STATEWIDE
STANDARD OPERATING PROCEDURE

FOR

TELEDYNE API MODEL T500U NITROGEN DIOXIDE ANALYZER

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
OFFICE OF AIR MONITORING

Prepared by: Florida PQAO Date: November 2022

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Quality Assurance Manager

Submitted to:______________________________ Date:__________________

EPA Region IV Approval Officer

DOCUMENT HISTORY

Revision No.	Date	Responsible Person	Description of Change
0	September 2016	Vicki Taylor	Initial Release
1	June 2019	Florida PQAO	Format for SESD
2	November 2022	Florida PQAO	Grammatical changes and clarifications, replaced FAMAS references with AirMVP, removed requirement to calibrate after > 72-hour data interruption, added guidance on calibrator flow rate requirements, updated calibrator NO concentration points to match manufacturer recommendations, updated maintenance schedule, updated form references.

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1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to guide the operator in the installation, set-up, calibration and maintenance of the analyzer to conform to the practices used for the API Model T500U Nitrogen Dioxide (NO2) Analyzer used in the State of Florida Ambient Air Monitoring Program.

Adherence to this manual will enable the site Field Technician to know and follow state-wide quality assurance/quality control (QA/QC) requirements. Site Field Technicians, however, should be knowledgeable of and refer to the references noted in this Standard Operating Procedure (SOP). Other information such as theory of operation, servicing and microprocessor control are covered in the manufacturer's instruction manual and will be referred to as needed. Both the instruction manual and this SOP are to be kept with the instrument or be accessible in electronic format at all times.

These procedures are consistent with the data management requirements specified in the Quality Assurance Project Plan for the Florida Gaseous Ambient Air Monitoring Program, (FDEP QAPP- 002). The final data are verified and submitted to the Air Monitoring Validation Program (AirMVP) then uploaded by the Florida Department of Environmental Protection (FDEP) to the US EPA Air Quality System (AQS).

2.0 SCOPE

The Florida Department of Environmental Protection and Florida Local Air Monitoring Agencies utilize the API Model T500U analyzer to monitor for compliance with the National Ambient Air Quality Standard (NAAQS) for NO2.

This document is intended to be used as a reference for the set-up, calibration, maintenance and operation of the T500U analyzer. Additional detailed technical information may be found in the manufacturer's instruction manual. Technicians will refer to the manufacturer's manual for schematics and diagrams.

The proper utilization of this procedure by the technician, in conjunction with the equipment manufacturer's operation manual (and addendums), will conform to the local, state and federal data quality objectives, the State of Florida Quality Assurance Project Plans (QAPPs), the air monitoring regulations published in the Code of Federal Regulations (CFR). The air monitoring data generated as a result of implementing these procedures will be comparable to the National Ambient Air Quality Standards (NAAQS) and reported to the state and federal ambient air monitoring databases

IMPORTANT: *Before beginning any operation described in this document, ensure that any related manuals and SOPs are also at hand.*

3.0 SUMMARY OF METHOD

The Model T500U CAPS NO_2 Analyzer provides a direct measurement of NO_2 utilizing Cavity Attenuated Phase Shift (CAPS) spectroscopy. CAPS spectroscopy has become a leading technology for this purpose due to its accuracy, response, low maintenance, and affordability. This technique has many advantages over chemiluminescence, eliminating nearly all of the maintenance items and producing an extremely accurate and fast response measurement of NO_2. The Model T500U possesses the US EPA Federal Equivalent Method (FEM) designation (EQNA-0514-212).

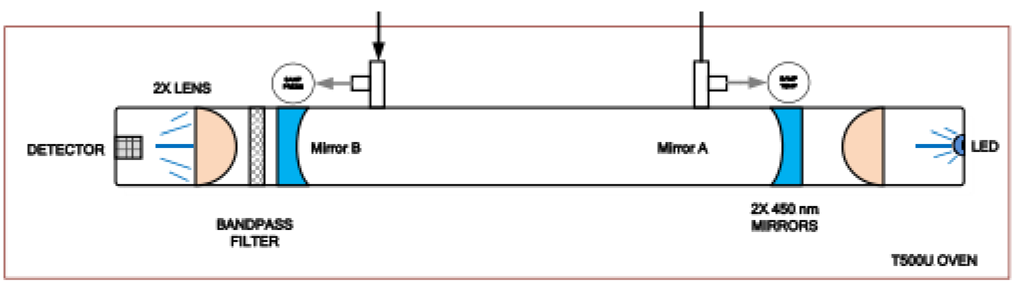
The T500U CAPS NO_2 Analyzer operates as an optical absorption spectrometer that yields both reliable and accurate measurements of ambient nitrogen dioxide down to sub ppb concentration, with lower noise levels than chemiluminescence-based monitors. The CAPS method uses light from a blue Ultraviolet (UV) light emitting diode (LED) centered at 450 nm, a measurement cell with high reflectivity mirrors located at either end to provide an extensive optical path length, and a vacuum photodiode detector. These components are assembled into the optical cell which resides in a temperature-controlled oven. The oven raises the temperature of the sample gas to ~45 degrees Celsius. This mitigates the formation of moisture on the surfaces of the mirrors while also minimizing changes in the absorption coefficient due to temperature fluctuations.

As stated, the T500U analyzer measures NO_2 directly, using optical absorption. This phenomenon is well-defined and is described by Beer's Law, where the absorbance (lost light) is directly proportional to both the path length and concentration of the absorbing gas.

$$A = e\,l\,c$$

(A = Absorbance, e = Molar absorptivity, l = Mean path Length, c = concentration)

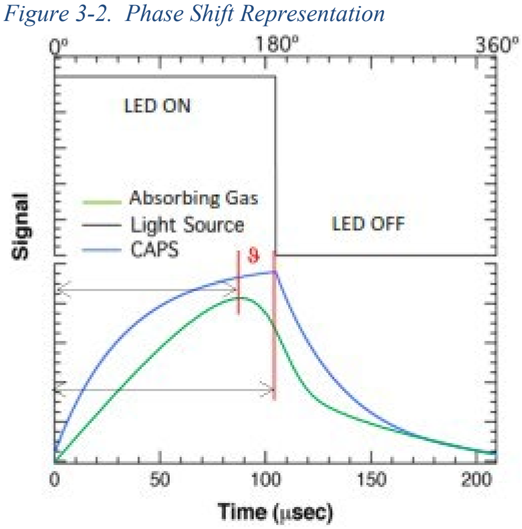
Figure 3-1. T500 U Optical Measurement Cell



The CAPS method, employed in the T500U, is unique in that it applies this fundamental optical absorption law in the frequency domain, rather than using relative changes in light intensity as the primary signal. UV from the modulating high intensity LED enters a near confocal optical cell through the rear of the mirror A. The intensity of the light, as observed by the detector, which is also modulating at a slightly different frequency, located behind Mirror B, builds exponentially in the cell while the LED is ON. The opposite is true when the LED is OFF. Because both mirrors are highly reflective at 450nm, a prominent absorption band for NO_2, the light takes a considerable amount of time to plateau in the absence of absorbing gas. However, when NO_2 is present, the mean path length traveled by the light is significantly reduced. This has two effects on the observed intensity as measured by the detector:

- The light plateau intensity level is lower
- The light intensity plateaus sooner

Figure 3-2. Phase Shift Representation



Thus, an observed phase shift from the modulating LED is detected. The phase shift is largest when measuring zero air and decreases when NO_2 is present.

Through the use of precisely timed data acquisition coupled with a proprietary algorithm the measured absorption is translated into a phase shift, from which the NO_2 concentration is calculated. The phase shift decreases as the NO_2 signal increases.

The CAPS method is faster and more specific than the traditional chemiluminescence method since the sample does not require cycling through a thermal converter, in order to calculate a differential measurement. The method also uses significantly less power (70-80W), requires less maintenance, and contains fewer components.

4.0 DEFINITIONS

1. Site Operator – The individual(s) tasked with properly running and maintaining instrumentation at the site(s). This is a field-based position that relies heavily on proper maintenance tracking and documentation to ensure the equipment is operating properly.

2. Calibrator – An instrument used to calibrate the T500U. The calibrator consists of mass flow controllers to measure dilution (zero) air, and calibration gas (NO). The calibrator used for the T500U also has an on-board ozone photometer certified as an ozone standard.

3. Ozone Primary Standard – A microprocessor-controlled ozone generating instrument that is used to provide known concentrations of ozone to an analyzer. The Ozone Primary Standard remains in a fixed location and is only moved for its annual re-certification against a higher-level standard.

4. Zero Air System – A stand-alone system composed of inline scrubbers meant to remove any contaminants from the air that is used for dilution air for the calibrator. This system can either be a commercially available unit or a unit constructed using a pump/compressor, activated carbon scrubber, and a scrubber with desiccant. The goal is to provide dry, pollutant free zero air.

5. Calibration - The semi-annual multipoint check/adjustment to an analyzer that confirms the analyzer is operating at peak performance. Note: Calibrations can be performed every 365 days and 1/ calendar year if continuous zero/span performed daily

6. One Point QC Check – The nightly/bi-weekly analyzer check done at a precision point of 34ppb.

7. Zero, Span, Precision Check (z/s/p) – The nightly/bi-weekly analyzer check done to establish legally defensible data. This check is also done to bracket periods of valid data and done before and after any major maintenance/repair to the analyzer or sample train. The z/s/p can also be done manually if necessary.

8. Parts per Billion (PPB) – A scientific measurement indicating one part in one billion.

9. Sample Line Integrity Check (SLIC) – The quarterly check done to verify the integrity of the sample line and ensure that the sample line is not having a negative effect on the concentration values read by the analyzer. It typically is made from a short piece of
¼” Teflon FEP tubing with a Teflon “T” in the middle for a vent. One end is

connected to the output of the Ozone Primary Standard and the other end to the input of the analyzer.

10. Data Logger – An electronic device used for short term storage and retrieval of measured data at a site.

5.0 HEALTH AND SAFETY

Only those trained and authorized are to operate the NO_2 analyzer and associated equipment.

1. Electrical Hazards: Equipment used in air monitoring operates on 110/120 volts alternating current (VAC). Site operators must be very careful to avoid touching (with the hands or tools) live wiring and electrical components. Whenever possible unplug any equipment being worked on.

2. Eye Protection: Ozone analyzers and calibrators use ultraviolet (UV) lamps. Never look directly at a UV lamp.

3. Protection from Chemicals: Certain zero air system components as well as certain solvents used can create hazards from breathing or skin contact. Be sure to read and be familiar with Material Safety Data Sheets (MSDS) or Safety Data Sheet (SDS) for any chemicals used. Ozone calibrators generate ozone. Be sure ozone calibrators and analyzers are properly vented to the outside.

4. Burn Hazards: Certain electrical components within the equipment used for NO_2 monitoring generate heat. Be knowledgeable of these components and do not touch them.

5. Mechanical Hazards: Pumps, fans, and other components with moving parts can cause injury. Keep clear of these hazards.

6. Weather and Natural Hazards: Outdoor work in the field can result in exposure to lightning and other weather hazards. During lightning conditions take cover indoors. Insects (wasps, bees, fire ants, etc.), spiders, snakes, and other animals can create hazards. Be alert when working in the field and avoid these hazards.

7. Additional Warnings: Please note these warning from the T-API T500U factory manual.

Figure 5-1. T-API T500U factory manual warnings.

WARNING
ELECTRICAL SHOCK HAZARD

Never disconnect any electronic assemblies or subassemblies while the instrument is under power.

Note

To maintain compliance with EMC standards, it is required that the cable length be no greater than 3 meters for all I/O connections, which include Analog In, Analog Out, Status Out, Control In, Ethernet/LAN, USB, RS-232, and RS-485.

WARNING
ELECTRICAL SHOCK HAZARD

High Voltages are present inside the analyzer's case.

Power connection must have functioning ground connection.

Do not defeat the ground wire on power plug.

Turn off analyzer power before disconnecting or connecting electrical subassemblies.

Do not operate with cover off.

CAUTION
GENERAL SAFETY HAZARD

To avoid damage to your analyzer, ensure that the AC power voltage matches the voltage indicated on the analyzer's model/specs label located on the rear panel before plugging the T500U into line power.

6.0 INTERFERENCES / LIMITATIONS

A high efficiency (0.01µm) particulate sample filter is combined with a Nafion® dryer to condition the sample gas stream prior to entering the cell for analysis. This minimizes contamination of the cell, preserving the mirror reflectivity and optical cell path length.

To account for changes in reflectivity of the mirrors over time, the T500U conducts an Auto Reference (AREF) measurement once per hour. The AREF process flushes the cell with NO_2 free ambient air and performs a new baseline measurement to account for any variability in the mirror reflectivity, and thus the baseline path length. During this two-minute period, the analyzer holds the previous NO_2 concentration measurement. IMPORTANT NOTE: The AREF will automatically be conducted when the analyzer is in SAMPLE Mode. It will not run when in CAL mode.

The T500U uses an UV LED light source centered at 450nm, with a ±5nm bandpass filter. There are no known gases that exist in typical ambient air that absorb in this wavelength range with any appreciable absorption strength.

7.0 PERSONNEL QUALIFICATIONS

Personnel who operate instruments used for the ambient monitoring of NO_2 within the State of Florida are typically selected for their position based on demonstrating they have the required knowledge, skills, and abilities to perform the essential elements of the position. Prior to independently operating NO_2 monitoring equipment, personnel are to be thoroughly trained in these duties. Supervisory/Management staff will then document they have the required training and will then authorize the employee to perform the operations outlined in this SOP.

Several levels of air quality field personnel and quality assurance are involved in the data collection and handling process. The titles associated with each level vary by agency. Regardless of title, each agency has field staff, QA staff, and various level of management. In general, the field staff is responsible for calibrating and maintaining the equipment associated with their respective agencies. They are responsible for the initial data review. They verify preliminary data from each of the monitors associated with their respective agencies. The QA staff checks all records and data collected from the ambient air monitoring network according to the official standard operating procedures (SOPs) to assure compliance with the State's Quality Assurance Project Plan (QAPP), the Environmental Protection Agency (EPA) guidelines, and the Code of Federal Regulations (CFR). The QA staff ensures the record of certification and the NIST-traceability for all standards/consumables utilized in the network. And, lastly, the QA managers, supervisors, or coordinators oversee all staff and ensures protocols are followed. These staff review monthly data for verification and validation and addresses errors or discrepancies in data.

> ***Note:*** *Depending on the agency, these functions may be shared by staff. For example, some field staff may also perform QA staff tasks. Or management/supervisors may dually*

serve as QA staff. Care should be taken that independent reviews are performed at some level to ensure the integrity of the data.

8.0 EQUIPMENT AND SUPPLIES

The following equipment and supplies are necessary for ambient air monitoring of nitrogen dioxide.

1. NO_2 Monitor -- T-API model T500U -- The NO_2 analyzer must be designated by EPA as an official reference or equivalent method and bear the designation sticker on the front of the instrument. The analyzer must meet factory specifications and be set up and operated per API factory manual and this SOP.
2. Calibrator (Dynamic dilution system with on-board ozone photometer) API T700U or Equivalent -- The on-board ozone photometer will be related back to a SRP (standard reference photometer) annually. The calibrator's mass flow controllers must be calibrated at least annually and be traceable to a NIST traceable primary flow standard. Refer to the appropriate SOP for these instruments (identified in section 14 of this SOP).
3. NO cylinder – NIST traceable gas standard with a concentration appropriate for the generation of at least 270ppb of NO.
4. Zero Air (Dilution Air) System -- Zero air must be free of contaminants, which will cause analyzer response (to slow?) or react with ozone. The zero-air system must be equipped with a pressure regulator capable of maintaining a stable output pressure. Refer to the appropriate SOP for this instrument/equipment (identified in section 14 of this SOP).
5. Flow Meter -- Used to verify sample flow from the T500U instrument.
6. Sample Line -- Constructed Teflon, 1/4" outside diameter (O.D.), 3/16" inside diameter (I.D.). The sample line should be checked prior to use with the sample line integrity check (SLIC) as described in this SOP.
7. Exhaust Line -- Used to direct the model T500 U's exhaust to the outside of the shelter. Typically constructed of 1/4" outside diameter (O.D.) Teflon (clear FEP Teflon or white TFE Teflon can be used) with all fittings being Teflon or stainless steel.
8. Particulate Filter -- Made of Teflon, two-inch (47 mm) diameter with a five micron pore size, the filter is to be enclosed in a Teflon filter holder utilizing Teflon or stainless steel fittings and components.
9. Thermometer -- Used to calibrate the internal monitor temperature probe(s), graduated in 1degree C increments (minimum), calibrated against an NIST traceable thermometer and accurate to ± 1degree C.
10. Sample Shelter -- Of adequate size to house equipment, internal temperature must be maintained between 5 to 40° Celsius (C) for the operation of the T-API T500 U NO_2 instrument.
11. Sample Shelter Temperature Probe -- Used to document the internal sample shelter temperature stays within specifications. Calibrated initially and then annually against

a NIST traceable primary or secondary temperature standard, continuous readout, accurate to ±1°C.

12. Minimum/Maximum Thermometer -- Used as a backup to the temperature probe. Calibrated initially and then annually against a NIST traceable primary or secondary temperature standard, resettable, accurate to ±1°C.
13. Data Logger -- Used to electronically record T-API T500U instrument digital or analog outputs (raw data). Digital output concurrency checks should be performed routinely. Analog outputs are calibrated against a NIST traceable voltage standard initially and then at one-year intervals, must be properly initialized. Channels must be left down until the analyzer is calibrated and begins official data collection.
14. Computer – Capable of communicating with the data logger (Note: the computer may be an on-board computer module as is the case with the Agilaire 8872). Computer is used for electronic documentation of calibrations, checks, maintenance, and other operations using MS-Excel or other software.
15. Logbooks, Log Forms, etc. -- Must be designed to accommodate all pertinent information in an organized manner. These are typically on Excel spreadsheets, but other software products capable of recording the documentation per this SOP are acceptable.
16. Tubing and Fittings -- All tubing and fittings must be made of a non-reactive material. Tubing must be FEP Teflon. Fittings can be Teflon or stainless steel. Do not intermix materials (e.g. stainless threaded onto a Teflon fitting) or mix fittings of different manufacturers due to potential safety and operational problems.

9.0 INITIAL START-UP PROCEDURES

Tools Required:

- Phillips head screwdriver (#1)
- Adjustable wrench
- Snips
- Zip ties
- Flow meter (of appropriate range to measure sample flow rate of 900 cc/min)
- Leak checker tool (TAPI p/n 01960)

** Alternatively, a tank of pressurized gas with the two-stage regulator adjusted to ≤ 10 psi, a shut off valve and a pressurized gauge may be used*

9.1 Unpacking

Upon receipt of the instrument, it should be unpackaged and set on a table suitable for its weight (33 lbs.). Using a Philips head screwdriver, remove the four screws (two on either side) of the chassis. Slide the top backward (toward the rear panel) and lift the cover off the instrument. Following the pneumatic diagram, check for integrity of the sampling lines, and be sure that all circuit boards, and other components are well secured, and any cable connections are properly seated. Once done, replace the cover and support screws.

9.2 Installation

For installation, the required clearance for the analyzer to allow for adequate ventilation is shown below:

- Back of the instrument: 4” (10 cm)
- Top, Bottom, Sides of the instrument: 1” (2.5 cm)

1. Set the instrument onto a bench top, table, or in a rack suitable for its weight which meets the above ventilation requirements, and within reach of the pneumatic sample tubing line.
2. Connect the AC power cord to the rear panel and to a suitable power source. An external sample tube (1/4” OD PTFE) should be connected to the rear port labeled sample and adequately tightened using proper procedures for compression fittings. See Figure 9.4.1 and 9.4.2
3. Be sure to remove all other plugs from the rear panel, including the EXHAUST before powering ON. Keep these plugs in a safe place for reuse later if moving or shipping the instrument.
4. Turn ON the instrument power using the switch on the front panel.

9.3 Internal Leak Check

Tools Required:

- Leak Checker Tool (if you do not own one, or have questions about the tool, please contact TAPI Technical Support)

Process:

1. Be sure the instrument is powered OFF.
2. Install the leak checker tool on the sample inlet at the rear panel port.
3. Cap rear panel PORTS and the pump port.

   ** **NOTE**: If zero / span valves are installed, disconnect the tubing from the zero and span gas ports and cap the ports.*

4. Pressurize the instrument with the leak checker, allowing enough time to fully pressurize the instrument (DO NOT EXCEED 10 PSI).
5. Turn off the pressure supply and observe the leak-down rate --- it should be less than 1 psi in 5 minutes after the pressure has been turned off.
6. If the test reveals a leak-down rate above 1 psi over 5 minutes, a detailed leak test should be conducted using the manual or contact TAPI Technical Support.
7. Disconnect the leak checker tool.

9.4 Sample Flow Check

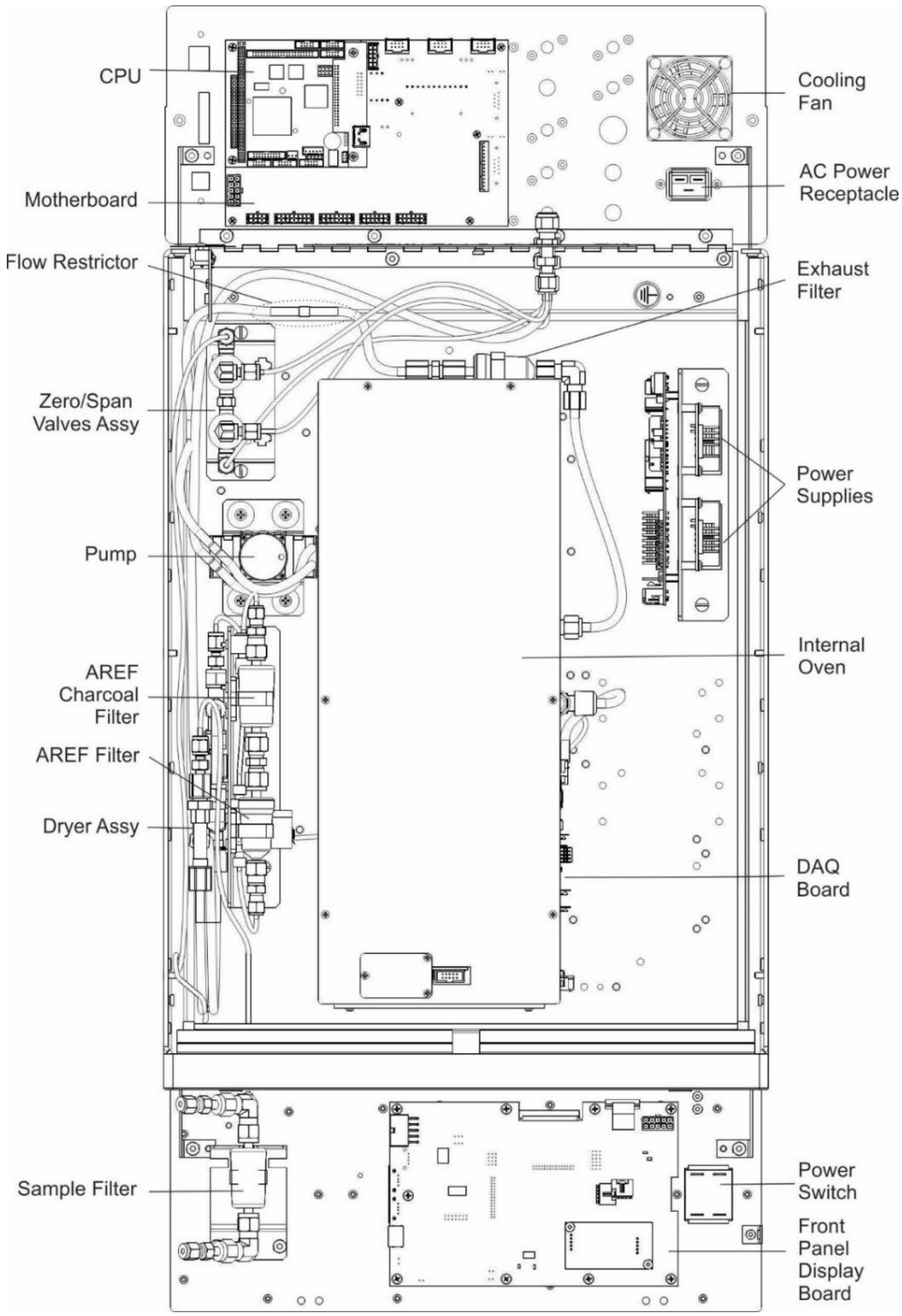
1. Disconnect sample tubing from the rear panel SAMPLE port.
2. Attach the outlet port of a flow meter to the sample inlet port on the rear panel.

** Ensure that the inlet to the flow meter is at atmospheric pressure*

3. Check that the sample flow measured with the external flow meter is within specification (900 cc/min ±10%).
4. If the sample flow check is outside of the allowable limits, change the sample particle filter, and/or sample flow orifice, and recheck the flow. Contact TAPI Technical Support if the flow remains outside of the acceptable limits.

   ** **NOTE**: the instrument measurement is not sample flow dependent and therefore no sample flow meter is present inside the instrument. The sample volume is resolved using the volume of the measurement cell.*

Figure 9-1. T500U Analyzer Internal Component Diagram.



9.5 Analyzer Removal

This section details the removal of an analyzer that is already installed at a site, such as if the analyzer requires extensive maintenance or replacement. The procedures for reinstalling the analyzer should not be confused with first time installation procedures. In some instances, the analyzer may need to be removed from the site, such as if it needed total replacement or if a site were to be deactivated. In such an instance, the following procedures should be followed.

NOTE: *For removal/restart before and after storm, a manual z/s/p must be performed to bracket the data. Otherwise, the data may need to be invalidated back to the last good z/s/p.*

1. Perform a manual zero/span/precision check to bracket the data.
2. Using the data logger, down the affected analyzer input channel for the long term. Also, note, in the "Operator Comments" section, the removal of the analyzer on the form DEP-09-06-B Calibration T500U, found in Section 14 of this SOP.
3. Turn off the analyzer and unplug the power cord from the 120 VAC outlet.
4. At the rear of the analyzer, disconnect the ¼-inch sample inlet and exhaust tubing.
5. If the analyzer is to be re-installed at the same location, label all of the wire connections that are connected to the analyzer to ensure proper re-installation.
6. All of the pertinent connections to the analyzer should now be disconnected. However, before actually removing the analyzer, inspect the location to ensure that no physical obstructions are present that could cause problems. Clear any obstructions, then remove the analyzer.

9.6 Analyzer Reinstallation

Any analyzer installation or reinstallation requires more than simply placing the analyzer into the desired location and hooking up the correct fittings and wires. Any reinstallation procedure must also incorporate all operational and precision checks required to place the analyzer back into fully certified ambient monitoring condition. The below procedure should be followed to perform this task.

1. Place the new/repaired analyzer into its new operating position.
2. Reconnect the sample inlet tubing to the sample port at the rear of the analyzer. Now connect the ¼-inch exhaust tubing to the exhaust port at the rear of the analyzer.
3. Reconnect the power plug to the power port at the rear of the analyzer and plug the opposite end into a 120 VAC outlet.
4. Reconnect the wiring that was previously labeled and removed in Step 9.5.E above.
5. After the analyzer and all ancillary equipment are connected properly, proceed to Section 9.0 to begin start-up procedures.
6. NOTE: Temperature and Pressure settings are stored in the internal memory of the analyzer and it is therefore unnecessary to recalibrate if operational checks are passing upon re-installation.
7. Complete a full calibration check of the instrument as described in Section 10.

10.0 INSTRUMENT CALIBRATION

The calibration procedure is used to document the relationship between the gas concentration measurements made by the analyzer and known concentrations. Florida Department of Environmental Protection Air Monitoring relies upon this documented relationship to establish the legal traceability of the ambient NO_2 measurements subsequently made by the analyzer. All primary records (e.g. records documenting observations, or other relevant information, that cannot be obtained from another more direct or reliable source) must be dated and signed by the operator and retained as part of the permanent analyzer calibration record. The operator's signature on the calibration form certifies that the calibration has been performed in accordance with this SOP and that the information contained on the form, including any pre-printed entry, is accurate. Calibration records must be reviewed and initialed by the agency QA Coordinator, QA staff, or another knowledgeable authority to verify that they are legible and complete. Electronic signatures are acceptable provided that they are secured by a unique password.

The analyzer is required to be calibrated prior to its use in collecting ambient data that may be reported to the AirMVP database. The analyzer must be recalibrated under the following conditions:

1. Prior to the resumption of ambient data collection following any repairs or service that might affect its calibration.

2. Following a bi-weekly zero response that exceeds ±5.0 ppb or a bi-weekly span response that exceeds 15.0% relative difference for NO_2.

3. Following any multipoint calibration QC check in which all points are not within ±2.0% or ±1.5 ppb of the calibration curve best-fit straight line. This is the relative difference between the analyzer response and the best fit concentration determined by the linear regression line.

4. Upon any indication of analyzer malfunction or change in calibration. This includes exceedance of the control limits during bi-weekly checks.

5. Following physical relocation of the analyzer.

NOTE: *The multipoint calibration QC check refers to the calibration check after an adjustment or calibration of the analyzer, or any other check used to validate the ambient data.*

Calibration Gases for zero air or zero calibration gas is defined as a gas that is similar in chemical composition to the measured medium, but without the gas to be measured by the analyzer. A zero-air generator such as the Teledyne API Model 701 or 701H can be used. Zero and span gas should be supplied more than twice the instrument's specified gas flow rate:

Gas Flow Rate - (900 cc/min x 2 = **1800 cc/min**).

Span calibration gas is specifically mixed to match the chemical composition of the type of gas being measured at near full scale (80%) of the desired reporting range. This can be achieved a few different ways:

1. Use a NO gas cylinder that can provide a concentration of 80% of desired measurement range.
2. Use a multi-gas calibrator to dilute the NO gas with zero air.
3. Use a Calibrator with a trusted source of stable ozone, such as the Teledyne API Model T700 or T700U containing an O_3 generator and a certified photometer for producing confident levels of O_3, and thus NO_2 using GPT.
4. If using the T700/U calibrator the NO flow rate should be **greater than 45 cc/min** in order to achieve a reasonable response time during the GPT and to satisfy the EPA requirement that the residence time in the GPT reaction chamber be less than two minutes.
5. It is important to also meet the Dynamic Parameter specification, as described in 40 CFR Part 50 Appendix F Sec 1.4, and as shown below.

***NOTE:** An excel spreadsheet with these calculations has been included with Form DEP-09-06B for reference.*

1.4 *Dynamic parameter specification.*

1.4.1 The O^3 generator air flowrate (F^0) and NO flowrate (F^{NO}) (see Figure 1) must be adjusted such that the following relationship holds:

$$P_R = [\mathrm{NO}]_{\mathrm{RC}} \times t_R 2.75\mathrm{ppm\text{-}minutes}(2)$$

$$[\mathrm{NO}]_{RC} = [\mathrm{NO}]_{\mathrm{STD}} \left(\frac{F_{\mathrm{NO}}}{F_O + F_{\mathrm{NO}}}\right) (3)$$

$$t_R = \frac{V_{\mathrm{RC}}}{F_O + F_{\mathrm{NO}}} < 2\mathrm{minutes}(4)$$

where:
PR = dynamic parameter specification, determined empirically, to insure complete reaction of the available O^3, ppm-minute
[NO]RC = NO concentration in the reaction chamber, ppm
R = residence time of the reactant gases in the reaction chamber, minute
$[NO]^{STD}$ = concentration of the undiluted NO standard, ppm
F^{NO} = NO flowrate, scm ^{3}/min
F^O = O^3 generator air flowrate, scm ^{3}/min
VRC = volume of the reaction chamber, scm ^{3}

6. In order to satisfy both of the criteria in steps 4 and 5, it is possible to use a NO cylinder with a concentration between 8.9ppm to 57ppm but concentrations in the middle of that range will give the most flexibility for dilution ratios.

For the purposes of this SOP, instructions are provided using external zero and span sources.

10.1 Pre-Calibration Procedures

1. The analyzer calibration is required to relate instrument response to ambient pollutant concentrations by using a known gaseous standard. The calibration is done using the gas phase titration (GPT) method. GPT enables the operator to make up various NO_2 concentrations using NO (Nitric Oxide) gas and a dynamic calibrator equipped with an ozone generator.

2. The calibration must be done initially at installation and then at semi-annual intervals. Or annually if automated QC checks are performed.
3. Before performing a routine calibration of the T500U, perform the initial unadjusted QC Check - Zero, Span and Precision

10.2 Overview of Calibration Procedure

In this procedure, the operator uses a Multi-Gas Calibrator to provide the analyzer with zero air and various concentrations of NO and O_3 over the analyzer's measurement range. The analyzer's response to each concentration is recorded and, if necessary, the analyzer is adjusted to accurately measure the gas concentrations. Multiple gas concentrations allow the analyzer's linearity to be assessed. Below are the calibration concentrations for the Model T500U trace-level instrument.

Calibration point	T500U NO2 ppb
Zero	0
Span	240
Upscale 2	175
Upscale1	100
Low	34

To ensure the accuracy of the calibration record, the operator must systematically document the calibration process using only approved calibration forms and procedures. All relevant observations or other information must be recorded immediately. The calibration form and equipment status reports must be completed in their entirety, including the heading. Calibration forms may be pre-printed or, have entries on electronic forms made in advance, with any information that is unlikely to change during the time period covered by the logbook. It is the technician's responsibility to ensure that any pre-printed information contained on the calibration form is correct. In the event any of the pre-printed information changes (e.g., temporary use of replacement equipment), the operator should use standard initialed strikethrough(s) to correct the information for hardcopy documents.

The current year calibration records should be kept at the site, or be accessible from the site, in electronic format or at the site in hard copy form

Essentially all the equipment described in this manual will be utilized for the calibration. Practically all of this equipment will have already been installed at the site. A summary of this equipment (plus a few additional items) is as follows:

- Calibrator (T-API T700U or equivalent)
- Zero air system (properly maintained regarding filter and desiccant and scrubber materials)
- NO cylinder with regulator (NO cylinder must be properly certified and be within

the certification period.)

- External manifold
- Clean or new Teflon tubing to connect the above equipment
- Calibration and daily check logbooks

4. Calibration Equipment Set-up
   A. NO Cylinder Pressure Regulator: Install a pressure gauge on the NO tank. Quicker response will result if the regulator is flushed 3 to 5 times with NO when the regulator is first installed. Make sure there are no leaks.
   B. Nitric Oxide (NO) Standard Connection: Connect the NO standard to the calibrator port "A" with stainless steel fittings and 1/8 " FEP Teflon or stainless steel tubing. Keep the tubing less than 24". Check the certification date to ensure the cylinder was certified according to a valid EPA protocol. Don't use the tank if not properly certified or if the cylinder pressure is less than 150 psig.
   C. T700U Calibrator & Output Manifold: If the unit has not been in operation, turn on the power and allow 30 minutes warm up time. Check also to ensure the unit has been calibrated within the past year. Connect a clean line from the external output manifold to the GPT calibrator output port.
   D. Zero Air System: Check to ensure the zero-air system is properly maintained. Maintain if necessary. Connect the air coming from the zero-air system to the zero-air inlet on the back of the calibrator. Make sure the pressure is 30 psig to ensure proper operation and avoid damage to the GPT calibrator's mass flow controllers.

10.3 Step-by-Step Multipoint Procedure

10.1.1 Downing Channels

1. If not already done, using the data logger, mark the NO_2 channel as down.
2. Start NO_2 Calibration. Record all data on the Calibration Spreadsheet.
3. On the calibrator select a flow of approximately 4-5 l/min for an airflow rate. Zero air is now being generated and the NO2 instrument should begin to respond.
4. Allow the zero to run until 10 minutes of stable trace occurs.
5. Record the gas flow (this is 0.0), the dilution air (zero air) flow rate and the Data Logger observed readings (average of the last 5 stable one minute averages).
6. If the stabilized T500U response is within ± 5ppb no adjustment is required
7. If the response is greater than ± 5ppb, or an adjustment is desired to bring the response closer to zero, follow the steps in section 10.4
8. Open the main cylinder valve on the NO tank, adjust the second stage regulator until the second stage regulator pressure gauge reads 30 psig. Open the outlet valve. The second stage regulator gauge

should be checked during the calibration to ensure it remains at 30 psig.

9. Set up the calibrator (API T700U) to run GPTPS, adjust the calibrator to output the NO gas flow is 270 ppb. Set the Ozone conc. to 240ppb.(There should be at least 10% excess NO gas to O3) The diluent is set to approximately 5 liters.
10. Let the point run for 10 minutes and record the calibrator values for Ozone Actual, Cal Flow Actual, diluent flow Actual on the spreadsheet (the NO2 instrument will not respond in this mode).
11. Set the calibrator (API700U) to run GPT (Press Generate > GPT > ENTER)- keeping the same values. NO2 is now being generated and the model T500U should begin to respond.
12. Allow this first point plenty of time to stabilize (10 minutes ± 2ppb and no upward or downward trend)
13. From the data logger record the NO2 minute averages into the appropriate boxes on form DEP-09-06-B
14. The form will calculate the results based on the comparison of the observed NO2 from the T500U vs the O3 actual observed during the GPTPS cycle
15. If the NO2 response is less than ± 2% of the T700U GPTPS O3 Actual observed value recorded in step 9, then no adjustment is necessary. Continue to step19
16. If the response is greater than ± 2% of the primary standard, then the “Result” cell will indicate “Calibrate”. Perform a span calibration as described in section 10.4
17. Once the zero and span concentrations are determined to be within allowable control limits, the remaining three concentrations must be supplied to the analyzer to establish the linearity of the instrument
18. NOTE: Teledyne API recommends keeping the NO concentration and Total Flow Rate constant and only adjusting the Ozone concentration for each of the NO2 concentrations needed
19. Initiate the Upscale 2 point by running a new GPTPS cycle, leaving the NO PPB and Total Flow the same but changing the O3 to 175
20. Let the GPTPS cycle run for 10 minutes and record the calibrator values for “O3 Actual”, “Cal Flow Actual”, and “Dil Flow Actual”
21. After recording the GPTPS values, set the calibrator to generate GPT, keeping the same values from GPTPS
22. Allow the point to stabilize for at least 10 minutes and then record the minute averages into the appropriate box in form DEP-09-06-B
23. Repeat steps 19-22 For the Upscale 1(100ppb) and Precision/Low(34ppb) points
24. A final 5-minute zero event should be run to ensure the analyzer has not experienced any shift in the zero concentrations. Any cells not filled in on the Forms should be filled in with N/A

Multipoint
Set Up Values

NO gas 270ppb	Ozone 240ppb
NO gas 270ppb	Ozone 175ppb
NO gas 270ppb	Ozone 100ppb
NO gas 270ppb	Ozone 34ppb

10.4 NO2 Adjusted Calibration Procedure

10.4.1 Zero Calibration

1. Deliver ZERO air to the analyzer and allow it to sample until a stable NO2 response is displayed on the data logger.
2. Once a stable ZERO point is reached the zero can be adjusted.
    - For Legacy software: On the home screen press [CAL] > [ZERO] > [ENTER]to adjust the instrument's zero-offset and set the NO2 reading to zero.
    - For NumaView software: From the home screen, press [Calibration] > [M-P] > [Start] > [Zero]

10.4.2 Span Calibration

1. Adjust the dilution air flow and the calibration gas / ozone flow on the dilution calibrator to provide approximately 80% to 90% of full-scale range; 240 ppb for the Model T500U analyzer to deliver SPAN air to the analyzer and allow it to sample until a stable NO2 response is displayed on the data logger.
   Note: Stability is defined as 10 one minute averages of ±2.0 ppb with no upward or downward trend.
2. Once a stable SPAN point is reached the span can be adjusted
    - For Legacy software: From the Main Menu press [CAL] > [CONC], set the span concentration to 240ppb, > [ENTER] > [SPAN]
    - For NumaView software: From the home screen, press [Calibration] > [M-P] > [Start] > [Set Span Target] (enter the span concentration 240ppb) > [Span]

10.5 Sample Line Integrity Check (SLIC)

In this procedure, the Field Technician must determine if contamination of the sample line is adversely affecting ambient NO_2 measurements made by the analyzer. This check is required to be performed once per quarter, and whenever visible moisture is observed in the sample line or sample line filter. It may also be performed at any time the Field Technician suspects the sample line has become contaminated. In the event that the sample lines are contaminated, the entire sample line must be cleaned or changed.

The Field Technician performs a SLIC after all maintenance and adjustments to the analyzer are complete. The SLIC procedure must be followed by a QC check, either Z/S or a multipoint calibration check, prior to resuming ambient air quality monitoring data collection. Therefore, the SLIC may be performed before the multipoint calibration check so as not to interrupt the check for the linearity of the analyzer's response curve. However, if the SLIC is performed after the multipoint calibration check, the technician must also complete a Z/S/ check, after the SLIC and prior to resuming ambient air quality monitoring.

Some agencies have safety protocols in place that determine how QA coordinators decide whether to leave the span gas running during the line changes, or to turn off gas generation and/or flow from the calibrator so that only dilution (zero) air is running during the line changes. Consult with your QA coordinator to identify the SLIC approach (Zero/Span/Zero or Span Only) used within your network.

10.5.1 Zero-Span-Zero SLIC Procedure

1. While the analyzer is sampling zero air from the calibrator, disconnect the sample line between the analyzer and multi-gas calibrator and replace it with the SLIC tubing assembly. The SLIC tubing will connect the "Output" fitting of the multi-gas calibrator and the "Sample" fitting of the analyzer. The vent located on the SLIC line "TEE" can be vented to any external vent that is available.
2. Adjust the calibrator to the same settings used in generating the NO2 span concentration.
3. Allow the analyzer responses to stabilize and then record 10 stable one- minute average readings, as displayed from the data logger on the Data Worksheet under SLIC.
4. When finished, set the calibrator to supply zero air to the system, and then disconnect the SLIC line from the calibrator, analyzer and vent. Re-install the original sample line in the same configuration as before the SLIC.
5. Adjust the calibrator to the same settings used in generating the NO2 span concentration.
    - Note: It is not necessary to perform another GPTPS cycle after switching back to the sample line, as it could change/influence the final span value with a different O3 Gen Drive setting.
6. Allow the analyzer responses to stabilize and then record 10 stable one- minute average readings, as displayed from the data logger on the Data Worksheet under SPAN.
7. When finished, set the calibrator to supply zero air to the system, and then calculate the SLIC percent difference.
8. Compare the observed NO2 response for SLIC to the observed NO2 response for SPAN and then record the RESULT as "*PASS*" or "*CALIBRATE*" on the calibration form.

10.5.2 Span Only SLIC Procedure (Use one GPTPS span setting by performing a zero, precision, span, SLIC line span, sample line span, final zero procedure)

1. Disconnect the sample line between the analyzer and multi-gas calibrator and

replace it with the SLIC tubing assembly. The SLIC tubing will connect the "Output" fitting of the multi-gas calibrator and the "Sample" fitting of the analyzer. The vent located on the SLIC line "TEE" can be vented to any external vent that is available.

2. Adjust the calibrator to the same settings used in generating the NO_2 span concentration.

3. Allow the analyzer responses to stabilize and then record 10 stable one- minute average readings, as displayed from the data logger on the Data Worksheet in the boxes, under SLIC.

4. Record the average of 10 stable one-minute NO2 response values on the Calibration Form in the Observed NO2 field, in the *SLIC Check Block*, SLIC event row.

5. When finished, disconnect the SLIC line from the calibrator, analyzer and vent. Re-install the original sample line in the same configuration as before the SLIC.

6. Allow the analyzer responses to stabilize and then record 10 stable one- minute average readings, as displayed from the data logger on the Data Worksheet under SPAN.

7. When finished, set the calibrator to supply zero air to the system, and then calculate the SLIC percent difference.

8. Compare the observed NO_2 response for SLIC to the observed NO_2 response for SPAN and then record the RESULT as "*PASS*" or "*CALIBRATE*" on the calibration form.

9. Th equation below calculates the relative percent difference between the data logger response through its normal sample line and through the clean SLIC line:

$$\%\ \text{Diff.} = \frac{\text{Response (PPB) through sample line - Response (PPB) through SLIC line}}{\text{Response (PPB) through SLIC line}} \text{ x } 100$$

If the calculated difference is ≤±2.0%, the analyzer's sample line is approved for further use without additional effort. If the calculated difference is greater than ±2.0%, the analyzer's sample line must be cleaned or replaced before proceeding with the analyzer calibration or resuming ambient data collection. Replace/recheck the sample line until the calculated results are within
±2.0%. Record the sample line service in the Comments section.

11.0 INSTRUMENT OPERATION AND MAINTENANCE

The Model T500U is a simple instrument to operate. Once powered ON, the instrument will begin to initialize, warm-up, and then begin to sample automatically. Any warning messages will be suppressed for an initial 45-minute period. After powering on, it will take approximately 60 minutes for the instrument to produce valid measurements. It is normal to have a "System Reset" warning message upon start-up. This can be removed by pressing <CLR>. Any warnings that continue to exist after the 45-minute initialization period should be investigated using the manual or by contacting TAPI Technical Support. A full list of warnings can be found in the Operating Manual. See Figure 11.0 below:

Figure 11-1. Maintenance Frequency Matrix

ITEM	ACTION	FREQ	CAL CHECK REQ'D
TEST functions	Review and evaluate	Weekly	No
Zero/span check	Evaluate offset and slope	Weekly	No
Zero/span calibration	Zero and span calibration	Every 3 months	Yes
Sample filter	Change sample filter	Annually (may need more frequently in a high dust load environment)	No
AREF filter and charcoal filter	Change both	Annually	Yes
Spectrometer mirrors	Contact Technical Support	As necessary due to excessive Measured Loss	Yes
Pneumatic sub-system	Check for leaks in gas flow paths	Annually or after repairs involving pneumatics	Yes, if a leak is repaired
Internal Pump	Replace	Measured Flow less than 800 cm^3/min	Yes

Below is a list of additional normal routine checks for the T500U analyzer.

1. Review Test Functions (Daily or Weekly)
2. Manual Zero / Span Verifications (Minimally Every 14 days)
3. Sample Flow Rate Check (Minimum annually, can be more frequent)
4. Leak Check (Annually or whenever pneumatic components are changed)

Below is a list of the normal routine maintenance for the T500U analyzer.

1. Zero / Span Calibration (Monthly or as needed based on Checks)
2. Change Particulate Sample Filter (Annually)
3. Change AREF Loop Filter and Scrubber (Annually)
4. Change Internal Vacuum Pump (Every 2-3 years or whenever sample flow drops below 800 cc/min)
5. Service Optical Cell Mirrors (As needed, when AREF measured loss signal increases above 1100 Mm-1)

11.1 Functional Checks

The various test functions can be scrolled through using the <TST> buttons on the front panel. See Figures 11.1.1 functions and descriptions.

Figure 11-2. Front Panel View.

Below is a full list of these functions and description:

Figure 11-3. Function and Description.

DISPLAY	PARAMETER	UNITS	DESCRIPTION
RANGE	RANGE	PPB PPM UGM MGM	The Full Scale limit at which the reporting range of the analyzer's ANALOG OUTPUTS is currently set. **THIS IS NOT** the Physical Range of the instrument. See Section 6.3 for more information.
PHASE	PHASE	DEG	Measurement phase value.
MEAS_L	MEASURE LOSS	Mm^{-1}	Measurement loss value. (Mega (10^6) per meter)
AREF_L	AUTOREF LOSS	Mm^{-1}	Auto reference value (to null any baseline drift from the measurement).
SMP PRS	SAMPRESS	InHg	Sample pressure.
SMP TEMP	SAMPTEMP	℃	Sample temperature.
BOX TEMP	BOXTEMP	℃	Temperature inside the analyzer chassis.
SLOPE	SLOPE	n/a	The slope for current range, computed during span calibration.
OFFSET	OFFSET	PPB	The offset for current range, computed during zero calibration.
STABIL	STABILITY	PPB	The standard deviation of concentration STABILITY • Data points are recorded every ten seconds (default; this frequency can be changed in the STABIL_FREQ variable). • The calculation uses the last 25 data points (default; this number of samples can be changed in the STABIL_SAMPLES variable).
OVEN TMP	OVEN TEMP	℃	Oven temperature
TEST*	TESTCHAN	MV	*(When DIAG>TEST CHAN OUTPUT is configured for a test function). Displays the signal level of the Test Function that is currently being produced by the Analog Output Channel **A4**.
TIME	CLOCKTIME	HH:MM:SS	The current time. This is used to create a time stamp on DAS readings, and by the AutoCal feature to trigger calibration events.

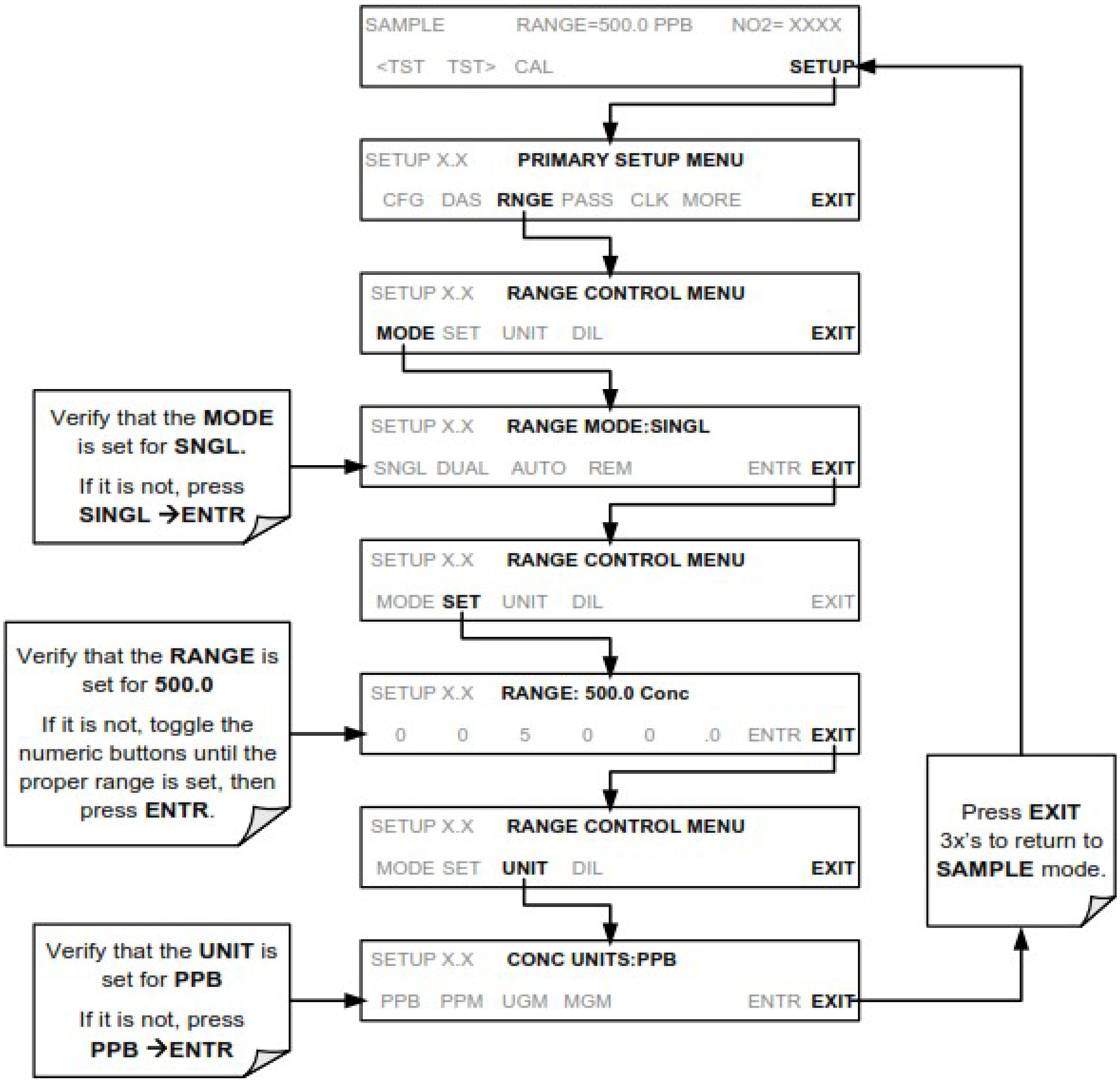
11.2 Verify the Operating Range

The analyzer range can be set from the front touch display screen using the <TST> function buttons. The default range settings are:

- Unit of Measure: ppb
- Reporting Range: 300 ppb (you can view this in Numaview by pressing **Setup > 929 > Vars > Conc Range #1**)
- Mode Setting: SNGL

These settings can be adjusted using the following menu button sequence below:

Figure 11-4. Setting Adjustment Procedure.

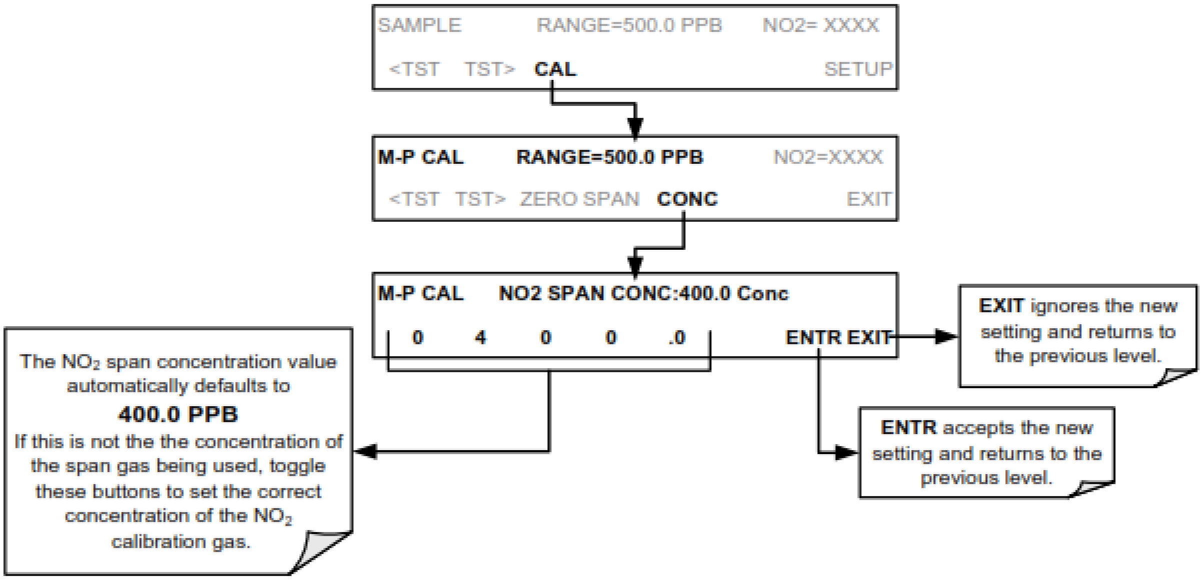


11.3 Verify the Instrument Span Gas Concentration

It is recommended that the span gas concentration is chosen at 80% of the maximum range setting. For example, an NO_2 span gas of 240 ppb is recommended for a range setting of 300 ppb.

To verify and adjust the span gas concentration, the following menu sequence can be used see below:

Figure 11-5. Verify and adjust span gas concentration.



Test Functions Review

Figure 11-6. Review primary parameters.

FUNCTION	EXPECTED	ACTUAL	INTERPRETATION & ACTION
SAMP (pressure)	Constant within atmospheric changes (Typically 2 InHg below ambient)	Fluctuating	Developing leak in pneumatic system. Check for leaks.
		Slowly increasing	Developing leak in pneumatic system prior to the orifice. Check for leaks. Sample pump requires replacement. Check flow rate.
		Slowly decreasing	Flow path is clogging up. Replace sample filter.
AREF	Constant within ±100Mm-1 of check-out value	Significantly increasing	Developing AREF valve failure. Replace valve.
			Developing leak in pneumatic system. Check for leaks.
			Debris on mirrors. Replace charcoal scrubber.
NO_2 (Concentration)	Constant for constant concentrations	Slowly decreasing signal for same concentration	Developing leak in pneumatic system. Check for leaks.

11.4 Internal Sample Filter Replacement

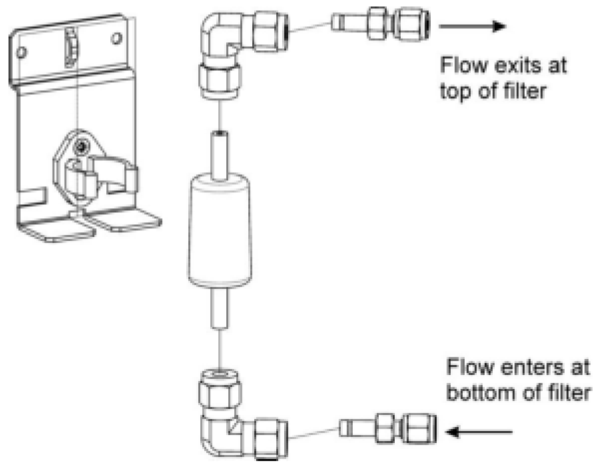
Tools Required:

- Screwdriver for lowering front panel
- Adjustable wrench
- Snips
- Replacement sample filter (TAPI p/n FL-0000033)
- Zip ties

The particulate filter should be inspected often for signs of plugging or contamination. To change the filter, follow these steps:

1. Turn OFF the analyzer (this is important to avoid potential for contamination of the measurement cell). Alternately, the instrument can be kept on, but the vacuum pump MUST BE TURNED OFF prior to changing the particle filter. This can be done by pressing: Set Up → More → Diag from the instrument front display panel. From the Signal I/O screen, press Enter → Scroll or Jump to Parameter 23 (INTERNAL_PUMP) and press ON. You should hear the pump turn off. (See Figure 11.4)
2. Open the T500U hinged front panel (may require removal of small Phillips head screw on one side of front panel)
3. Using snips, remove zip tie used to secure the filter to the mounting bracket.
4. Using a wrench, remove the fittings that connect the filter in place.
5. Replace filter with a new one. (*NOTE: the arrow points in the opposite direction of the actual flow path – during normal operation, the flow enters the filter at the bottom and exits the top of the filter)
6. Snap the filter back into the bracket and place a new zip tie around the filter as a secondary support
7. Once complete, perform a system leak check using instructions in the Factory Manual or proceed to the AREF Loop Filter Replacement procedure.
8. Following leak check, turn instrument or pump back on to resume operation.

Figure 11-7. Replacing the sample particulate filter.



11.5 AREF Loop Filter Replacement
Tools Required:

- Phillips Screwdriver for removing instrument cover
- Adjustable wrench
- Snips
- Replacement AREF particle (TAPI p/n FL-0000003)
- Replacement NO_2 (charcoal) scrubber (TAPI p/n FL0000020)
- Zip ties

**NOTE: An annual maintenance kit (TAPI p/n 081910000) can be purchased which will include this filter and scrubber, as well as the sample filter described above*

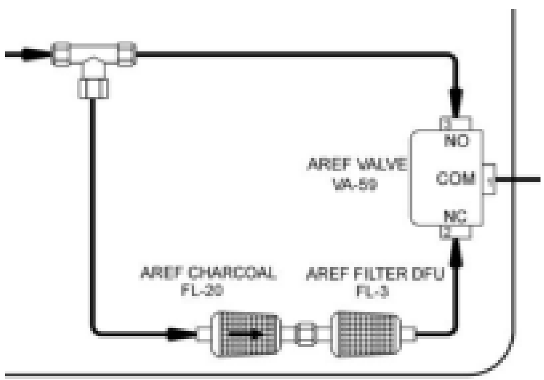
The AREF loop consists of two filters, one is an NO_2 gas scrubber and the other is a backup particulate filter. Both should be replaced once per year. (See Figure 11.5). To change the filters:

1. Turn OFF the analyzer (this is important to avoid potential for contamination of the measurement cell). Alternately, the instrument can be kept on, but the vacuum pump MUST BE TURNED OFF prior to changing the particle filter. This can be done by pressing Set Up → More → Diag. From the Signal I/O screen, press Enter → Scroll or Jump to Parameter 23 (INTERNAL_PUMP) and press ON. You should hear the pump turn off.
2. Remove the top cover of the analyzer.
3. Using snips, remove the zip tie holding the pair of fittings to the mounting bracket.
4. Using a wrench, disconnect the fitting on the left that is connected to the particulate filter. Then, disconnect the fitting on the right that is connected to the NO_2 scrubber.

This will free up the AREF filter assembly.

5. Remove the AREF filter assembly from the mounting brackets.
6. Remove the fittings that connect the two filters to one another.
7. Install replacement filters using the same procedure to remove the filters in reverse order.
8. Once complete, replace the instrument cover and perform a system leak check procedure using instructions in the Factory Manual.
9. Following leak check, turn instrument or pump back on to resume operation.

Figure 11-8. Pneumatic layout of AREF Loop.



11.6 Internal Pump Replacement

Tools Required: (See Figure 11.6.1 and 11.6.2)

- Phillips Screwdriver for removing instrument cover and pump bracket
- Snips
- Replacement vacuum pump/bracket assembly (TAPI p/n 078510000)
- Zip ties

Figure 11-9. Pump Assembly (pn 078510000).

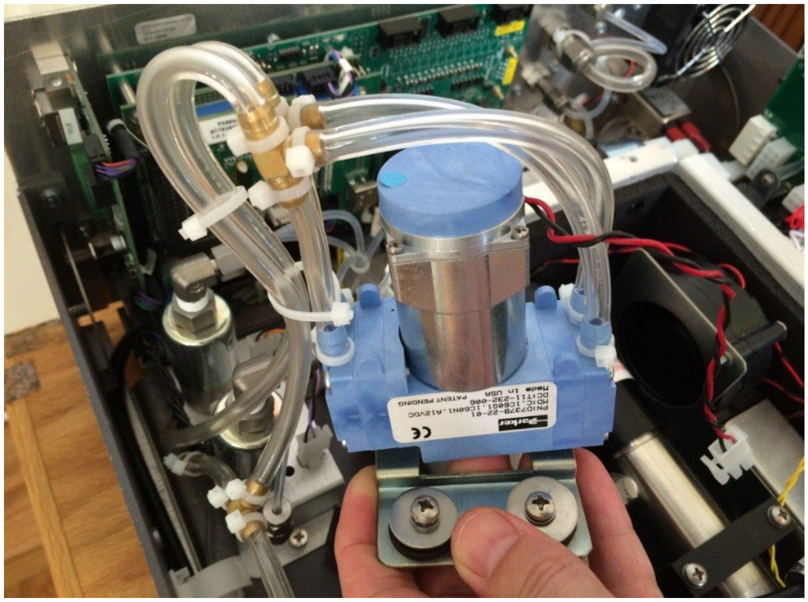
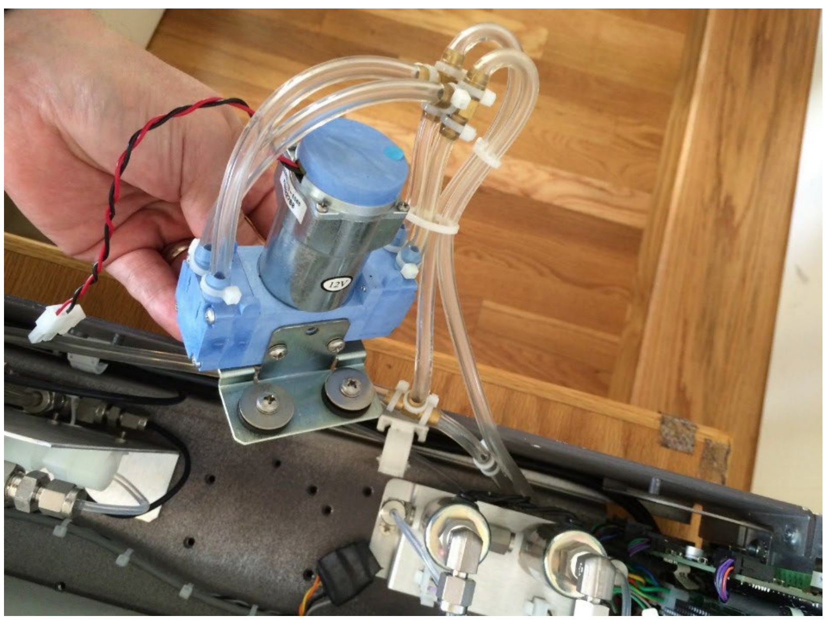


Figure 11-10. Tubing Connections for Internal Pump.



1. Turn OFF the analyzer (this is important to avoid potential for contamination of the measurement cell). Alternately, the instrument can be kept on, but the vacuum pump MUST BE TURNED OFF prior to changing the particle filter. This can be done by pressing Set Up →More →Diag. From the Signal I/O screen, press Enter → Scroll or Jump to Parameter 23 (INTERNAL_PUMP) and press ON. You should

hear the pump turn off.

2. Remove the top cover of the analyzer.
3. Locate the vacuum pump and using snips, remove the zip ties that secure the four hoses that connect to the pump (two on each side)

    *(*Note the tubing connections before disconnecting to make the replacement easier.)*

4. Remove the four tubes from the hose barb connections on the pump.
5. Remove the four screws that hold the pump/bracket assembly to the bottom of the chassis.
6. Disconnect the power connector labeled "pump" located about 4 inches down the black/red cable coming from the top of the pump.
7. Pull pump assembly out and set aside.
8. Install replacement pump/bracket assembly.
9. Be sure to reconnect tubes in the proper orientation and zip tie to secure.
10. Replace screws for the pump mounting bracket into the bottom of the chassis.
11. Connect the power connector.
12. Use caution when fastening the new pump into position that no wires or pneumatic tubes get pinched under the pump mounting bracket.
13. Once complete, replace the instrument cover and perform a system leak check procedure using instructions in the Factory Manual.
14. Following leak check, turn instrument or pump back on to resume operation.

11.7 Mirror Servicing

Tools Required:

- Phillips Screwdriver
- Adjustable wrench
- Powder-free gloves
- Grounding strap
- Dust-free room (if available)

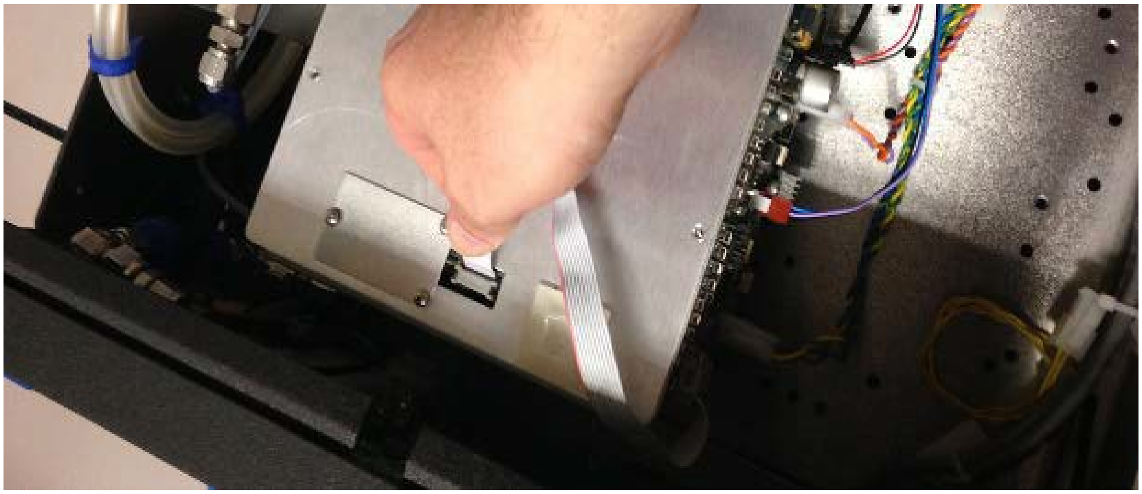
The mirror servicing frequency will be dependent on the environment and operating condition of the instrument. Using care whenever changing any of the internal filters as described in this SOP will maximize the lifetime of the mirrors. The mirrors should be serviced whenever the AREF test function value increases above 1100 Mm-1.

There are currently two ways of servicing the mirrors: See procedures below:

Removing and Disassembling the Optical Cell

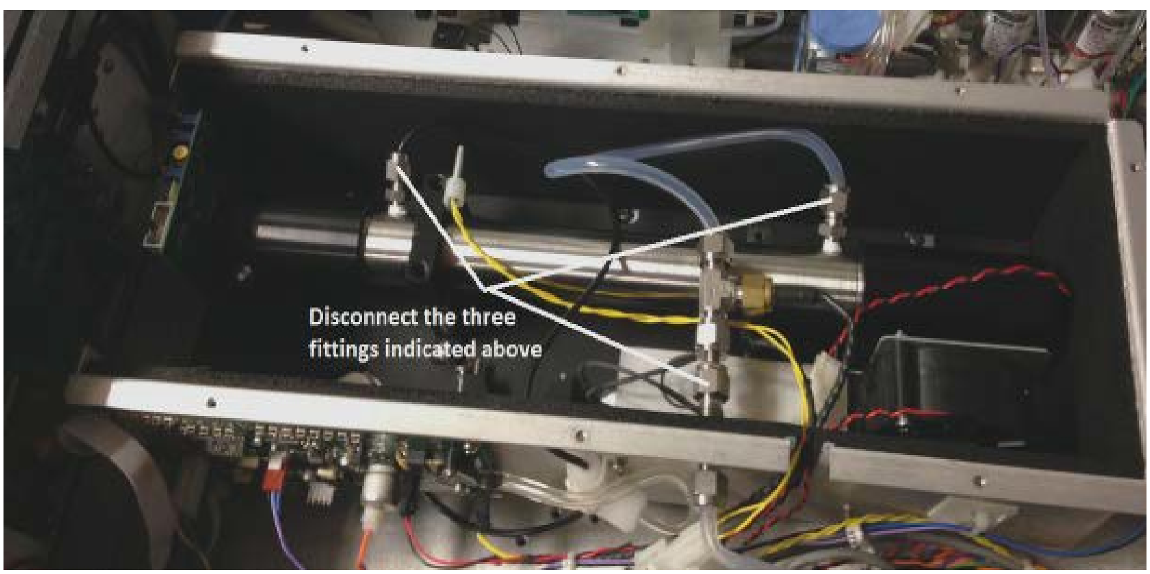
1. Turn OFF the analyzer (this is important to avoid potential for contamination of the measurement cell).
2. Remove the top cover of the analyzer and lower the front panel.
3. Disconnect the detector ribbon cable from the top of the optical cell.

Figure 11-11. Detector ribbon cable



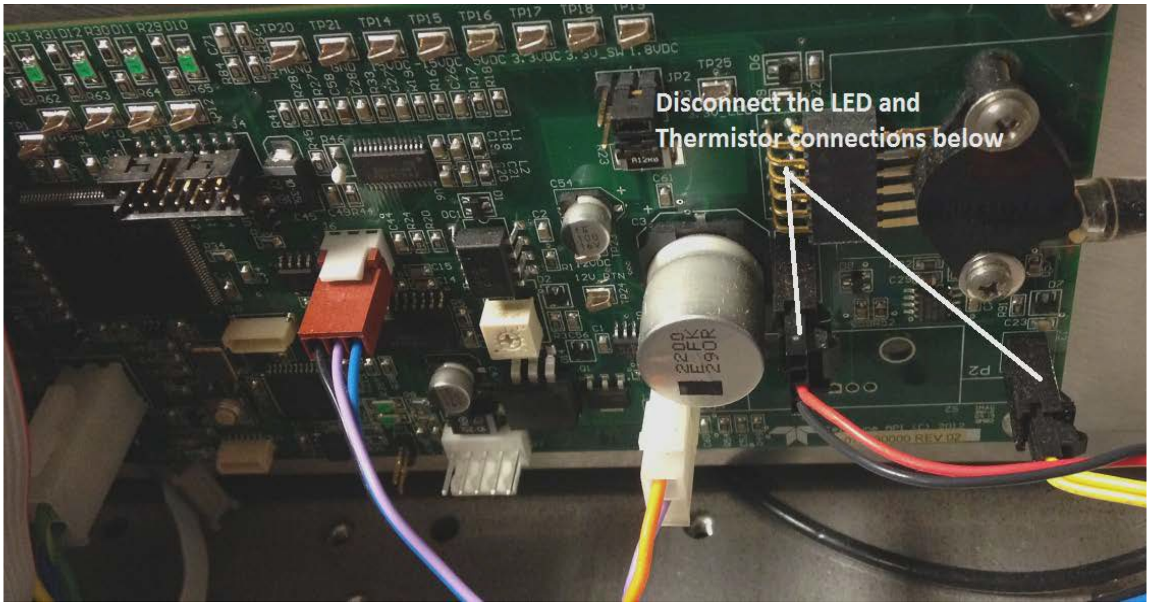
4. Remove the six screws from the top of the optical cell oven. Remove the two screws in the front of the oven cover (access through the front).
5. Pull off the optical cell oven cover.
6. Disconnect the three fittings as shown in picture below.

Figure 11-12. CAPS Optical Cell Components



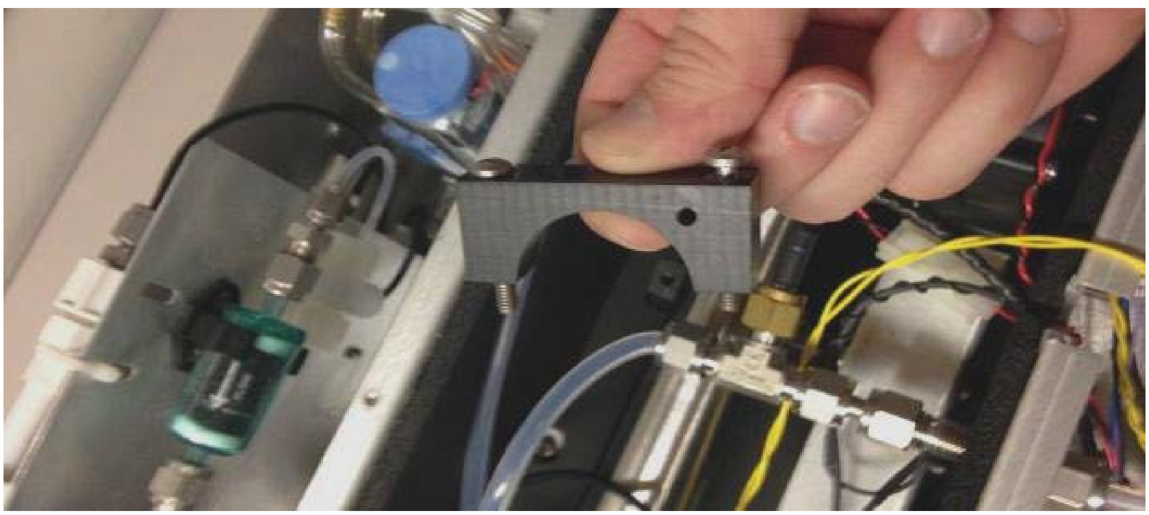
7. Disconnect the Thermistor and LED connectors as shown in picture below. (See Figure
   11.7.2 and 11.7.3)

Figure 11-13. CAPS Control Board with LED adjustment POT and connectors.



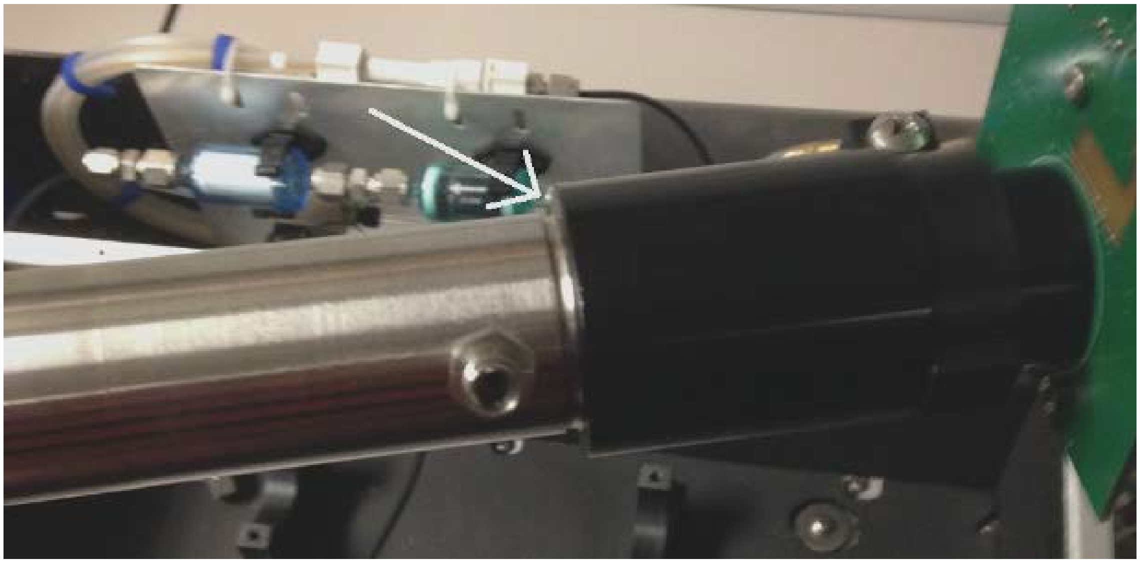
8. Remove the two mounting brackets that secure the optical cell.

Figure 11-14. Upper portion of Optical Cell Mounting Bracket.



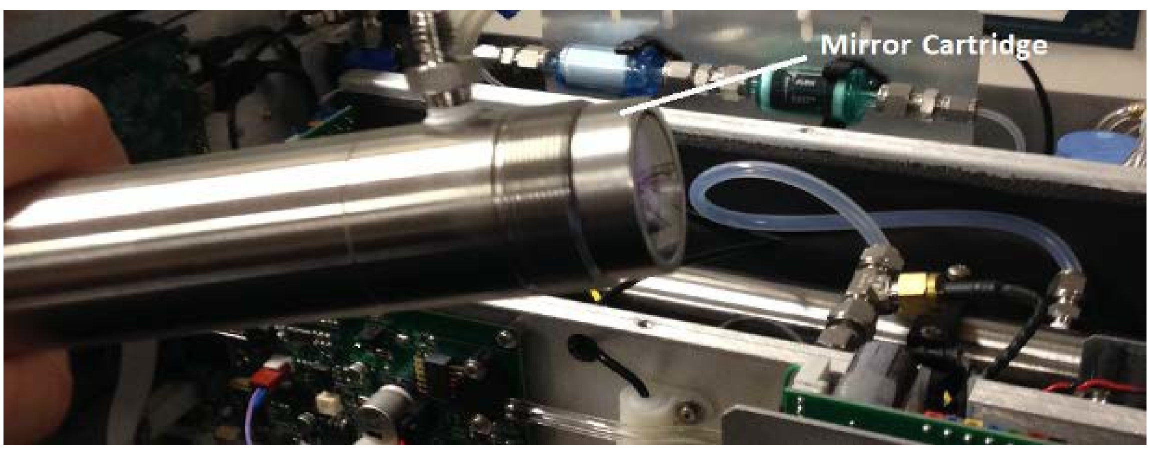
9. Carefully unscrew the black section of the stainless section of one end of the tube as shown
*(*NOTE: there is an O-ring between the mirror and black section inside – do not lose it!).*

Figure 11-15. Optical Cell with Black Section (Vector Side).



10. Once the black section is removed, you can now see and access the mirror housed in its cartridge.
11. Repeat this step on the opposite side of the optical cell.

Figure 11-16. Optical cell with Black Section Removed showing Mirror installed.



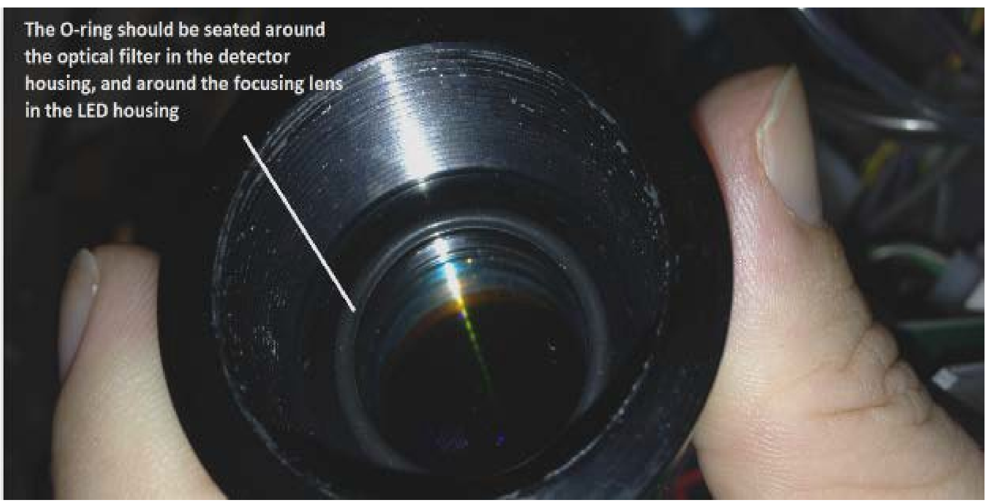
12. To remove the mirror cartridge, gently grip the sides of the cartridge and pull (wiggle) the cartridge from the optical cell sleeve. (See Figure 11.16 and 11.17) *(*NOTE: Be very careful not to touch the mirror surface.)*

Figure 11-17. Mirror is housed in a protective holder.

Figure 11-18. Mirror with Reflective Surface side showing.

13. Once the mirror is removed from both ends of the optical cell, set them aside and use compressed air to blow out any debris.
14. Check the O-ring in the two black end housings to make sure they are fully seated as shown below. (See Figure 11.19)

Figure 11-19. Black Section removed from the Optical Cell.



15. Once the optical cell has been disassembled and the mirror cartridges removed, you can proceed to the Mirror Cleaning.
16. Following the Mirror Replacement or cleaning procedure, replace the instrument cover and perform a system leak check procedure using instructions in the Factory Manual.
17. Following leak check, turn instrument or pump back on to resume operation.

Mirror Cleaning

The mirrors are readily cleaned. Their coatings are relatively robust and should be treated just as one would treat any multi-layer optical film. Initially, gloves can be employed when handling the mirrors to avoid contamination. However, with practice, these are readily dispensed with.

Tools Required:

- High quality lens tissue (we recommend ThorLabs)
- Spectroscopic or HPLC-grade methanol and acetone
  Sigma-Aldrich CHROMASOLV Plus Acetone (pn 650501) Sigma-Aldrich CHROMASOLV Plus Methanol (pn 646377)
- Clean glass bottles with glass eyedroppers
  Nalgene 2414 Drop-Dispenser Bottle (pn 2414-0030)
- Supply of particle-free air (i.e. N_2 bottle) or Aeroduster
- A means of holding the 1" mirrors in place while cleaning.

1. In a reasonably particle-free environment, place mirror on holding block with curved side of mirror up. The curved side will have a circular mark near the mirror edge.
2. Put the near edge of a single lens paper sheet on the mirror and allow 1-2 drops of solvent to fall on paper. (Do not overly wet the paper!! This is a beginner's mistake.)
3. When the mirror becomes fully wetted, draw the lens paper along mirror towards you. *Repeat multiple times, first with acetone and then with methanol. With practice, one sheet of lens tissue can be used to make 3 different swipes. We recommend making at least 6 swipes with acetone and 6 with methanol.*
4. Use dry air or emission from Aeroduster to remove any excess solvent.
5. Proceed to the section on Assembly and Re-installation of the Optical Cell on subsequent pages.

   ***Note** on mirror cleaning:* Learning to clean mirrors takes practice and patience. If you attempt to clean the mirrors and the results are worse than before or if they do not improve, just keep trying. Make sure that there is no lint or other particulate contamination on the mirror surface. A single visible particle is sufficient to cause substantial optical loss. Avoid performing this operation in high relative humidity environments as the evaporation of solvents can cause liquid water condensation on the mirrors.

12.0 QUALITY ASSURANCE & QUALITY CONTROL

Quality assurance is a system of management and operational activities designed to ensure that the data produced by the operation of the analyzer will be of the type and quality needed and expected by the data user. Quality control defines the procedures implemented to assure that acceptable precision, bias, completeness, representativeness, and comparability are obtained and maintained in the generated data set. Quality control procedures, when properly executed, provide data that meet or exceed the minimally acceptable quality criteria established to assist management in making confident decisions. It is the policy of the Florida PQAO to implement a QA program and QC procedures to assure that data of known and acceptable precision, bias, completeness, comparability, and representativeness are collected from all monitoring projects. The following procedures and their associated intervals are used to manage the quality of data generated by the analyzer.

Figure 12-1. QA/QC Acceptance Criteria

One Point QC Precision	Control with ±15.1 % RD or 1.5 ppb difference whichever is greater	Minimum every 14 days
Zero, Span QC check	Zero drift ±3.1ppb(24hr) ±5.1 ppb (>24hrs-14 day)/Span drift ±10.1%rd	Minimum every 14 days
SLIC	Within ± 2.1%	Upon installation, minimal every 90 days
Multipoint Calibration	Zero drift within ± 3ppb, All points <± 2.1% or ≤ ± 1.5 ppb of calibration range best-fit straight line, whichever is greater.	Upon initial installation, maintenance, repair; every 182-days if biweekly Z/S/P or 365 days if automated QC checks are performed
Temperature Sensor - Check the analyzer bench temperature sensor against a NIST traceable standard	Within ± 2.1°C	Annually, every 365-days
Flow Sensor – Check the analyzer flow sensor at Zero and Span against a NIST-traceable standard	Within ± 0.01 LPM	Annually, every 365-days
Pressure Sensor - Check the analyzer pressure sensor at Zero and Span against a NIST traceable standard	Within ± 2.1 mmHg	Annually, every 365-days
Performance Audit	Within ± 15.1% of audit levels 3-10; within ± 1.5 ppb of audit levels 1&2.	Annually, every 365-days

12.1 Equipment Status Report

An Equipment Status Report is completed at a minimum monthly. It is used to document the shelter environmental conditions and diagnostic parameters of the analyzer. Once complete, the operator will sign, date, and submit the form to QA Staff for review and document retention in the agency Document Management System.

To complete the Equipment Status Report (ESR):

1. Enter the equipment information in the *Identification Block*,
2. Enter the instrument information in the *Standards Block*.
3. Indicate "YES" or "NO" for any [Analyzer Alarms] on the instrument's display.
4. Enter the local standard time [LST] from the NIST-traceable time standard. Enter the time displayed on the analyzer and then indicate the results of the [Time Check] as "PASS", or "CALIBRATE" if the absolute difference between the time standard and instrument display is greater than 2 minutes.
5. In the *QC Check Block*, complete the Concurrency checks between the instrument display and the DAS recorder by calculating the absolute difference for [Time Display] and [Concentration Display], and then enter the [RESULT].
   NOTE: If any System Checks or QC Checks result in the need for "CALIBRATION" (adjustments), the technician will affirm calibrations in the Operator Comments Block.
6. Enter the values for each *Equipment Status* parameter in the *Analyzer Checklist Block*.
7. In the *Maintenance Checklist Block*, indicate if the external particulate filter was replaced and whether the sample probe lines were checked and free of contaminants.
8. Complete the ESR form by adding any pertinent *Operator Comments*. Then sign and date the form and submit it to the QA staff for review.

12.2 Routine QC Checks

Routine manual (operator-observed) Z/S/P checks must be performed at least every 14 days (bi-weekly). More frequent checks are permitted for diagnostic purposes or confirming instrument repairs. However, if the DAS/calibrator is configured for automated nightly checks, then the routine manual QC checks may be performed every 30 days (monthly).

All precision data is to be documented and reported to the AirMVP database. This specifically includes the "unadjusted" zero, span, and precision QC checks performed prior to any calibration or maintenance of the analyzer. These checks must also be performed under the following conditions (unless prevented by analyzer malfunction):

A. Immediately prior to a calibration of the analyzer unless prevented by its malfunction.

   NOTE: *No checks are required prior to the calibration performed following the analyzer's initial installation (or re-installation) at the monitoring site.*

B. Immediately prior to an intentional analyzer shutdown (e.g. hurricane, end of site operations etc.) likely to last longer than four (4) hours, unless prevented by its malfunction.

C. Immediately prior to performing any of the "major" maintenance procedures for analyzer described in the manufacturer's manual and/or addendum, unless prevented by its malfunction.

D. Prior to any other operation which is likely to affect the response of the analyzer (e.g., sample line cleaning or drying, sample filter replacement, voltage
adjustment), unless prevented by its malfunction.

To perform the routine manual Z/S/P checks, the operator will follow the Multipoint Check procedures for the initial zero and then only the span and precision calibration check points. It is not necessary to perform a SLIC, therefore, the operator will skip the SLIC information section.

Review the Measurement Quality Objectives for NO_2, as reported by the Florida Ambient Air Monitoring Network. The ***Acceptance Criteria*** define the QC limits for the Model T500U analyzer. A *One Point QC Check for Precision* is performed as part of a Z/S/P QC check and the *Calibration QC Check* is a multipoint verification that any adjustments to the instrument response are acceptable.

QC checks at the Span and Precision points which result in the percent difference greater than the ***Control Limit*** of 15.0 % for NAAQS comparison require corrective actions that may include calibrating the analyzer according to Section 10.0 of this SOP. QC checks which result in the percent difference greater than the ***Warning Limit*** of 12.0% for NAAQS comparison require the technician to investigate the poor performance which may include taking corrective actions.

Once the routine QC check is complete, the operator will deliver zero air to the analyzer and only observe 1 or 2 minutes before returning the instrument to sample ambient air. All Z/S/P checks are documented on the Calibration form. When complete, the operator will sign, date, and submit the calibration form to QA Staff for review and document retention in the agency Document Management System.

13.0 DATA ACQUISITION AND RECORDS MANAGEMENT

The Model T500U can be interfaced with analog connection, serial or via network Ethernet cables. The Florida Ambient Air Monitoring Network is configured to use digital connections from the T500U through the data acquisition system to the main data storage in the main office. The Florida Statewide Data Handling and data Validation SOP covers the data handling for the state of Florida

14.0 DEP FORMS

14.1 FORM DEP 9-06-A Teledyne API T500U Equipment Status Report

Form No. DEP 09-06-A			**Teledyne API T500U Equipment Status Report**			Effective Date: November 2022	
Identification Block							
Date Performed:		Site Name:		Site AQS #:		Procedure:	Z/S/P
Analyzer Mfr:		Analyzer Model:		Analyzer Serial #:		Date Calibrated:	
Data Logger Mfr:		Data Logger Model:		Data Logger Serial #:		Date Verified:	
Standards Block							
Gas Cylinder #:		NO (ppm):		Tank Press. (psig):		Expiration Date:	
Time Standard Mfr:		Model:		ID/Serial #:		Date Certified:	
Analyzer Checks					Shelter Checks		
Parameter	Limits	Units	Value		MIN Temp (°C)	≥ 5°C	
Alarm Displayed?	Yes or No	n/a			MAX Temp (°C)	≤ 40°C	
Range	0 - 300	PPB					
Phase	30 ± 10 w/ zero air	DEG					
MEAS_L	400-800 w/ zero air	Mm -1					
AREF_L	400-800 w/ zero air	Mm -1					
SMP PRS	~1-5" < ambient	InHg					
SMP Temp	45 ± 3	°C					
BOX Temp	Ambient ± 5	°C					
SLOPE	1.0 ± 0.3	n/a					
OFFSET	0 ± 5	n/a					
STABIL	≤ 1 ppb w/ zero air	PPB					
OVEN TMP	45 ± 1	°C					
Concurrency Checks:							
	NIST Time:	Data Logger:	Analyzer:	Difference NIST vs Data Logger		NIST vs Analyzer:	Limits
Time Display:							± 2 minutes
	Data Logger		Analyzer Front Panel:		Difference		Limits
Concentration:							± 0.5 ppb
Operator Comments:							
Performed by:		Date:					
QA Comments:							
Verified by:		Date:					

Instructions:

This Equipment Status Report is formatted as an electronic spreadsheet used specifically for the Model T500U NO_2 analyzer. All the information on this form has been incorporated into form DEP 09-06-B so this form is optional to complete when recording diagnostic information during a site visit. The information contained in each activity report may be aggregated as a running instrument operational log.

1. Enter the activity date [Date Performed] and site/equipment information in the *Identification Block* at the top of the form.
2. Enter the [Parameter] as "NO2" for the standard analyzer
3. Enter the [Calibration/Certification Dates].
4. Enter the equipment information and [Certification Dates] in the *Standards Block*.
5. In the *System Checks Block*, record "YES" or "NO" for the status of any analyzer alarms displayed.
6. Enter time (hh:mm) from the transfer standard and analyzer display, and then indicate "PASS" for time difference within ± 2 minutes, or "CALIBRATE" for a difference out of tolerance.
7. In the *QC Checks Block*, enter the time and concentrations displayed on the analyzer and the DAS. Calculate and record the difference and then record the RESULT as "PASS" for checks within the limits or "CALIBRATE" for checks exceeding the limits.
8. In the *Analyzer Checklist Block*, record the observed values from the instrument's diagnostic displays.
9. In the *Maintenance Checklist* B*lock*, record the "YES" if completed, "NOT DUE", or "NO" if not completed. If "NO" is entered, explain in the *Operator Comments Block*.
10. Enter operator/technician comments in the comment box.

The operator should provide a descriptive comment indicating the purpose for completing an Equipment Status Report, explain any conditions that are out of tolerance, and any maintenance checks answered with a "NO", "N/A" or similar non-affirmative answer. Once the form is complete, the operator will submit it to the QA officer for quality control, accuracy, and data review. The QA officer may add comments in the [QA Comment] box, then sign and date the report/log.

14.2 FORM DEP 9-06-B T500U NO2 Analyzer QC Check and Calibration Log

Form No. DEP 09-06-B	Teledyne API Model T500U NO2 Analyzer QC Check and Calibration Log	Effective: November 2022

Identification Block

Date Performed:		Site Name:		AQS #:		Procedure:	
Data Logger Mfr:		Model:		Serial #:		Date Verified:	
Calibrator Mfr:		Model:		Serial #:		Date Photometer Certified:	
						Date MFC's Certified:	
Zero Air Mfr:		Model:		Serial #:		Date Serviced:	
Time Standard Mfr:		Model:		Serial #:		Date Certified	

Standards Block

Gas Cylinder #:		NO (ppm):		Tank Press. (psig):		Expiration Date:	

Analyzer Operating Parameters

T500U Serial Number:		Calibration Date:		Range:	
Phase (30 ± 10 w/ Zero Air)		SMP Temp (45°C ± 3)		Stability (<= 1 ppb w/ zero air)	
MEAS_L (400 - 800 w/ Zero Air)		Box Temp (Ambient ± 5°C)		Oven Temp (45°C ± 1)	
AREF_L (400 - 800 w/ Zero Air)		Slope (1.0 ± 0.3)			
SMP PRS (~1-5" < Ambient)		Offset (0 ± 5)			

Concurrency Checks:

	NIST Time:	Data Logger:	Analyzer:	Difference NIST vs Data Logger	NIST vs Analyzer:	Limits
Time Display:						± 2 minutes

	Data Logger	Analyzer Front Panel:	Difference	Limits
Concentration:				± 0.5 ppb

Z/S/P Check — GPTPS / GPT

Calibration Point	Gas (L/min)	Dilution (L/min)	Calc. NO (ppb)	Observed O_3 / Assessment NO_2 (ppb)	Observed NO2 (ppb)	% or ppb Diff	Critical Limits	RESULT
Zero (0 ppm)			N/A		N/A	N/A	± 5 ppb	N/A
Span (240 ppb)			N/A		N/A	N/A	± 10.0%	N/A
Precision (34 ppb)			N/A		N/A	N/A	± 15.0%	N/A

Post-Adjustment Analyzer Coefficients	Offset:		Slope:

Calibration Check — GPTPS / GPT

Calibration Point	Gas (L/min)	Dilution (L/min)	Calculated NO (ppb)	Observed O_3 / Assessment NO_2 (ppb)	Observed NO2 (ppb)	% or ppb Diff	Critical Limits	RESULT
Zero (0 ppb)			N/A		N/A	N/A	± 5 ppb	N/A
Span (240 ppb)			N/A		N/A	N/A	± 2.0%	N/A
Upscale 2 (175 ppb)			N/A		N/A	N/A	See Linearity Check Results	
Upscale 1 (100 ppb)			N/A		N/A	N/A	See Linearity Check Results	
Low (34 ppb)			N/A		N/A	N/A	See Linearity Check Results	
Final Zero (0 ppb)			N/A		N/A	N/A	See Linearity Check Results	

SLIC

	Sample Line	SLIC Line	% Diff	Limits	RESULT
SLIC Values	N/A	N/A	N/A	±2%	N/A

Post Maint. Z/S/P Check — GPTPS / GPT

Calibration Point	Gas (L/min)	Dilution (L/min)	Calculated NO (ppb)	Observed O_3 / Assessment NO_2 (ppb)	Observed NO2 (ppb)	% or ppb Diff	Critical Limits	RESULT
Zero (0 ppb)			N/A		N/A	N/A	± 5 ppb	N/A
Span (240 ppb)			N/A		N/A	N/A	± 10.0%	N/A
Precision (34 ppb)			N/A		N/A	N/A	± 15.0%	N/A

Linearity Check/Calibration Assessment

	Zero	Low Point	Upscale 1	Upscale 2	Span	slope (m)
						N/A
Calibrator Value (X)	N/A	N/A	N/A	N/A	N/A	intercept (I)
Instrument Value (Y)	N/A	N/A	N/A	N/A	N/A	N/A
Best Fit Concentration		N/A	N/A	N/A	N/A	
% Diff or Abs. Diff (Best Fit Conc. vs. Y values)		N/A	N/A	N/A	N/A	
RESULT:		N/A	N/A	N/A	N/A	

Operator Comments:

Performed by: Date:

QA Comments:

Verified by: Date:

Instructions:

This calibration form is formatted as an electronic spreadsheet used for the Model T500U NO2 analyzer. Once the operator selects the [Procedure] from the cell dropdown menus, the electronic version of this form will determine the corresponding limits to apply.

1. Enter the activity date [Date Performed] and site/equipment information in the *Identification Block* at the top of the form.
2. Select the [Procedure] from the cell dropdown menus.
3. Enter the calibration gas information in the *Standards Block*.
4. Record the serial number, calibration date and diagnostic parameters in *Analyzer Operating Parameters*
5. Record the Time and Concentration data in the *Concurrency Checks* block
6. Depending on which procedure is being performed, In the *Z/S/P Check* and/or *Calibration Check Block* record the Gas and Dilution Air Flows while generating each calibration check point. The NO_2 concentrations are calculated based on the Observed O_3 during the GPTPS mode and recorded Observed NO_2 response from the analyzer during GPT for each QC check point.
7. The relative percent difference of each point is calculated and then shows the RESULT as “PASS”, “WARNING LIMIT” or “Calibrate”.
8. If the Procedure is a “Calibration” or “Verification” check, then the *Linearity Check/Calibration Assessment* block will calculate the linear regression slope and intercept equation to determine the Best Fit Concentration, and then calculate the relative percent differences for each calibration check point. Record the RESULT as “PASS” or “Calibrate”.
9. In the *SLIC Check Block*, record the Gas and Dilution Air Flows while generating a SPAN concentration level, and then calculate the NO2 concentrations based on the calibration gas cylinder concentration.
10. Enter the average Observed NO_2 values with the SLIC configuration and again under normal ambient air sampling configuration.
11. Calculate and record the relative percent difference between instrument SLIC and SPAN responses. Record the RESULT as “PASS” or “Calibrate”.

The technician should provide a descriptive comment indicating the purpose for performing the calibration(s) and any adjustments performed. Once the form is complete, the operator will submit it to the QA officer for verification and data validation review. The QA officer may add comments in the [QA Comment] box, then sign and date the report/log.

14.3 FORM DEP 9-06-C Teledyne API T500U Maintenance Schedule

Form No. DEP 09-06-C | **Teledyne API T500U Maintenance Schedule** | Effected date: November 2022

Identification Block					
Year:		Site Name:		AQS #:	
Instrument Mfr:		Model:		Serial #:	

Minimum Maintenance Frequency:		Quarterly		Annual						As Needed			
Date	Operator	Sample Line Filter Change	Sample Line Integrity Check	Clean Instrument Interior	Replace Sample Line	Box Temperature Sensor Verification	Pressure Sensor Verification	Flow Verification	AREF and Charcoal filter inspect/ change	Replace Internal Pump	Examine/Clean Pneumatic Lines	QA Verification	QA Date
ENTER DATE LAST PERFORMED:												LEAVE BLANK	
	Due Dates:	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				
	Warnings:	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				

Comments:

Instructions:

This Maintenance Log is formatted as an electronic spreadsheet for the Model T500U NO2 analyzer. It is completed for all scheduled or unscheduled maintenance activities.

1. Enter the 4-digit calendar [Year], site name and AQS #
2. Enter the equipment information and certification/installation dates.
3. For each Maintenance Activity, the technician will enter the [Maintenance Date] (mm/dd/yyyy) the maintenance was performed and their first initial, last name in the [Operator] field.
4. Using the cell dropdown list, select a response {YES, NO, NOT DUE, N/A} under each maintenance activity item.

The [Maintenance Due Date] is 30, 60, 90, or 365 days from the [Maintenance Date] entered by the technician (date performed).

The technician should provide any descriptive comments regarding maintenance activity items answered with a “NO” and explain why the maintenance item was not performed. Once the form is complete, the technician will submit it to the QA officer for quality control, accuracy and data review

14.4 FORM DEP 9-06-D Teledyne API T500U Sensor Verification / Calibration Form

Form No. DEP 09-06-D **Teledyne API T500U Sensor Verification/ Calibration Form** Effected date: November 2022

Identification Block							
Date Performed:		Site Name:		AQS #:			
Instrument Mfr:		Model:		Serial #:		Date Calibrated / Verf.:	

Standards Block							
Pressure Standard Mfg:		Model:		ID/Serial #:		Date Certified:	
Temp. Standard Mfg:		Model:		ID/Serial #:		Date Certified:	
Flow Standard Mfg:		Model:		ID/Serial #:		Date Certified:	

Sensor Calibration / Check					
Box Temperature	Front Panel	Ref. Standard	**Difference**	**Limits**	**RESULT**
As Found (°C)			N/A	± 2°C	N/A
Sample Pressure	Front Panel	Ref. Standard	**Difference**	**Limits**	**RESULT**
As Found (in Hg)			N/A	± 0.2 in Hg	N/A
Post Calibration (in Hg)		N/A	N/A	± 0.2 in Hg	N/A
Flow		Ref. Standard		**Limits**	**RESULT**
As Found (cm³ / min.)				> 800 cm³/min.	N/A
Post Maintenenace (if needed)				> 800 cm³/min.	N/A

Operator Comments:

Performed by: ____________ Date: ____________

QA Comments:

Verified by: ____________ Date: ____________

Instructions:

This Sensor Verification Form is used to document the temperature, pressure, and flow comparisons performed as part of instrument maintenance.

1. Enter the Site and Analyzer information in the *Identification Block*
2. Enter the information for the certified standards used to check each parameter in the *Standards Block*.
3. Enter the readings from the instrument and the associated reference standard in the *Sensor Calibration / Check* block.
4. If adjustments to temperature or flow are required, fill out the appropriate box and make a comment.
5. If the flow is measured to be <800 cc/min then the flow path will need to be inspected for blockages and/or sample pump will need to be replaced.

15.0 <u>REFERENCES</u>

AirMVP User Manual, August 2020, Florida Department of Environmental Protection, Tallahassee, FL.

Quality Assurance Project Plan for the State of Florida Gaseous Ambient Air Quality Monitoring Program, FL-Gaseous QAPP, Revision 2, April 2022, Florida Department of Environmental Protection, Tallahassee, FL.

Standard Operating Procedure for Air Monitoring Data Handling and Data validation, DEP 18-27, Revision No. 2, February 2022, Florida Department of Environmental Protection Bureau of Air Monitoring, Tallahassee, FL.

Teledyne-API Product Manual, T701H Zero Air Generator, Revision F, 11 June 2021

Teledyne-API Product Manual, T500U NO_2 Analyzer, Part number 07834, Revision D, 01 June 2015

Teledyne-API Product Manual, T500U with NumaView Software Manual, 18 October 2019

Teledyne-API Product Manual, T700U Dynamic Dilution Calibrator, Part number 06873, Revision E, 10 June 2015.

Teledyne-API Product Manual, T700U with NumaView Software Manual, 25 February 2020