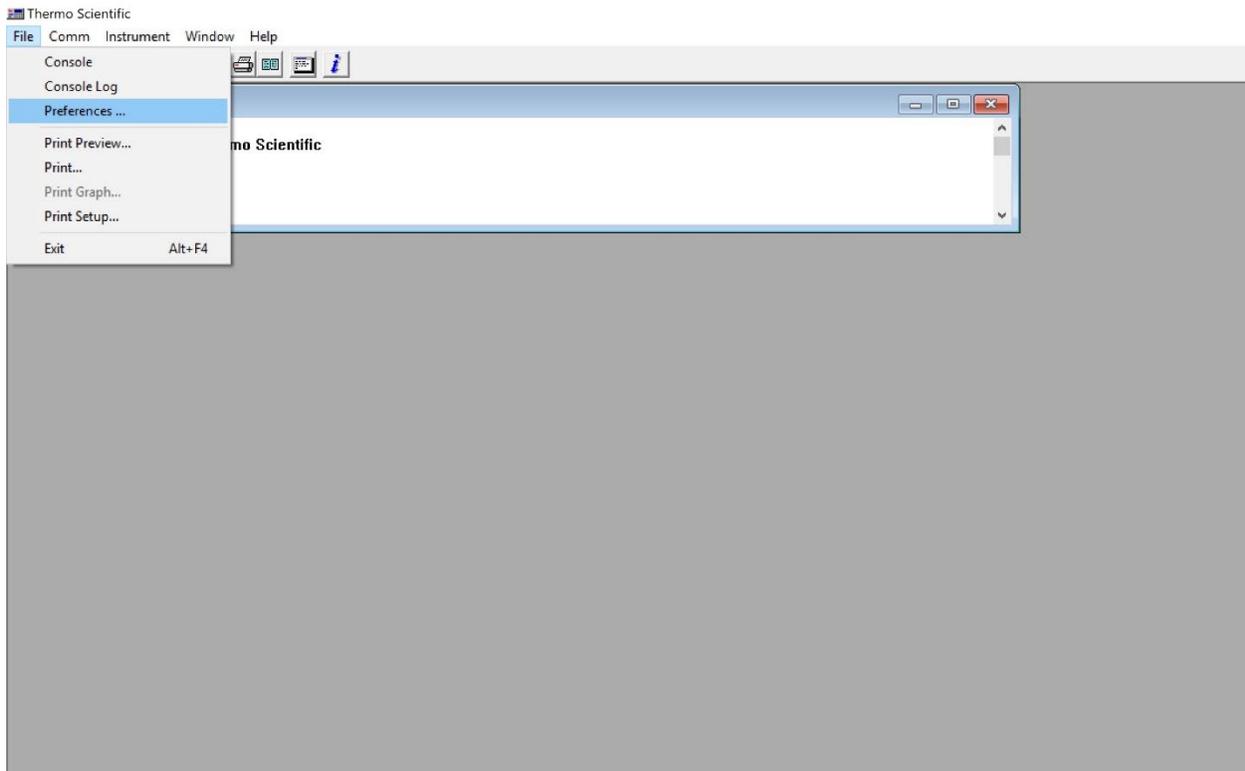
Go to **File** and then **Preferences**

Go to **Set Preferences** and make sure **DIRECT TCP/IP enabled (check box),**

Hit OK

Connect to Instrument by Set up I/P addresses for Monitor (49i) and Calibrator (49iPS) by checking Instrument and TCP Connection and I/P address
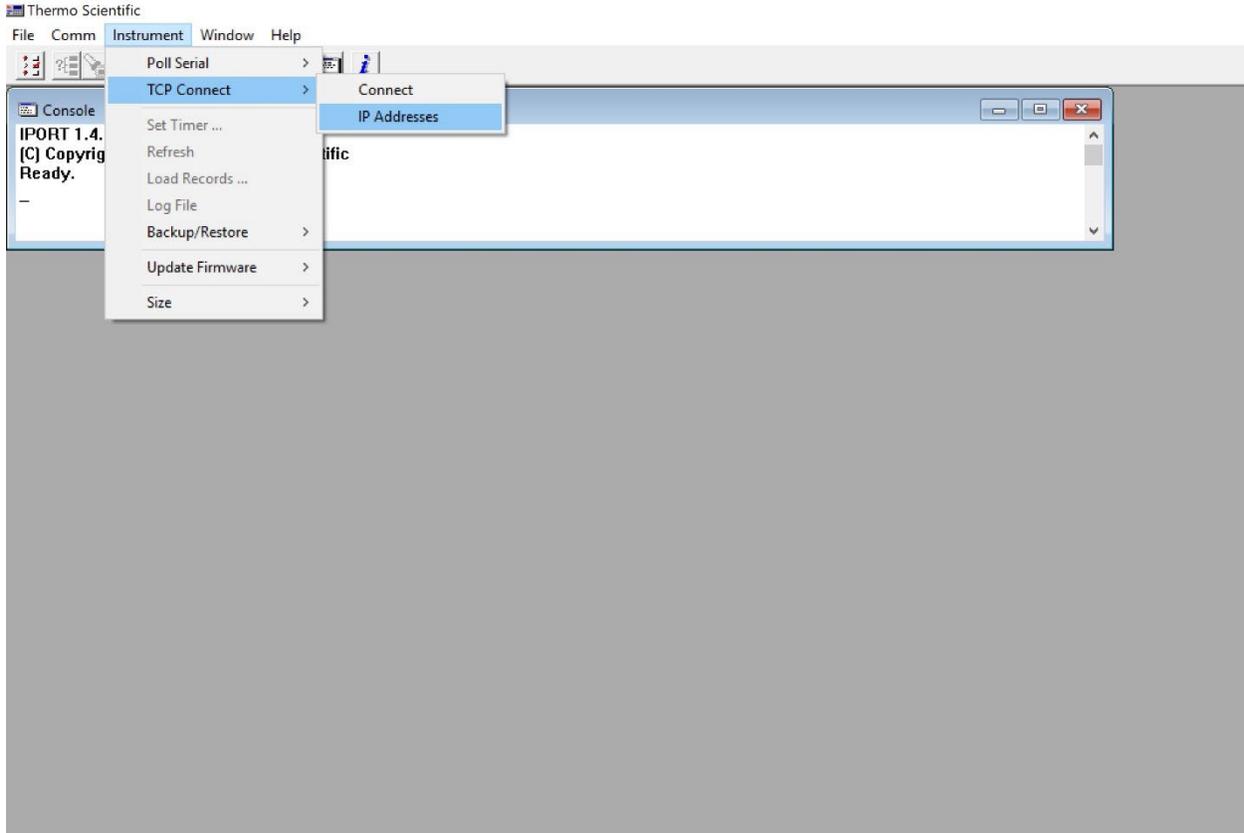
Pull up Ethernet Connections (Local)

Type in the Instrument(s) of choice you are Communicating with

Screenshot below is an example of both Calibrator and Monitor at every site

192.168.0 is path for all sites
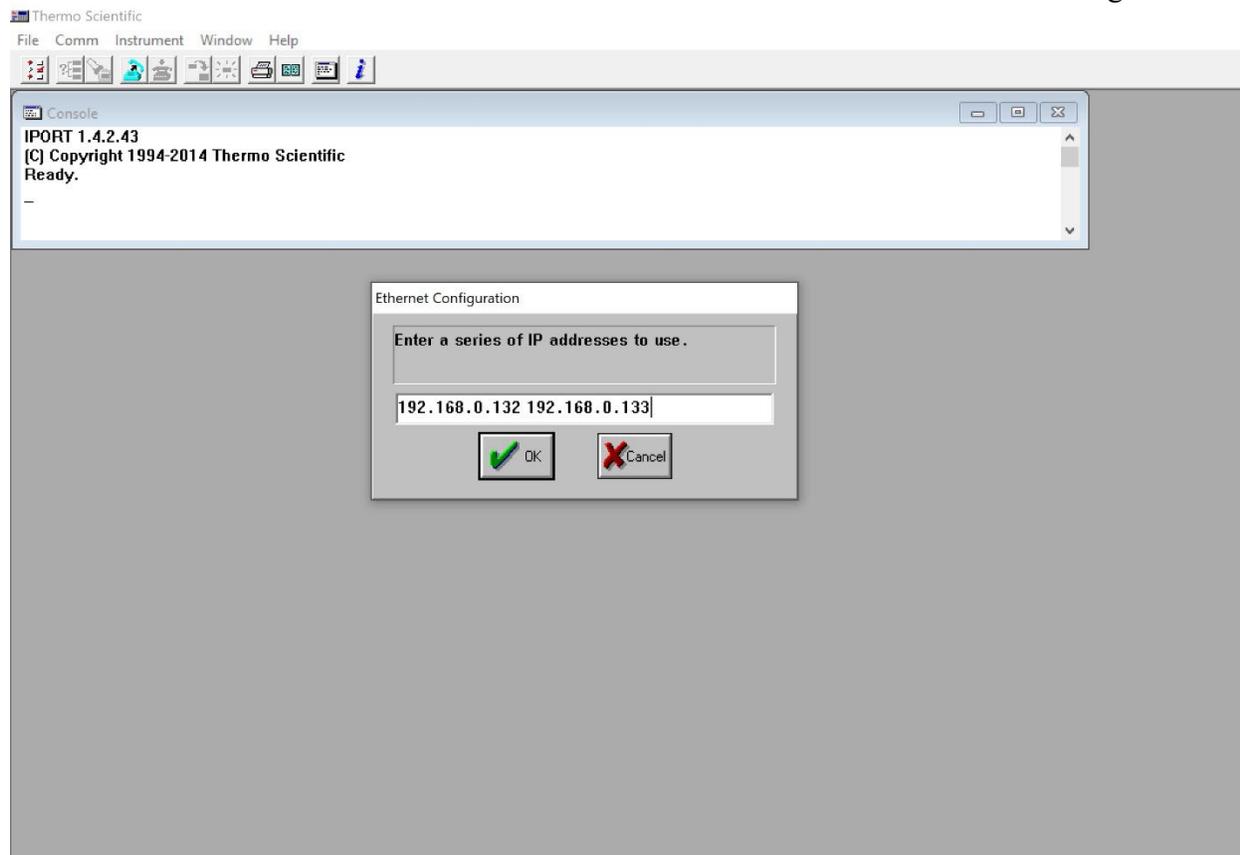
**i.e. 192.168.0.<u>132</u> (calibrator at this site) and 168.0.<u>133</u> (monitor at this site)
(132=Calibrator, 133= Monitor)**

Hit OK

Connect to Instrument
This will connect to I/P address as seen above for monitor and calibrator
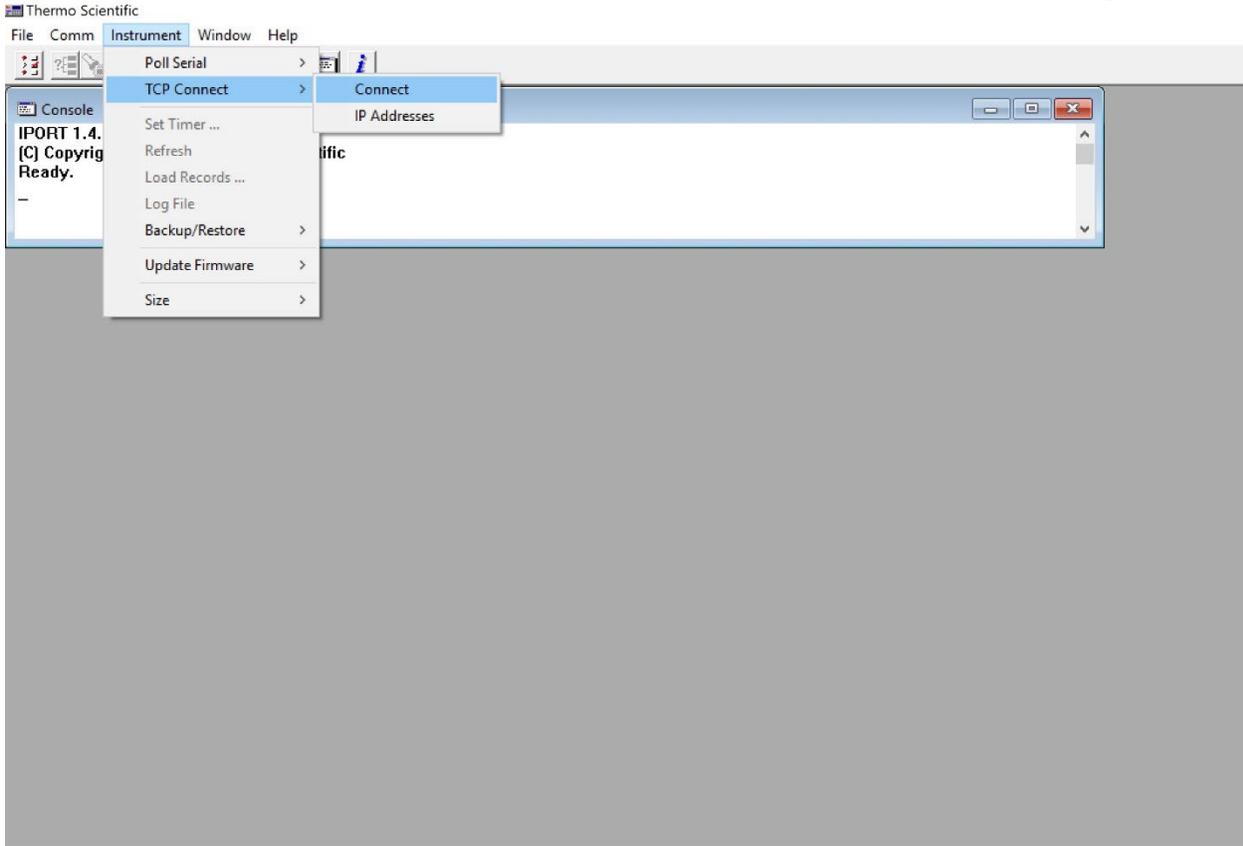
If it connects it should look like below;
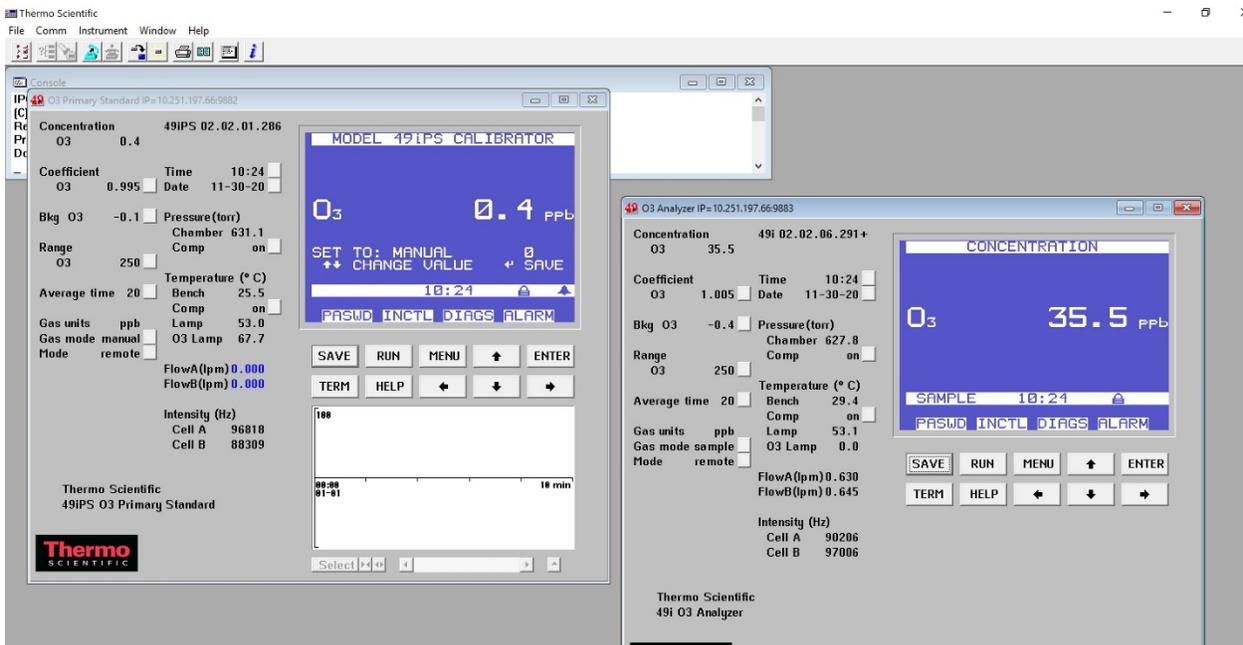
If it connects as above, you are done and can close iPort

The specs for Ozone shelter is to be set to maintain a minimum **>5C** and a maximum **<40C**.

Section 7.8 Other Equipment Settings

Section 7.8.1 Comet temperature sensor---confirm it shows up in Envidas **Viewer** temperature channel and compare it to ECB certified standard (currently Omega HH804)--open Viewer and confirm match of values for ambient temperature (optimally set around 20-25C)

Section 7.8.2 HOBO temperature sensor---compare to Comet and mineral thermometer with Omega HH804 (ECB field standard); Go to Port 2 (**COM2**), **9600** Baud rate, Inst.**T0310**
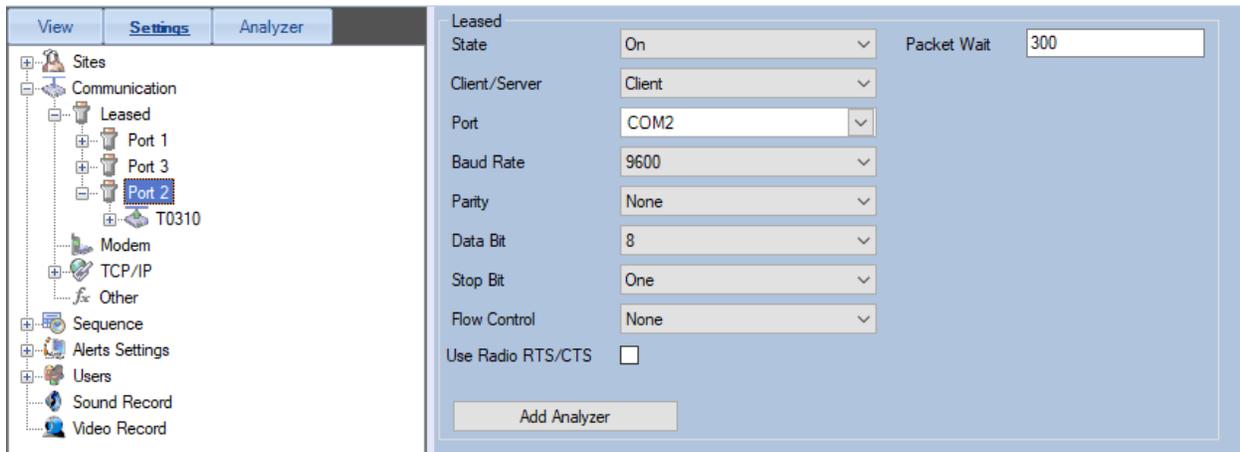
State-**On**, Name **T0310**, Sample Rate **5 sec**, Sample Timeout **1000 ms**, Sample **Active box** checked
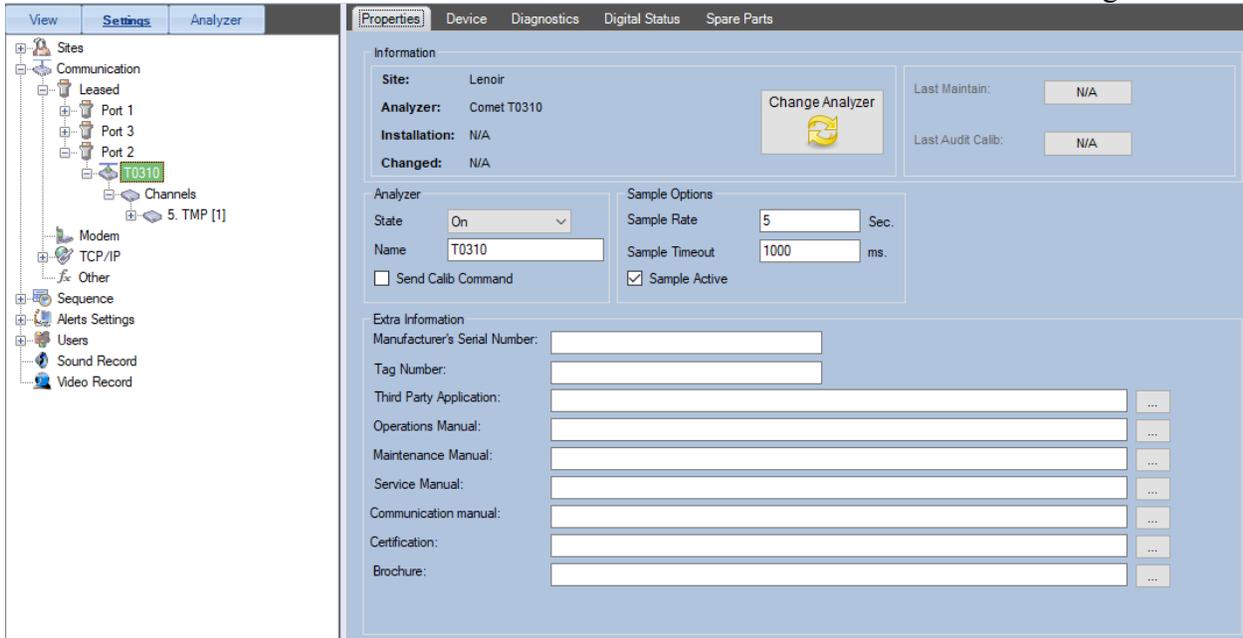
Name **TMP**, Low **Range -15**, High **100**, Threshold **75%**, **Format ##,** Average **Mean**, **Web Display Box** checked
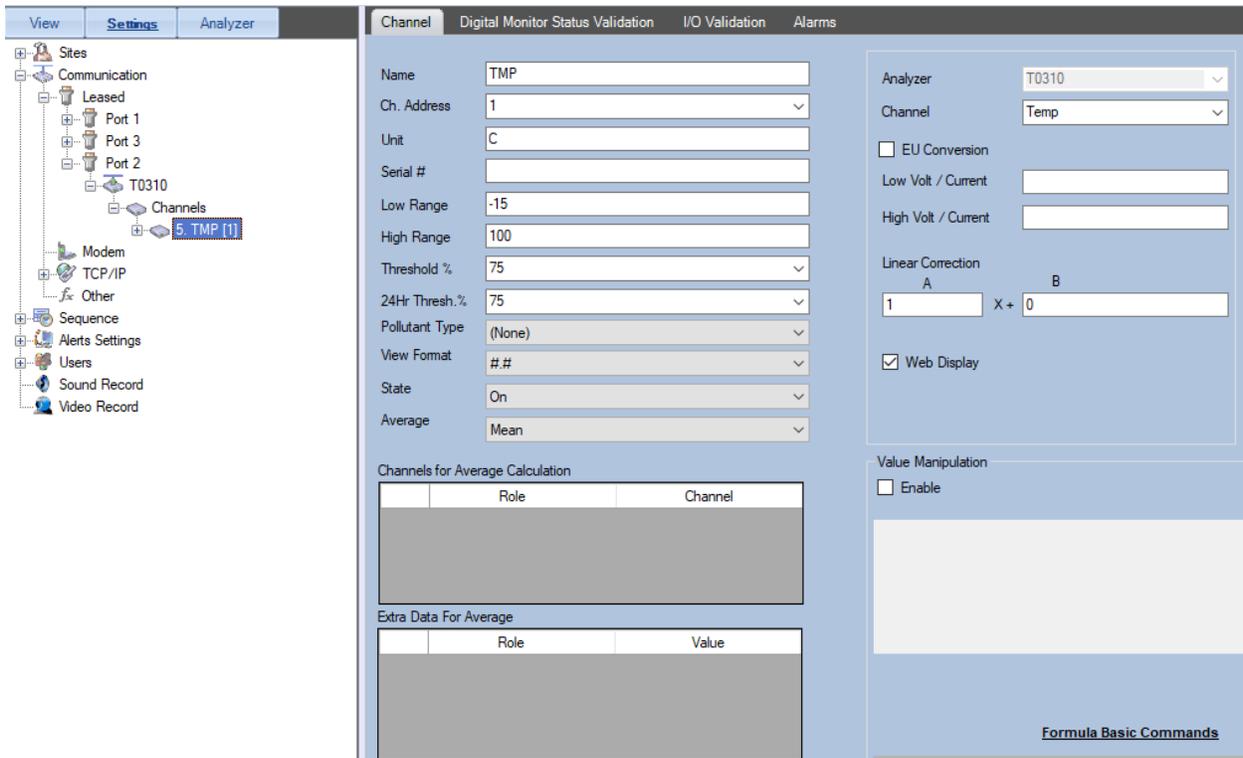
Section 7.8.3   Check and set Time and Date---match computer and 49i Monitor---match 49i and 49iPS to site computer (NIST time) and set accordingly if out of sync.
Note: there is a time sync sequence embedded in the Envidas software.

Section 7.9 Leak check the system and replace the filter (if necessary)

1.   Run a **Pre-Leak** check prior to changing the filter by disconnecting the filter line to the 'Common Solenoid port on the back of the 49i Monitor and capping the port as well as the filter 'open line'.   Press the Menu Button on the front of the TEI 49i Ozone Monitor and select **Diagnostics** and then select **Pressure** (see steps 1-6 below for leak check
    a. Disconnect the Ambient input line from the back of the analyzer and plug the opening with a plastic insert. (This will check not only the filter, but the whole system for leaks).
    b. The pressure should decrease <u>below</u> **250 mm Hg** <u>within 60 seconds</u> (usually much faster).
    c. If pressure does not drop there is a leak. Remove the Ambient Inlet plug fitting and check all fittings and check the input lines for cracks and correct as necessary
    d. Repeat leak test. If fails, check all connections, bulk heads, and solenoids for connectivity
2.   Now, replace the in-line filter (if necessary) before testing the system for post leak check
3.   Disassemble the filter holder with the filter disassembly wrenches provided.
3.   Remove the existing filter and inspect the filter support screen.
4.   If the filter support screen is dirty rinse with de-ionized water and then dry.
5.   Reinstall the filter support screen.
6.   Touching only the outer edge of the new filter place the filter in the holder.
7.   Reassemble the filter holder.
Note: Do <u>not</u> over tighten the filter holder for this can tear the filter and/or damage the filter holder

Perform a Leak Test on the 49i <u>after</u> changing the Filter (if necessary to change filter)

Press the Menu Button on the front of the TEI 49i Ozone Monitor

1. Select "**Diagnostics**" then select "**Pressure** "
2. Disconnect the Ambient input line from the back of the analyzer and plug the opening with a plastic insert. (This will check not only the filter, but the whole system for leaks).
3. The pressure should decrease <u>below</u> **250 mm Hg** <u>within 60 seconds</u> (usually much faster).

4. If pressure does **not** drop <u>there is a leak</u>. Remove the Ambient Inlet plug fitting and check all fittings and check the input lines for cracks and correct as necessary (sometimes the replacement of an additional filter will solve the problem)
5. Repeat leak test. If fails, check all connections, bulk heads, and solenoids for connectivity.
6. If leak corrected and test is passed, reattach the ambient input line to the filter holder.
    Press **Run** and continue with filter conditioning

Section 7.10 Ozone Performance Audits

Ozone Performance Audits are a valuable independent tool in assessing the performance of an ambient air ozone monitoring system and the site operator's adherence to approved operating procedures. An ozone performance audit is conducted at each ozone monitoring site at a minimum of once every calendar year and 365 days within the period of operation. In addition, an ozone monitoring site performance audit is performed as a diagnostic tool when requested by a regional office or central office ambient monitoring staff and approved by the ECB Supervisor. The ECB also provides support to the Local Air Pollution Programs through the Ozone Monitoring Performance Auditing Program when requested and approved by the ECB Supervisor.

Per 40 CFR 58 Appendix A, a 10 level audit system is in place to assure an expansive coverage of instrument operations and adherence. The ECB performs a 3 point (Level) check during the seasonal audits plus a Zero point. *One point must be within two to three times the method detection limit of the instruments within the PQAOs network, the second point will be less than or equal to the 99th percentile of the data at the site or the network of sites in the PQAO or the next highest audit concentration level. The third point can be around the primary NAAQS or the highest 3-year concentration at the site or the network of sites in the PQAO. An additional 4th level is encouraged for those agencies that would like to confirm the monitors' linearity at the higher end of the operational range. <u>In rare circumstances, there may be sites measuring concentrations above audit level 10.</u> Notify the appropriate EPA region and the AQS program in order to make accommodations for auditing at levels above level 10.*

The Certified Primary Standard Audit Device and a Certified Zero Air Supply are taken to the ozone monitoring site to conduct the performance audit by the ECB. This Audit Device System is allowed to warm-up (acclimate) for at least 1-hour at the site before beginning the audit. During this 1-hour warm-up period the site is removed from the determination of ambient air ozone concentration and collection of air quality data.

Section 7.10.1 ECB Audit Procedure

Alarm Check of the TEI 49i Site

Ozone Monitor

Check the ozone monitor run screen. Is the word "ALARM" displayed? If no alarms are activated, then proceed. If an alarm is activated, the number in the upper right hand corner indicates the number of alarms that have been activated. If an alarm is activated, the monitor is

outside of acceptable operational limits and the audit cannot proceed. The Activated Alarm must be investigated and documented on the AQ-121 in the Auditor Remarks section.

If an Alarm is displayed on the 49i Ozone Monitor

1   Press Alarm Shortcut key on front panel of 49i
2.   Scroll through the parameters listed below to determine which item is in the Alarm Mode.

Note: Verify the Mins and Maxs with the chart in Section 1.3 (beginning)

Parameter	Min	Max
Bench Temp	15 C	40 C
Lamp Temp	50 C	60 C
Ozone(PS)Lamp	60 C	80 C
Pressure	200 mm Hg	1000 mm Hg
Flow Cell A& B	0.4 Lpm	1.4 Lpm
Intensity Cell A & B	45 Khz	150 Khz

5.   All alarms should be noted on the AQ-121 in the Auditor Remarks section.
6.   Notify the ECB Supervisor, the PPB Supervisor and the Regional Chemist of the monitor Alarm Findings.
7.   Press Run to return to the Run Screen.
8.   The Ozone Performance audit cannot proceed if any of the alarms are activated from being out of specification above. The items would be investigated and corrected before proceeding.

Systems Audit Procedures

1.   Plug up power cord to audit device (CPS).
2.   Connect zero air out to audit device zero air in.
3.   Connect ozone line from audit device and run outside. Put filter holder on end of line for conditioning. Ideally you would condition the line and let the audit device warm up for one hour.
4.   Open Viewer and set CPS channel to Audit before disconnecting anything.
5.   Disconnect site CPS ethernet cable from back of site calibrator and connect to the Audit Device ethernet port.
6.   Turn on Audit Zero Air Generator 'Little Chugger' (Pressure between 20-30 psi) and pump in audit device. Set audit device to 210 ppb.
7.   Fill out audit paperwork. (Audit Form & Audit Calculator)
8.   Temperature Audit.

   a. CPU= Comet and Tmp channel in Viewer
   b. HOBO= HOBO
   c. Thermometer= Orange Omega RTD
9. After warming up & **only after 46 mins** in the hour set O3 channel to **Audit**
10. Connect audit filter holder to site probe.
   a. Once connected the O3 channel in **Viewer** should climb to 200 ppb 'ish' and you want to see a gradual increase closer to 210 ppb.
11. Open **Reporter**
   a. Select **Dynamic**
   b. Select **Dynamic Charts**
   c. Select **O3**. This brings up graph and minute data for stability.
12. Once audit device and site monitor are stable and both reading around 210 ppb you can begin the audit.
13. Start Zero **0** (**Level 6**) in audit device.

Note: **Audit Level "0" Data Evaluation.** To address the performance of the Audit Device during the site ozone monitor audit the following criteria must be satisfied.

Theoretical Audit Concentration	**Audit Device Concentration**
0 ppb	**0 $\pm$ 2 ppb**

If the Reported Audit Device concentration is within the range specified above, continue the performance audit.

If the reported Audit Device Concentration is greater than 0.000 $\pm$ 0.003 ppm ozone, the ozone performance audit is stopped. The Audit Device performance is determined to be unacceptable. Proceed to reconnect the sampling line and up the channels and to bring the ambient air ozone monitoring site back on line and investigate problem

   a. Audit Level Rules = A minimum of 10 minutes of run time (warmup) with no more than a 1 ppb change in the last 5 minutes. (Both audit device and site monitor.)
   b. **Record the flows from the site monitor diagnostics in the Audit Calculator.**
14. Start **100 ppb** (**Level 3**) in audit device
   a. Follow audit level rules.

I. **AUDIT LEVEL 3 EVENT**   (100 ppb Ozone).

   Begin the **Audit Level 3 Event** (100 ppb Ozone) with the Audit Device.

After the Audit Event stabilizes (Approximately 10 minutes) **record** 5 x 1-minute average ozone **Audit Level 3 Event** concentrations from the Envidas Reporter, and Ozone Audit Device on the AQ-121.

Audit Level 3 Event Data Evaluation. To address the performance of the Audit Device during the site ozone monitor audit the following criteria must be satisfied.

Theoretical Audit Concentration	Audit Device Concentration
100 ppb	**100 $\pm$ 2 ppb**

If the reported Audit Device concentration is within the specified range of 98 to 102 ppb ozone proceed and continue the performance audit.

If the reported Audit Device Concentration is greater than 100 $\pm$ 2 ppb ozone, the ozone performance audit is stopped. The Audit Device performance is determined to be unacceptable. Proceed to reconnect the sampling line and up the channels and to bring the ambient air ozone monitoring site back on line.

15. Start **70 ppb** (**Level 2**) in audit device
   a. Follow audit level rules

Begin the **Audit Level 2 Event** (**70 ppb** Ozone) with the Audit Device**.**

After the Audit Event stabilizes (Approximately 10 minutes) **record** 5 x 1-minute average ozone **Audit Level 2 Event** concentrations from the Envidas Reporter, and Ozone Audit Device on the AQ-121 Form.

Audit Level 2 Event Data Evaluation. To address the performance of the Audit Device during the site ozone monitor audit the following criteria must be satisfied.

Theoretical Audit Concentration	Audit Device Concentration
70 ppb	**70 $\pm$ 2 ppb**

After the Audit Events Ozone Readings stabilize (Approximately 10 minutes) **record** 5 x 1-minute average ozone for each **Audit Level Event** concentration from the PDL, and Ozone Audit Device on the AQ-121.

16. Start **15 ppb** (**Level 1**) in audit device
   a. Follow audit level rules

Begin the **Audit Level 1 Event** (15 ppb Ozone) with the Audit Device**.**

After the Audit Event stabilizes (Approximately 10 minutes) **record** 5 x 1-minute average ozone **Audit Level 1 Event** concentrations from the Envidas Reporter, and Ozone Audit Device on the AQ-121.

AUDIT LEVEL 1 EVENT   15 ppb Ozone   **15 $\pm$ 2 ppb**

If the reported Audit Device Concentration is greater than the ranges specified above for the Intermediate Audit Level Events ozone, the ozone performance audit is stopped. The Audit device performance is determined to be unacceptable. Proceed to reconnect the sampling line and up the channels and to bring the monitoring site back on line.

Once audit is complete **the most important thing is getting the O3 channel back up.**
Note: Channel needs to up before 15 mins after the hour.

      b. disconnect filter from site probe line. Give the O3 time to stabilize (2-3 minutes). Select **Reset all Flags** in the Viewer O3 channel.

17. Turn off audit device pump and set to **Manual**. Turn off Little Chugger (Audit Zero air supply). Close the dynamic chart.

18. Disconnect all audit equipment and load in truck.

19. Make sure site Ethernet cable is put back into the site calibrator.

20. Select **Reset all Flags** in the **Viewer CPS channel** after Ethernet cable is plugged back up.
    a. Close **Viewer**

21. Open **Reporter**
    a. Select **Reports**
    b. Select **Sites**
    c. Select **Period** and set the **start time** to a few minutes before you downed the channels and set the end time to a few minutes after you upped the channels. Select **status tab** and check the **separated status/values box**. Select **OK**.
    d. Once report opens select **Tools**, Then **Excel**. Give the report a **name** and select **Save**. Report will open in Excel and you will want to save this to your thumb drive.
    e. Close **Reporter** entirely.

22. Copy and paste the last 5 minutes of results in the Audit Calculator for the O3 and CPS.

23. Copy and paste the Audit Calculator Summary in Audit Form (see Screen shot example below). Be careful with formatting!

24. Double check you have saved the completed Audit Form, completed Audit Calculator, and minute data to your thumb drive.

25.   Check all connections after you finish and before you leave.
26.   Close everything in site computer and **Sign Out.**

Audit Calculator Summary Worksheet (for field Audits)

O3 0ppb (CM)	O3 15ppb	O3 70ppb	O3 100ppb	CPS 0ppb (CA)	CPS 15ppb	CPS 70ppb	CPS 100ppb
#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

* Concentration results truncated to one decimal place

Level	% Error
15	#DIV/0!
70	#DIV/0!
100	#DIV/0!

$$((CM-CA)/CA)*100= \% \text{ error}$$

*Percent difference results rounded to 1 decimal

CPS = Audit Device	Pass/Fail	
O3 = Site Monitor	15	+/- 1.4
	70	8%
	100	8%

	Flow A	Flow B	Total
0 PPM			0.00
7 PPM			0.00
70 PPM			0.00
100 PPM			0.00

*Flows rounded to two decimals

0.00	#DIV/0!	#DIV/0!	XXXXX
0.00	#DIV/0!	#DIV/0!	#DIV/0!	Summary
0.00	#DIV/0!	#DIV/0!	#DIV/0!
0.00	#DIV/0!	#DIV/0!	#DIV/0!

#DIV/0!   Overall Percentage Average

Ozone Performance Audit Reports.

The results of each ozone monitoring site performance audit must be reported to the ECB Supervisor or designee within 3 workdays for review. The ECB supervisor or designee reviews each Ozone Performance Audit for completeness, procedural adherence, and then must forward the report to the Supervisor of the Projects and Procedures Branch of the Ambient Monitoring Section. The Audit Results are put into the **AQ-121** form (screenshot below) along with Evaluation Criteria and Pass/Fail results.

AQ-121 Form (blank form)

CONTINUOUS MONITOR PERFORMANCE AUDIT REPORT [Compatibility Mode] - Word

CONTINUOUS MONITOR PERFORMANCE AUDIT REPORT

ACCURACY AUDIT FOR _____ RANGE

REGIONAL SUPERVISOR _____   REGIONAL CHEMIST _____   RCO CHEMIST _____

POLLUTANT		POLLUTANT		POLLUTANT		POLLUTANT		POLLUTANT	
(X) O3	44201-047-08-0	( ) NO	42601-200-08-1	( ) HSNO	42601-075-08-1	( ) HSNH3	42604-051-08-1	( ) NOY-TLE	42600-2-674-08-2
( ) CO	42101-054-07-1	( ) NO2	42602-200-08-1	( ) HSNOY	42600-075-08-1	( ) CO-TLE	42101-2-554-08-2	( ) SO2-TLE	42401-2-560-08-2
( ) SO2	42401-060-08-2	( ) NOX	42603-200-08-1	( ) HSNOX	42603-051-08-1	( ) NO-TLE	42601-2-674-08-2	( ) SO4	88403-875-08-2

AQS #: 37-		SITE:			REG:		QTR: 2		YR: 2020
ADT. DEV. MODEL #: 49i-PS		SN: 1170480019		# 50	CERT. DATE: 03-06-20			EXP. DATE: 03-06-21	
ADT. ZAP MODEL #: 751H		SN: 75		# 1	CERT. DATE: 03-11-20			EXP. DATE: 03-11-21	
ADT. CYL. #:		TYPE:		CONC.		PSI:		EXP. DATE:	
ADT. CYL. #:		TYPE:		CONC.		PSI:		EXP. DATE:	
SITE CAL. MODEL #: 49i-PS		SN:		#	CERT. DATE:			EXP. DATE:	
SITE ZAP MODEL #: T701		SN:		#	CERT. DATE:			EXP. DATE:	
SITE MON. MODEL #: 49i		SN:		#	MDL DATE:			EXP. DATE:	
SITE CYL. #:		TYPE:		CONC.		PSI:		EXP. DATE:	
SITE CYL. #:		TYPE:		CONC.		PSI:		EXP. DATE:	
AUDITOR (S): S. Ginn		DATE:		REVIEWED BY: D. House			DATE:		

AUDIT POINT PPB	EPA AUDIT LEVEL	GAS FLOW SCCM	ZERO FLOW SCCM	TOTAL FLOW LPM	AUDIT DEVICE (CA) PPB	ANALYZER ENVIDAS AVERAGE	
						READING (CM) PPB	Percent Difference (D1)
0	Zero						
15	Level 2						
70	Level 5						
100	Level 6						

AUDITOR REMARKS: _Audit was performed through the probe assembly with truncated results. Temperature CPU: _ _; HOBO: _ ; Thermometer;_

AUDIT RESULTS: GOOD _____   NOT ACCEPTABLE _____   INDICATE ACTION TAKEN BELOW:
_____ ADDITIONAL OPERATIONAL CHECKS (SPECIFY): _____
_____ DATA INVALIDATED FROM _____   TO _____
_____ PREVENTIVE ACTION (DESCRIBE) _____
REMARKS: _____
EVAL. DATE: _____   EVALUATOR: _____

REV 12/20/2017   AQ-121   (WORD) C:\Audit Forms\accuracy audit form

Page 1 of 2   298 of 298 words   75%

Ozone Performance Audit Evaluation Criteria.

The Ozone Performance Audit is a "**Pass – Fail**" evaluation of the performance of an operating Ozone Monitor at a North Carolina monitoring site.

The Supervisor of the Projects and Procedures Branch of the Ambient Monitoring Section or designee evaluates the Ozone Monitoring Site Performance Audit Data The criteria for evaluating the Acceptance or Failure of the Ozone Monitoring Site of the Performance Audit is below:

Performance Audit Acceptance Limits

Audit Device   **Site Monitor**

Audit Device Level "6" Event (0)   Audit Device Level "0" Event $\leq$ +/- 3 ppb

Audit Device Level "1" Event (15) Audit Device Level "1" Event $\leq$ +/- 1.4 ppb

Audit Device Level "2" Event (70) Audit Device Level "2" Event $\leq$ +/-4.9 ppb (7 %)

Audit Device Level "3" Event (100) Audit Device Level "3" Event $\leq$ +/-7 ppb (7 %)

NOTE: If the site Ozone Monitor does not report concentrations within the ranges specified above when compared to the Certified Audit Device the monitor has "Failed" the NC Ozone Performance Audit. The Regional Chemist or designee must be IMMEDIATELY NOTIFIED that the monitor at the specific site failed.

NOTE: The Regional Ambient Monitoring Coordinator or designee is responsible for scheduling the recalibration of the site monitor as soon as possible.

NOTE: Ozone Performance Audits performed for Local Programs are forwarded to the Local Program Office for their review

Section 8 Routine Maintenance by ECB

Section 8.1 49i Analyzer Maintenance
Section 8.1.1 Verify Alarm(s) ranges within specs
Section 8.1.2 Clean all filters, clean internal components with dry air
Section 8.1.3 Leak check all connections under vacuum
Section 8.1.4 Clean A and B cell with dry air
Section 8.1.5 Clean Flow Capillaries with stainless wire
Section 8.1.6 Replace components as needed
Section 8.1.7 Run Zero and Span points to confirm integrity of instrument

Section 8.2 49i PS Calibrator Maintenance
Section 8.2.1 Verify Alarm(s) ranges within specs
Section 8.2.2 Clean all filters, clean internal components with dry air
Section 8.2.3 Leak check all connections under vacuum
Section 8.2.4 Clean A and B cell with dry air
Section 8.2.5 Clean Flow Capillaries with stainless wire
Section 8.2.6 Replace components as needed
Section 8.2.7 Run Zero and Span points to confirm integrity of instrument
Section 8.2.8 Certify by comparing to newly certified Transfer standard which
was certified by US EPA

Section 8.3 Zero Air Generator Maintenance
Section 8.3.1 Change activated charcoal and Purafil desiccant and permeable
retainer pads
Section 8.3.2 Test system pressure to **50-60 psi** to assure full flow; if good
proceed to next step, if not a flow issue is present and you need
to investigate and repair/replace pump and or 4-way valve
Section 8.3.3 Connect rotameter to output port and allow **5 lpm** flow for 1-5
days to allow conditioning of system with a desired result of
'green' dew point sensor (i.e. the dew point of the air is lower
than -15C)
Section 8.3.4 Certify by comparing to aforementioned certified Transfer
standard

**Section 8.4 Site Repair visits and checks---dispatch/response---case by
case**
Section 8.4.1 Document and record in **AQ-109** and site logbook

Section 8.4.2 AQ-109 reports and Equipment logbooks and minimal information to be supplied by ECB technicians

**AQ-109 Form (blank)
Example**

Section 8.4.3 Include the Date, site, list problem and solution and relevant comments

Section 8.4.4 Maintenance Repair reports—AQ109 and documentation and communication with Regions and Central Office

Section 8.4.5 Forms signed and 1 copy to Central Office, 1 copy to ECB Technician who performed work, 1 copy to ECB Central files

Section 9 Training Documentation

Section 9.1 Shadow train new technicians
Section 9.2 Present new technicians with relevant SOP's and require to read
Section 9.3 Present new technicians with relevant Training Manuals (i.e. 49i, 49iPS, and API 701) and require to read and review
Section 9.4 Attend software workshops and annual Ambient Monitoring workshop and discuss problems, issues, and emerging monitoring topics
Section 9.5 Document all training in site records

Section 10 General Steps for new site set up

Section 10.1 Siting of new site
Section 10.2 Purchase new building
Section 10.3 Contract with county Permitting and contractors to lay concrete pad and electrical connection
Section 10.4 Consult with Power company to arrange connectivity
Section 10.5 Once approved, pad is placed (poured)
Section 10.6 Place shelter
Section 10.7 Electrical connectivity with Permit
Section 10.8 Power turned on
Section 10.9 Install instruments, probe line(s), HVAC, communications (modem, switches)
Section 10.10 Set up instruments, software, etc.
Section 10.11 Remove old shelters if replacing an existing site

Section 11 Revision History

Date	Person Revising Document	Revision	Page No.	Approved by/Date
3/15/2022	Jeff Gobel	Section 7.10 was revised to be accordant with current DAQ and EPA language	43	Joette Steger 3/15/2022

Appendices

Appendix A: EPA SRP and NCSOP Direct Comparison Study (EPA Procedure)

The following procedure is used to establish the direct link between the EPA SRP and the NCSOP.

1. The NCSOP and the EPA SRP are connected to the EPA operated ozone sampling manifold.
2. The NCSOP (s) are powered-up and allowed to stabilize for a minimum of 4 hours while sampling EPA supplied Zero Air.
3. Following the 4 hour warm up period, review and record the NCSOP Operational Parameters. The approved ranges for the operational settings are as follows.

	Acceptable Range		
Bench Temp	5 C	-	50 C
Bench Lamp	65 C	-	75 C
Pressure	650 mm	-	850 mm
Flow Cell B	0.4 LPM	-	1.6 LPM
Flow Cell B	0.4 LPM	-	1.6 LPM
Intensity Cell A	65 Khz	-	120 Khz
Intensity Cell B	65 Khz	-	120 Khz

   NOTE: Compare to current Ozone SOP!!!

4. Record the Background Coefficient and the Ozone Span Coefficient

   Note: Adjust the operational parameters as necessary to within these ranges.

Initial EPA SRP and NCSOP Qualification (EPA Proc cont.)

1. Establish a stable Zero concentration readings on both the EPA SRP (0.000 ppm $\pm$0.003) and the NCSOP (0.000 $\pm$0.003 ppm).
2. After a stable Zero concentration is established
    a. If EPA SRP is within criteria above proceed to (c.).
    b. If EPA SRP is not within specified criteria request the EPA to resolve discrepancy before proceeding.
    c. If NCSOP is within specified criteria proceed to Step 3
    d. If the NCSOP is not within the specified criteria, the Ozone Background Coefficient of the NCSOP is adjusted to duplicate ($\pm$0.002 ppm) the value of the Zero determination of the EPA SRP. Following this adjustment record the Ozone Background Correction factor from the NCSOP.
    e. The Ozone Background Coefficient is adjusted by the following pathway;
        i. Go to Menu
        ii. Go to Calibration Factors
        iii. Go to Background

          iv. Up or Down arrow to match the EPA value

           v. Hit Enter

          vi. Hit Run/returns you back to the original menu

                1. Also see Section 3-12 of the 49i Primary Standard Users Manual under Calibration Factors Menu, O3 Background

3.   Record 10 x 1-minute averages of both the EPA SRP and the NCSOP.

4.   Both the EPA SRP and the NCSOP Average Zero concentrations must agree within the range of –0.003 to 0.003 ppm ozone. If this is true proceed to Step 5. If false repeat Step 1.

5.   Establish a stable Upscale Ozone Concentration on both the EPA SRP in the range of ~0.225 – 0.250 ppm $\pm$0.003 and the NCSOP ($\pm$0.003 ppm).

   a. If EPA SRP is within criteria proceed to (c).

   b. If EPASRP is not within specified criteria request the EPA to resolve discrepancy before proceeding.

   c. If NCSOP is within specified criteria proceed to Step 6

   d. If the NCSOP is not within the specified criteria, the Ozone Span Coefficient of the NCSOP is adjusted to duplicate ($\pm$0.003 ppm) the value of the Upscale Ozone Determination of the EPA SRP. Following this adjustment record the Ozone Span Coefficient from the NCSOP.

6.   Record 10 x 1-minute averages of both the EPA SRP and the NCSOP.

7.   Both the EPA Reference Photometer and the NCSOP Average Upscale Ozone concentrations must agree within $\pm$0.003ppm. If this is true proceed to Step 8. If false repeat Step 5.

8.   If adjustments were made to the NCSOP in both Step # 2 and Step #5 repeat Steps #1 through #7. If adjustments were not made to both Steps # 2 and Steps # 5 proceed to Step #9.

9.   Upon completion of the adjustments to the NCSOP a single ozone concentration level is analyzed to determine the accuracy of the Zero Point and Upscale point adjustments to the NCSOP.

10.   For this Intermediate Ozone Concentration establish a stable concentration reading on the EPA Reference Photometer ($\pm$0.003ppm) and record 10 x 1-minute averages from both the EPA SRP and the NCSOP. The average value of the intermediate point for both the EPA SRP and the NCSOP must agree within $\pm$ 0.003 ppm. If this agreement is true proceed below. If not repeat steps 1 through 10 above.

NCSOP and EPA SRP Reference Study

Upon successful completion of **Appendix A** (EPA) of the Initial Comparison of the EPA SRP and the NCSOP, the systems are considered to be satisfactorily comparable and stable. The following procedure is used to establish the traceable data link between the NCSOP and the EPA SRP. It is this link between the 2 standard photometers that ensures the most accurate ambient air ozone concentration measurements are determined across

the NC ozone monitoring network. The EPA SRP is considered to be Independent and the NCSOP is considered to be Dependent.

A series of 4 - 5 complete sequential comparative runs are made at various concentrations of ozone in the range of concentrations from 0.000 to 0.500 ppm ozone. As with the Initial Comparative Study both the EPA SRP and the NCSOP simultaneously sample from the same EPA provided ozone sample stream. The exact number of intermediate concentration points between the 0.000 ppm point and the 0.500 ppm is dependent upon the capabilities of the EPA ozone generation system. The EPA procedure for comparison of the EPA SRP and State operated Primary Standards and Standard Photometers usually includes ozone concentrations greater than 0.500 ppm ozone.   These data points greater than 0.250 ppm are not included or considered in the comparison study for the North Carolina NCSOP.

1. If the NCSOP and EPA SRP Reference Study is performed immediately (within 1 hour) following the Initial EPA SRP and NCSOP Comparison Study proceed to Step 2. If no change within 2-hours, record the following NCSOP operational parameters. The acceptable change for the NCSOP operational parameters from the protocol are as follows:

	Determined Value +/- Change
Bench Temp	$\pm$ 3 C
Bench Lamp	$\pm$ 3 C
Flow Cell B	$\pm$ 0.1 LPM
Flow Cell B	$\pm$ 0.1 LPM
Intensity Cell A	$\pm$ 10 Khz
Intensity Cell B	$\pm$ 10 Khz

Note: If the NCSOP operational parameters above are not within the acceptable change limits for the values determined in item 1 above, return to and repeat Steps above in EPA SRP and NCSOP Direct Comparison Study.

2. The EPA ozone generation device generates a series of ozone concentrations from 0.000 ppm ozone to approximately 0.500 ppm with a final step of a zero air purge of the system. Record the 10 x 1- minute averages for each comparative data points for all ozone concentrations generated by the EPA ozone generation devices and concentration determinations performed by both the EPA SRP and the NCSOP. Designate this comparative series as Run #1.

3. Repeat Step #2 three to four (3 – 4) times as time allows. Each successive repeated run of the series of concentration determinations is designated Run # 2, Run # 3, etc.

4. For each of the ozone concentration determinations in each Run determined the average concentration for each concentration level, from the 10 x 1-minute averages recorded.

5. Enter the average of each of the 10 x 1-minute concentration determinations into the example table below.

6. Using all the averages of the 10 x 1-minute averages of each concentration data point in the range of 0.000 to 0.500 ppm ozone from each of the 4 - 5 comparative runs determine the Slope and Intercept of the relationship between the EPA SRP and the NCSOP to develop the following equation.

EPA SRP = (Slope x NCSOP) + Intercept

Note: The EPA requires the slope to be in the range of 0.97 to 1.03 and the intercept to be within $0.000 + 0.3$

NCSOP and EPA SRP Study Data Analysis Example

For this example, five consecutive comparison runs were successfully recorded with 5 concentration points each in the range of 0.000 to 0.0250 ppm. The average of each of the reported data points from both the EPA SRP and NCSOP. The table below contains only example data. In this theoretical run scenario, the EPA SRP consistently reported higher values than the NCSOP.

Run #	EPA SRP Reported Conc.	NCSOP Reported Conc.
Run # 1	0.001	0.001
	0.051	0.050
	0.091	0.091
	0.163	0.160
	0.240	0.236
Run # 2	0.002	0.000
	0.051	0.050
	0.090	0.091
	0.163	0.158
	0.239	0.235
Run # 3	0.001	-0.001
	0.050	0.050
	0.092	0.090
	0.164	0.161
	0.242	0.237
Run # 4	0.001	0.000
	0.051	0.050
	0.091	0.089
	0.163	0.159
	0.240	0.237
Run # 5	0.002	-0.001
	0.051	0.050
	0.092	0.091
	0.163	0.161

	0.245	0.240

EPA SRP and NCSOP Comparison Study

$$EPA\ SRP = 1.008949\ NCSOP\ + 0.00089925$$
$$R^2 = 0.9998$$

NCSOP (y-axis) vs *EPA SRP* (x-axis)
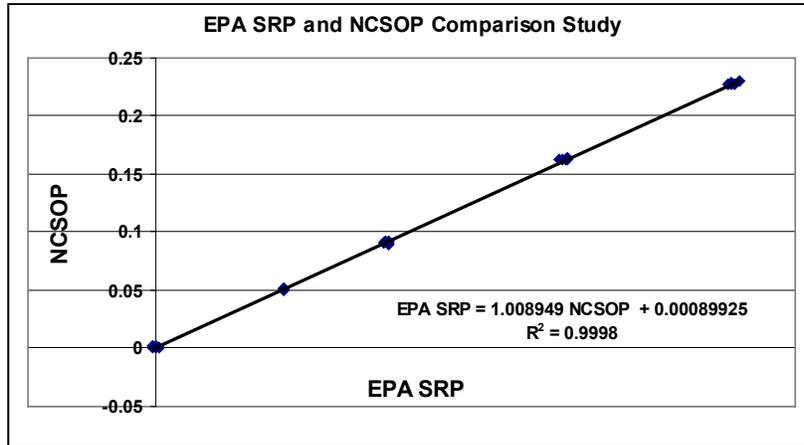
Thus the equation to determine the EPA SRP value when the NCSOP reports a concentration is:

EPA SRP = 1.008949 x NCSOP + 0.00089925

For this example, study data set, if the NCSOP reports 0.100 ppm ozone the corresponding value that would be reported by the EPA SRP would be 0.102 ppm ozone

EPA SRP = (1.008949 x 0.100) + 0.00089925

EPA SRP = 0.102 ppm ozone

Appendix B: Certification of Thermometers

**DAQ-15-001.1 Verification of Ambient Monitoring Thermometers Version 0.0
Located at   https://files.nc.gov/ncdeq/Air%20Quality/ambient/sops/DAQ-15-001-Standard-Operating-Procedure-for-the-Calibration-of-Thermometer---signed-20201120.pdf**