California Environmental Protection Agency

AIR RESOURCES BOARD

AIR QUALITY SURVEILLANCE BRANCH

STANDARD OPERATING PROCEDURES

FOR

TELEDYNE/ADVANCED POLLUTION INSTRUMENTS (API) MODELS 400E and T400 OZONE ANALYZER

AQSB SOP 002

Second Edition

MONITORING AND LABORATORY DIVISION

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California Environmental Protection Agency
AIR RESOURCES BOARD

Approval of Standard Operating Procedures (SOP)

Title:	TELEDYNE/ADVANCED POLLUTION INSTRUMENTS (API) MODEL 400E AND T400 OZONE ANALYZERS
SOP:	AQSB SOP 002, Second Revision
Section:	Operation Support Section
Branch:	Air Quality Surveillance Branch (AQSB)
Division:	Monitoring and Laboratory Division (MLD)
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1.0 GENERAL INFORMATION

1.1 Introduction:

This Standard Operating Procedure (SOP) describes procedures used by the California Air Resources Board (CARB) Air Quality Surveillance Branch (AQSB) to operate the Teledyne/Advanced Pollution Instruments Model 400E Ozone Analyzer (400E) as well as the Teledyne/Advanced Pollution Instruments Model T400 Ozone Analyzer (T400) to measure ozone levels in ambient air. These two instruments will be collectively referred to as "the instrument" unless otherwise required. This procedure is designed to supplement the instruction manual by describing hardware or operating procedures as implemented by the AQSB for monitoring of ozone in the ARB's ambient air monitoring network. It is not the intent of this SOP to duplicate or replace the instruction manual. A separate document is available for each instruments acceptance test procedures.

1.2 Principle of Operation:

The instrument is designed to accurately measure ambient ozone concentrations, despite the presence of interfering compounds. It detects ozone by measuring the absorbance of 254 nm UV light emitted by a mercury vapor lamp and collected by a detector at the other end of the sample gas path. Using Beer-Lambert law, this UV absorbance can be correlated to the concentration of ozone and any other compound which may absorb UV light at this frequency.

$$A = \log_{10}\left(I_o / I\right)$$

Equation 1 - Beer-Lambert law where Io is the original intensity, I is the post sample gas intensity, and A is the absorbance.

In order to correct for interfering compounds, the instrument calculates each value by taking the difference of two measurements and subtracting the difference.

$$A_{total} = A_i + A_{O3}$$

$$A_{O3} = A_{total} - A_i$$

Equation 2 - In the above equation: A_{total}, Ai, and AO3 stand for total, interfering compound, and ozone absorbance respectively. Total absorbance can be measured in the O3 measurement sample. Absorbance of the interfering compounds is measured in the O3 reference sample. The partial absorbance of the ozone is then calculated as the difference of the two.

For the interference measurement, the UV light passes through a band-pass filter and through a glass tube which is filled with ambient air. The UV light absorbance is subsequently measured by the detector located on the opposite side of the chamber. This initial measurement is commonly referred to as Ozone Measured (displayed as “O3 Meas” on the front panel).

For the second measurement, sample air is scrubbed of all ozone and a resulting reference measurement is taken (displayed as “O3 Ref” on the front panel). The amount of UV radiation absorbed by ozone in the sample is then calculated as the difference of the actual absorbance during the O3 Meas and the scrubbed O3 Ref measurement cycles. For a more detailed discussion of the analyzer's measurement principle, please reference the manufacturer's instruction manual.

1.3 <u>TAPI 400E and T400 analyzer comparison</u>:

The T400 and 400E are essentially equivalent in all analytical aspects. Both use the same underlying technologies. The specifications for both instruments are almost identical to one another. The only significant, documented difference between the two is that the T400 has a color touch screen and 2 USB ports on the front, whereas the 400E has an LCD display. The instruments described in this SOP refer to instruments using up to firmware version E.0 for the 400E and software revision 1.0.2 bld 71 for the T400.

Figure1: API 400T IZS front panel

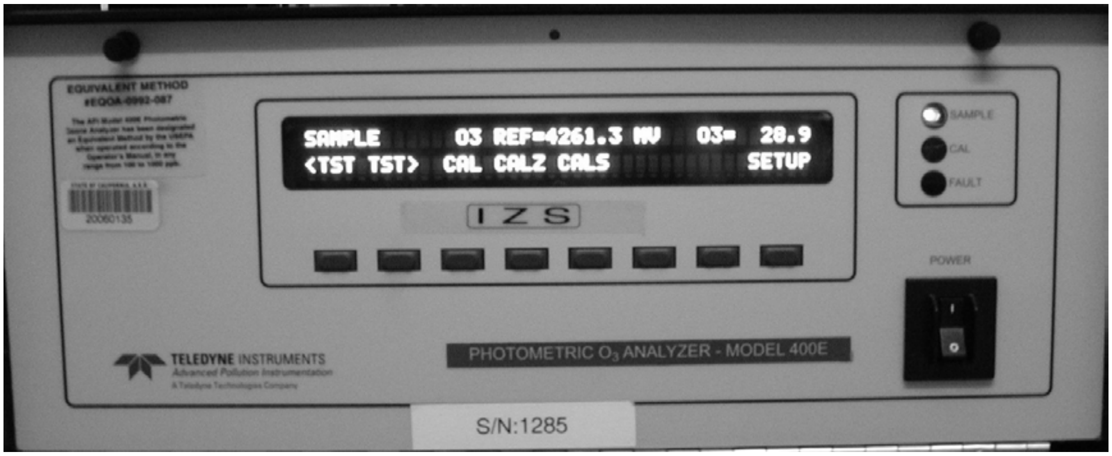

Figure2: API 400 E front panel

1.4 <u>Safety Precautions</u>:

Prior to cleaning the analyzer or performing any maintenance on the instrument, place the MAIN power switch to the OFF position, and unplug the power cord. Avoid the use of chemical agents which might damage components.

Always use a three-prong, grounded plug on this analyzer. Adhere to general safety precautions when using compressed gas cylinders (e.g., secure cylinders, vent exhaust flows).

2.0 INSTALLATION PROCEDURE

2.1 General Information:

The instrument is designed to have an operating temperature range between 5º and 40º C. However, good monitoring practices state that the instrument should be installed in a stable temperature controlled environment between 20 º C to 30 º C. Care should be taken to install the instrument in a standard 19" instrument rack such that it can be accessed for maintenance, repair work and troubleshooting etc. The standard 19" instrument rack should be bolted to the floor and properly grounded.

2.2 Physical Inspection:

The instrument is normally shipped with the following standard equipment when ordered by the Operations Support Section:

1. Power cord
2. Instruction manual
3. Side rails

Upon receiving the instrument, confirm that the instrument is in good working order and inspect for damage. If any damage is observed, contact your immediate supervisor. Prior to installation of the instrument, check the following:

1. Verify no apparent shipping damage.
2. Check that all connectors are fully inserted.
3. Check that all mechanical connections are tight.
4. Open and remove the internal shipping screws on the pump and the internal foam blocks.

2.3 Instrument Siting:

The instrument should be sited in accordance with the United States Environmental Protection Agency (U.S. EPA) Title 40, Code of Federal Regulations Part 58 Appendix E "Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring" and US EPA Designated Automated Equivalent Method EQOA-0992-087. See also the *Model 400E Ozone Analyzer Instruction Manual*, Section 2.2 "EPA Equivalency Designation" and the *Model T400 Photometric Ozone Analyzer*, Section 2.2 "EPA Equivalency Designation" for a detailed list of EPA designation related siting requirements.

2.4 Strip Chart Connections:

The instrument has an eight-pin output connector strip on the rear panel. The first two pins (A1) are the ozone concentration output for connection to the chart recorder. The pins are marked plus and minus and must be connected accordingly.

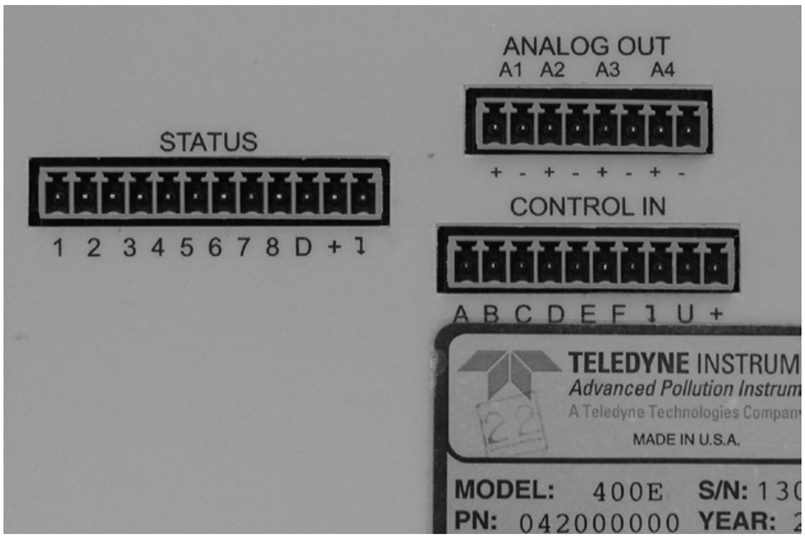

Figure 3 API 400E back panel

2.5 Analog Data Logger Connections:

Both instruments have eight-pin analog output connector strips on the rear panel. These lines are used to produce the voltage for the data logger. Pins 3 and 4 (A2) are the ozone concentration output for the ESC88XX data logger. The pins are marked plus and minus and must be connected accordingly.

For the T400IZS, follow the below steps in order to confirm that pin 7 works appropriately:

- From the front menu, enter the [Setup] menu.
- Hit the [More] key to advance to and select the [DIAG] menu.
- Use the 929 passcode to enter the [DIAG] sub-menu and select the [Factory Options] submenu.
- If not already configured, edit the [Alternate Status Output] condition to display “On”.

2.6 Analog Data Logger Connections for IZS models:

In addition to producing the voltage for data logging purposes, the 400E and T400 IZS model status outputs must be connected to an analog data logger in such a manner that IZS calibration cycles can be flagged (See Figure 4 and Figure 5 below). In figures 4 and 5, the left side of the figure shows the instrument pin outs and the right side shows the data logger pin outs.

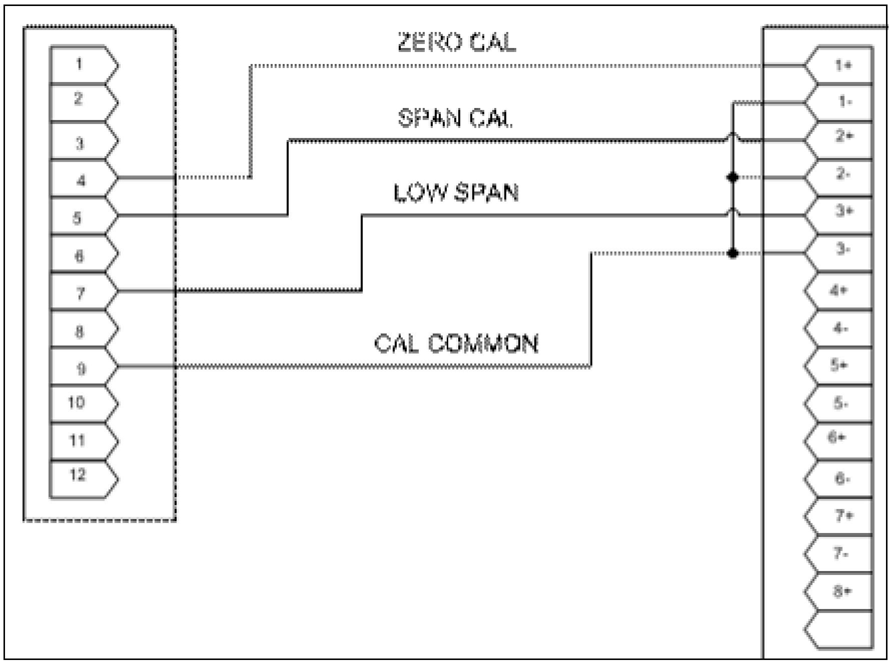

Figure 4 Ozone to ESC 8816 and 8832 connections

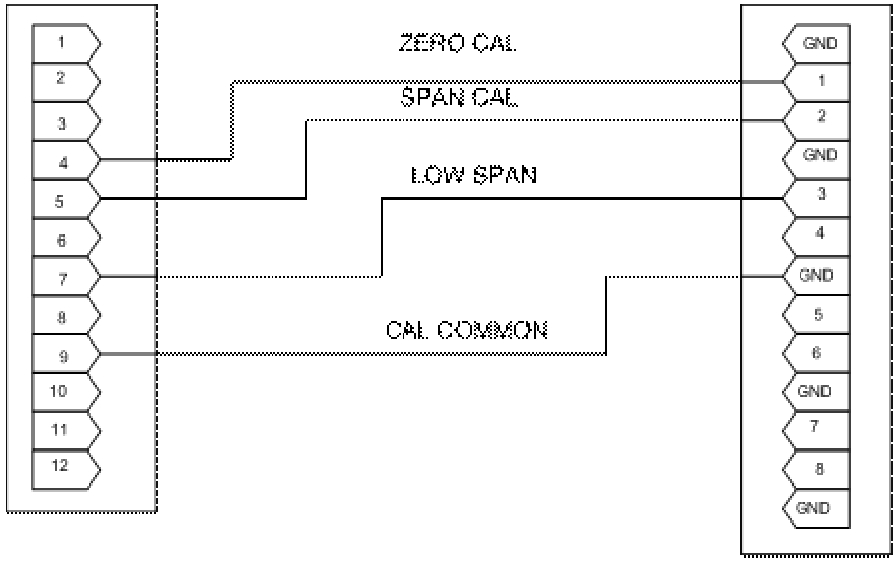

Figure 5 Ozone to ESC 8800 connections

2.7 <u>CARBLogger Connection:</u>

The ARB has expanded its air monitoring capability by including digital based data acquisition and logging methods. The ARB utilizes a custom open source PC-based digital diagnostic and data logging system referred to as CARBLogger. This system was developed by in-house by AQSB staff. When using CARBLogger, the RS-232 port on the instrument should be made active using the front control panel of the instrument. The following 400E/T400 communications settings should set in the instruments to allow for digital communications with CARBLogger:

- COM2 on
- BAUD RATE=9600
- Instrument ID=400

After connecting an RS232 cable to the back of the instrument from the CARBLogger PC to the instrument COM 2 port, ensure that both the amber and green RX/TX lights located above the instruments COM 2 interface are lit. If not, toggle the DCE/DTE switch located between instruments the two communication ports. No additional connections are required.

Note: In this mode, USB ports located on the front of the T400 will be disabled.

For assistance with specific CARBLogger configuration, contact the AQSB's Operation and Data Support Section (ODSS).

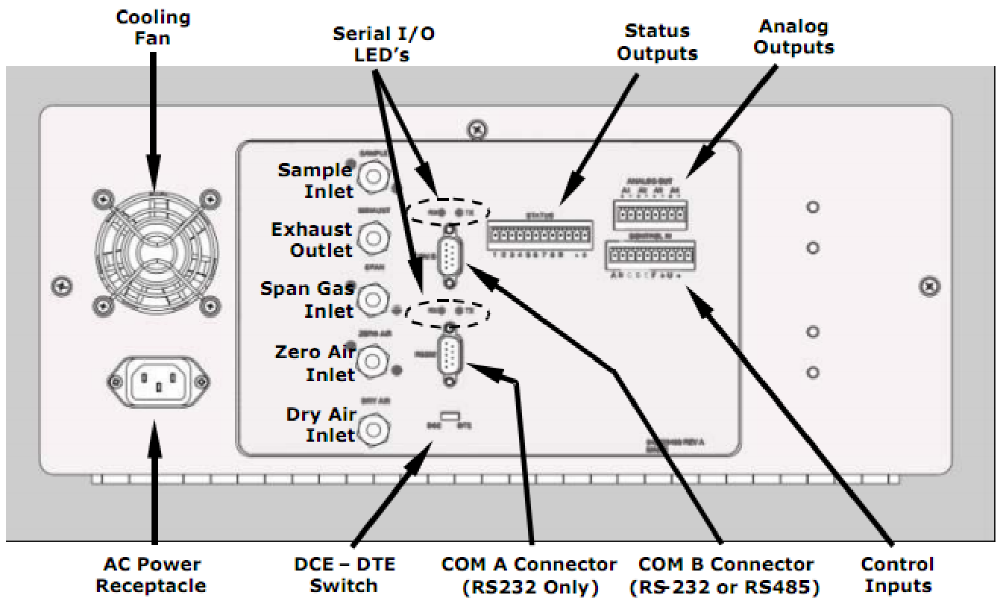

Figure 6 COM2 is the top most female db9, rs232 connection.

2.8 Operation Verification:

NOTE: Prior to operation of the instrument, operators must read the respective instruction manual to familiarize themselves with the operation of the instrument.

Prior to operating the 400E or T400, ensure that the proper connections have been made. In summary, at most ARB monitoring locations this involves the following connections:

- Connect the sample inlet line from the manifold to the sample port on the rear panel.
- Connect the pump exhaust to a suitable vent outside the analyzer area.
- Connect the power cord to a well-grounded and appropriate power outlet.
- Connect recording devices to the terminal strip on the rear panel.

After proper connections have been made, turn on the power switch.

Figure 7 Front panel of the API 400 E

At initial power on, the 400E the display will show a single dash on the left side of the screen for approximately 30 seconds. Subsequently, a boot progress meter will be displayed showing the percent completion of loading the operating system. The 400E should automatically enter into sample mode after reboot. The display will now show “SYSTEM RESET” on the top display line, the green sample light on the right front of the panel should be on, and the red fault light should be flashing with the word “SAMPLE” flashing in the upper right hand of the display until the warm-up cycle has completed. Allow approximately one hour for the instrument to stabilize before performing any further operations.

Review all diagnostic values by repeatedly depressing the first [<TST] or second [TST>] command keys on the front of the instrument. Compare these values to those listed on the factory final checkout sheet in the instruction manual or those listed on the Operation and Data Support Sections Instrument Laboratory Data Sheet.

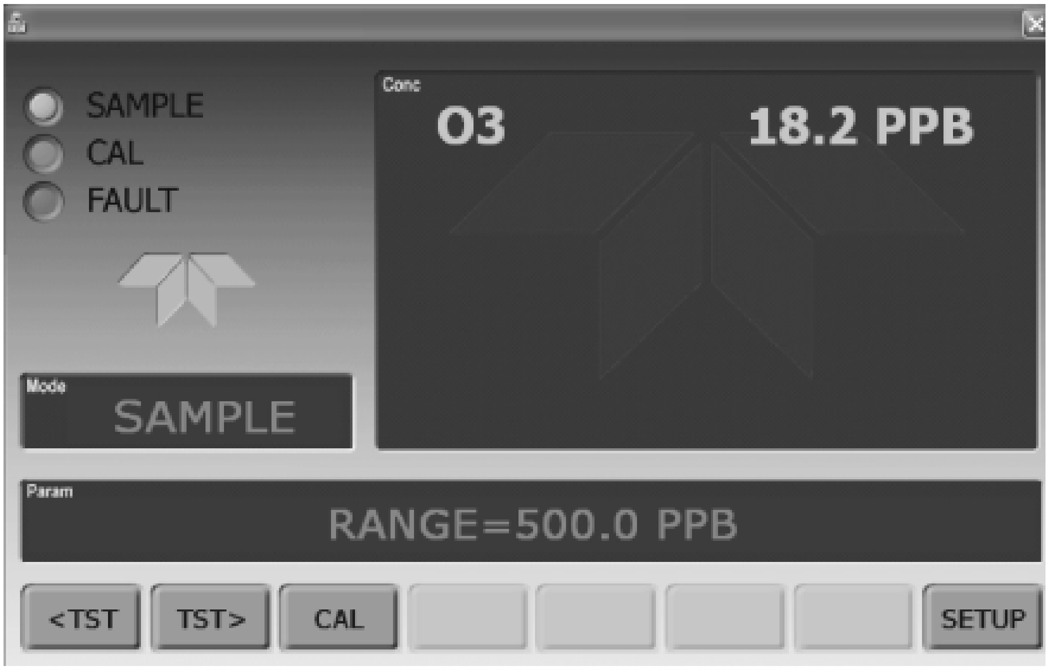

Figure 8 The API T400 digital display

After initial power on, the T400 display will show the API factory label, and a message to indicate that it is loading. The T400 will automatically enter into the sample mode after reboot and display “SYSTEM RESET” across the bottom of the screen. A blinking red “fault” light on the left side of the display will indicate that the system has been rebooted.

Compare these values to those listed on the factory final checkout sheet in the instruction manual or those listed on the Operation and Data Support Sections Instrument Laboratory Data Sheet. Verify that the test parameters are within the limits prescribed by Table 1, API 400E / T400 Standard Configuration Table.

If warning messages persist after the 30 minute warm up period is over, investigate their cause using the troubleshooting guidelines provided in the instruction manual.

Note: If this instrument is the T400 model connected to a CARBLogger using the APIT400 driver, all errors will be recorded, placed into the diagnostics email, and cleared from the instrument.

3.0 CONFIGURATION

3.1 Instrument Configuration

The instrument is usually configured by the ARB's Operation and Data Support Sections Instrument Laboratory and requires no field configuration. **However, field staff are strongly encouraged to verify that their instrument is properly configured prior to field use.**

TEST PARAMETER	NOMINAL	RANGE
Time	Current PST time	+/- 2 minutes
Range (ppb)	500	0 to 1000
Stabil (Standard Deviation of O3 Readings)	0.1 – 0.3	< 1 w. zero air
O3 Meas (Current V/F conv MV, measured channel)	4000	3500 to 4600 *
O3 Ref (Current V/F conv MV, reference channel)	4000	3500 to 4600 *
O3 Gen (IZS ref channel feedback)	+/- 10% demand	80-5000 MV
O3 Drive (Drive voltage for O3 Gen Lamp)	+/- 10% demand	0-5000 MV
Pressure (Absolute Pressure, inHg)	Ambient Press.	29 to 31
Sample Fl (Sample Flow through Analyzer, c/min)	720**	720 ± 80
Sample Temp (°C)	Ambient Temp	Ambient +/- 10°
Photo LMP (Photometer Lamp Housing Temp, °C)	58 C	58 +/- 2
O3 Gen Temp (O3 Generator Housing Temp, °C)	48 C	+/- 1°
Box Temp (Internal Box Temp, °C)	Ambient Temp	Ambient +/- 10°
Slope (Internal Formula, Slope)	1.00	0.9 to 1.1
Offset (Internal Formula, Offset)	0.0	-5.0 to 5.0

Table1: Standard ARB API 400E/T400 Configuration Table

** See UV Source Lamp Adjustment section of the appropriate instruction manual.*

*** Although the 400E/T400 instrument manual state a nominal sample flow of 800 ± the ARB's experience with the instruments show a nominal flow rate of ~720 sccm at sea level.*

The Teledyne Advanced Pollution Instruments (TAPI) internal data loggers (iDAS) default to recording hourly concentration data. The AQSB's Data Management System (DMS) is configured to ingest minute based data for most parameters. The AQSB's CARBLogger (CL) queries minute-based data from instruments that CL monitors. To provide a possible data back-up in the event that CARBLogger goes down, all ARB site operators should configure **ALL** TAPI instruments to record minute concentration data.

The procedures to program TAPI iDAS to record minute based data is as follows:

1. **WARNING: RECONFIGURING THE iDAS WILL CLEAR ALL RECORDS**. If you need to archive data, download the data from the analyzer prior to reconfiguring the iDAS. The iDAS can be reconfigured via the front panel controls. From the main menu, press the SETUP soft key.

2. Press the DAS key to view the iDAS settings. Next press the EDIT key to begin editing iDAS settings. The instrument will prompt for a password. Enter 929 and press ENTR to begin editing the iDAS settings.

3. The "Conc" channel is the default hourly average data channel. For all TAPI instruments this channel is pre-configured with the concentration data and on some instruments a diagnostic channel. Press the EDIT soft key to begin editing the channel.

4. Press [SET>] until the "Report Period" parameter is displayed. Press the [EDIT] key until the "Report Period Days" field is displayed. Ensure that "Report Period Days" is set to 000. Press [ENTR] to display the "Report Period Time". Set the "Report Period Time" field to "00:01" and select [ENTR].

5. Press [SET>] until the "number of records" parameter comes up. Press the [EDIT] key to change this value. To maximize storage of records, use the following procedure:
    a) The analyzer will prompt you to clear all data. Press [YES] if you have backed up your data and move on to step b, otherwise press [NO] and download the data from the analyzer. After downloading, perform steps 1-6 again.

    b) Set the number of records to all zeroes. The [ENTR] button will only appear if the number of records is a valid number, and will disappear if the number of records exceeds available memory. Increment the highest digit (leftmost digit, will either be the "tens of thousands" digit or "hundreds of thousands" digit) by one until the [ENTR] button disappears. Lower the value by one and press [ENTR]. The value for this digit is now maximized.

    c) Perform the procedure in step b for next digit to the right. Continue until all values have been maximized. Once the "ones" digit has been completed the maximum number of records will have been selected. Press the [ENTR] key to save the value.

6. Press the [SET>] key until "RS 232 Report" value appears. Set to [OFF] and press [ENTR], or press [SET>] if already the parameter is already set to [OFF].

7. Press the [SET>] key until "Channel Enabled" value appears. Set to [ON] and press [ENTR], or press [SET>] if the parameter is already set to [ON].

9. Press the [SET>] key until "Cal Hold" value appears. Set to [OFF] and press [ENTR], or press [SET>] if the parameter is already set to [OFF].

10. The iDAS is now configured to store 1 minute concentration averages. Press [EXIT]. The analyzer will display "Creating New Data File" and a percentage counter as it resets data storage. Continue pressing [EXIT] until the sampler returns to the main screen.

3.2 Analog Data Logger Configuration

Analog data logger channel configuration for the instrument can be found in the AQSB SOP for the datalogger model you are using. In most cases, set-up for the T400 is identical to the setup for the 400E. The data logger channel (A2) for the ozone analyzer must be configured for a 0 to 1 volt signal equaling 0 to 500 ppb assuming the range of the instrument is set to 500 ppb.

3.3 Strip Chart Recorder Configuration

Strip chart channel configuration for the instrument is covered in the AQSB SOP 604. The use of a strip chart recorder is currently optional for stations running a CARBLogger data logger. In most cases configuration of the strip chart channel for the T400 is identical to the 400E. In general, the strip chart channel (A1) for the ozone analyzer must be configured for a 0 to +1 voltage output range, with units from 0 – 500 ppb. The strip chart recorder color should be set to light green.

3.4 CARBLogger Configuration:

CARBLogger was designed to provide minute-based, digital data recording and alerts for a variety of instruments. AQSB staff can configure CARBLogger by following the instructions on the text based user interface provided by the program. **Care should be taken to install the proper CARBLogger driver for the instrument you are using.** For additional questions or concerns, please contact the Operation and Data Support Section.

4.0 CALIBRATION INFORMATION

4.1 Calibration Introduction:

A calibration is a procedure for aligning or checking the output of an instrument to a known "true" standard. To ensure the quality of the data provided by the 400E or T400, in general the analyzer must be calibrated in accordance with recommendations stated in this SOP.

The AQSB utilizes two forms of field multi-point calibrations, nominally referred to as "AS-IS" and "Final" calibrations. An "AS-IS" calibration is performed initially to evaluate the instruments accuracy. No adjustments, modifications or repairs are made to the instrument prior to the "AS-IS" calibration. This calibration verifies instrument accuracy of the recently generated data; usually back to the previous calibration check. A "Final" calibration is performed after an instrument has failed an "AS-IS" calibration or has undergone major maintenance or repair. Typically an "AS-IS" calibration will determine if the instrument warrants further maintenance. If it does then an adjustment/repair, followed by a "Final" calibration is performed. This section of the SOP provides a list of the necessary equipment and the correct procedures to accurately calibrate the analyzer.

4.2 Calibration Overview:

Test concentrations for ozone must be obtained in accordance with UV photometric calibration procedures listed in 40 CFR 50 Appendix D (Measurement Principle and Calibration Procedure for the Measurement of Ozone in the Atmosphere) or by means of a certified ozone transfer standard. The transfer standard must be traceable to a primary ultraviolet photometer and recertified as needed.

It is recommended that the test concentration for ozone using an ozone transfer standard should be delivered directly into the station sample manifold.

4.3 Calibration Apparatus*:*

1. Certified ozone/gas transfer standard.
2. One-quarter inch outside diameter (O.D.) Teflon tubing for air flow connections
3. Zero air supply
4. Calibrated laminar flow device for measuring air flow (mass flow meter)
5. Calibration report forms
6. Conditioned calibration line if using calibrator for ozone source.

5.0 CALIBRATION PROCEDURES

To ensure the quality of the data collected within the ARB's air monitoring network, **ALL** instruments used in the network must be calibrated

- during initial field installation and every six months thereafter,
- following physical relocation,
- after any major maintenance or repair,
- after an instrument has drifted outside of acceptable QC limits,

Multi-point instrument calibrations at all stations within the ARB network shall be performed in a consistent manner, so that all network monitoring stations in all areas of the State are calibrated in a similar fashion. **Instruments must be calibrated in accordance with the appropriate AQSB SOP and/or appropriate instruction manual.**

Multi-point instrument calibrations should be conducted such that all instruments are challenged at a minimum of four (4) different gas concentrations in addition to a pre and post zero check. The high calibration point should be at a level approximately 80% of the instrument's full analog scale and the low calibration point should meet the requirements of 40 CFR Part 58 App A Sec 3.2.

In general, routine instrument multi-point calibrations should be conducted during the spring and fall months. This assures that instrument calibrations bracket the beginning and end of the high ozone season.

5.1 Calibration at Altitude

Calibrating the instrument at altitude requires no special adjustments because it compensates for changes in temperature and pressure. Prior to calibration, verify the operation of the internal pressure transducers in the instrument by recording the values of temperature and pressure from the instrument and from a certified transfer standard for one point.

NOTE: The air monitoring stations data acquisition system (DAS) is used for primary data recording, therefore the stations DAS data values should be used for calibration calculations in lieu of the analyzer display readings.

5.2 AS-IS Calibration:

AS-IS instrument calibrations should be made prior to making any analyzer repairs or adjustments. It is acceptable to change the particulate inlet filter prior to an AS-IS calibration. Prior to beginning AS-IS calibration, disable the appropriate DAS channels on the station data logger and record the instruments diagnostic parameters.

1. When setting up the certified ozone/gas transfer standard to generate the test concentrations for ozone, configure the transfer standard so that the ozone generated is measured by the transfer standards UV photometer. Using one-quarter inch (1/4" O.D.) Teflon tube, connect a zero air source and exhaust lines to the transfer standard. Connect a 1/4" O.D. Teflon line from the transfer standard's output port to the stations sample manifold.

   Energize the zero air system and configure the transfer standard so that zero air is flowing through the calibration assembly.

2. Allow both the transfer standard and the analyzer being calibrated to warm-up for at least one hour. All instrument covers should be on during the calibration, as the calibration is dependent upon the internal temperature of the analyzer. The transfer standard diagnostic values should be stable; showing no upward or downward trend when operating temperature has been reached.

3. Record the station information, analyzer identification numbers, analyzer settings, calibration equipment information and any other pertinent information on the calibration data sheet (Appendix B).

4. Obtain the instruments internal slope and offset from the instrument's display following the steps detailed in the instruction manual. Record the AS-IS slope and offset on the calibration data sheet. Confirm that the values are the same as at the end of the previous calibration. If not, investigate when and why these values have changed prior to beginning calibration.

5. Adjust the sample air flow rate of the transfer standard to approximately 5.0 SLPM as calculated from the transfer flow standard reading and the transfer flow standard certificate values. Measure and record the AS-IS sample air flow rate of the instrument. Connect an 18 inch long Teflon line (1/4" O.D.) to the vent port of the transfer standard and measure the vent flow. The vent flow should be greater than 0.5 LPM.

6. Allow the analyzer and transfer standard to sample zero air. When a stable zero reading is reached (0 ± 3 ppb) and the instrument stability test function

(a measure of the standard deviation taken from the last three data points) is less than 1 ppb, record 3 consecutive DAS display values, recorded approximately one minute apart, with the respective columns labeled "pre-zero" on the calibration data sheet. Record the average strip chart and ozone zero reading in the space provided.

7. Set the transfer standard to produce a Span ozone concentration of approximately 80% of full scale analog output range (400 ppb) of the analyzer being calibrated as read by the transfer standard.

8. When the stability test function is less than 1 ppb, record three consecutive DAS values approximately one minute apart in the columns labeled "1st pt" for each analyzer. Calculate the sum and average of the three numbers and record the value on the calibration data sheet in the appropriate blocks. Record the average strip chart recorder and instrument span readings in the appropriate space.

9. Record data for the data points after adjusting the ozone transfer standard output to approximately 250, 125, and 50 ppb when stability readings are less than 1 ppb. Calculate and record the sum and average readings.

10. Repeat step 6 and record the value on the column marked "post- zero". Average the "pre-zero" and "post-zero" readings and use this value as the zero correction.

11. Calculate corrected averages for the transfer standard analyzer using the formula:

    Corrected Average (Transfer Standard) = (Average Reading - Zero Correction) x True Ozone Correction Factor

12. Calculate the summation of corrected averages for the transfer standard (S1) by adding the corrected averages for points 1, 2, and 3.

13. Calculate the corrected averages of the instrument being calibrated using the formula:

    Corrected Average = Average Reading - Zero Correction

14. These values should correspond to the analyzer's DAS display. If not, check the calibration of the recording device before making adjustments to the analyzer.

15. Calculate the summation of corrected averages for the instrument being calibrated (S2) by adding the corrected averages for points 1, 2, and 3.

16. Calculate the average percent difference from true ozone:

$$Overall\%\,Accuracy = \left(\frac{S2 - S1}{S1}\right) * 100$$

    If the Overall % Accuracy is more than ± 2% or 3 ppb (whichever is greater), **or** if the ozone scrubber is replaced, the analyzer must undergo a final calibration.

17. Using a best fit linear regression, calculate the slope (m) and intercept (b) equation of the calibration line:

    Where x = true concentration
    y = analyzer response

18. Calculate the percent change from the previous calibration:

    Percent change from the previous calibration =
    ABS[((New Slope - Old Slope)/(Old Slope))] x 100

19. Record the calibration data on the Calibration Report (See References).

5.3 Final Calibration:

As previously stated a Final calibration is conducted when an instrument fails an AS-IS calibration. After performing the necessary maintenance or instrument repairs, conduct a final calibration as follows:

1. Challenge the instrument with zero air until the reading stabilizes (not more than $\pm$ 2 ppb over a 5 minute time period).

   NOTE: IF THE ANALYZER FAILS TO STABILIZE WHILE SAMPLING ZERO AIR, IT WILL BE IMPOSSIBLE TO ENTER ZERO AND IT WILL BE NECESSARY TO REFER TO THE TROUBLESHOOTING SECTION OF THE INSTRUCTION MANUAL.

2. Perform a zero alignment on the instrument by following the steps in the relevant instruction manual. For the 400E, refer to Section 3.3.2 “Perform the Zero/Span Calibration Procedure”. For the T400, refer to Section 3.7.2.3 “Initial Zero/Span Calibration Procedure”. The instrument should now be zeroed, but the blinking cal light indicates that data is not being sent out. This status will last for approximately 5 minutes.

3. Challenge the instrument with a span level of ozone. This level should be approximately 80% of full scale analog output range (400 ppb) as measured by the UV photometer. Allow the instrument to sample until a stable reading is achieved.

4. When the span level is stable, SPAN the instrument by performing the steps in the “Dynamic zero/span adjustment” section of the appropriate instruction manual.

5. Obtain the instrument internal slope and offset from the instrument front display following the steps in the instruction manual. Record the final slope and offset on the Calibration Data Sheet (See References).

6. Return to Section 5.2 of this document, step 6 to complete the remaining steps of the final calibration. If the analyzer cannot be properly calibrated, refer to the instrument Instruction Manual for assistance in troubleshooting and repairing the analyzer.

5.4 Internal Ozone Generator Calibration:

The ozone generator calibration (O3 Gen Cal) is used to calibrate the internal ozone generator output to match its generator lamp drive voltage. The lamp drive voltages and corresponding ozone levels produced are stored in an on-board lookup table which is used for future ozone generation tasks. The 400E and T400 IZS instruments measure the ozone generator lamp voltages and ozone concentration at five different levels. During the calibration process the screen will display the percent completed, taking approximately one hour to complete.

AQSB standard configuration indicates that the auto-calibration low span target value should be set for 70 ppb and the high span auto-calibration target value should be set for 320 ppb. Refer to the 400E instruction manual, section 7.4 “Manual Zero / Span (IZS) Calibration with Zero/Span Valve Option Installed” to set the IZS calibration parameters. Analogous documentation exists in the T400 instruction manual, section 3.8.4 “Initial Calibration and Conditioning of T400 Analyzers with the IZS Option Installed”. Also, ensure that analyzers utilizing the IZS feedback option have their feedback mode set to *Ref*. If the IZS ozone concentration displays some fixed value higher or lower than 70 and 320, you may adjust these settings until the resulting display matches the targeted value.

At a minimum, the O3 Gen calibration should be performed following any change or rebuild of the sample pump, any adjustment of the flow rate, replacement of the photometer or O3 generator lamp, or any significant instrument repair or adjustment is made. **It is recommended to conduct an ozone generator calibration each time the instrument is calibrated (either AS-IS or Final).**

1. From the front panel of the instrument, choose *setup*, *more*, followed by *diag*.
2. Ensure that the password reads *929,* and choose *enter*.
3. Choose the *next* entry until obtaining the *ozone generator calibrator* menu item.
4. Choose enter and wait for approximately fifty minutes. After completion, choose *exit* several times until arriving back at the main menu.

Immediately following an O3 generator calibration, review nightly auto-calibration data and record the average of the next three precision and span values to determine the target values for precision, and span calibrations. These will become the new source values for use in determining for O3 precision and span percent from true values.

5.5 Internal Zero/Span Check:

The IZS option allows the 400E/T400 to conduct automated internal zero, precision and/or span calibration checks on regular intervals. After conducting an ozone generator calibration, daily calibration checks can be scheduled. Detailed procedures can be found in the API 400E Instruction Manual, section 7.6 “Automatic Zero/Span Check with Zero/Span Valve Options Installed”. Analogous procedures can be found in the API T400 Instruction Manual, section 9.4 “Automatic Zero/Span Cal/Check (Autocal)”.

Note: No ZERO or SPAN adjustments to the instrument should be made based upon the results of the IZS zero/span checks.

AQSB uses the parameters detailed in the following table for programing automatic IZS calibrations for instruments configured with the IZS option:

Parameter	Value
Mode	Zero-Lo-Hi
Starting Date	The day following the O3 Gen cal
Starting Time	0400 Hours
Delta Days	1
Delta Time	0
Duration	20
Calibrate	No

Table2: Instrument IZS configuration parameters

6.0 ROUTINE SERVICE CHECKS

6.1 General Information:

The following routine service checks are to be performed in accordance with the maintenance schedule (Table 3). Perform the routine service checks at least at the prescribed intervals. **Some site operators may need to perform these checks more frequently.** The AQSB Monthly Quality Control Check Sheet (See References) should be filled in weekly and submitted monthly to the station operator's supervisor. The station operator must keep a copy of the Monthly QC Check Sheet in the air monitoring station. Detailed routine maintenance procedures can be found in Chapter 11 of the instruction manual.

	Value	Daily*	Weekly	Monthly	Semi-Annual	As Req
Power On	On	X				
Error Flags	None	X				
Check Chart Recorder	None	X				
Record Test Parameters	Record		X			
Change Inlet filter	Clean		X			
Fill out the AQSB QC Form	None		X			
Complete and Submit the AQSB QC Form	None			X		
Perform field calibration	6 months				X	
Adjust photo lamp	< 2500 mV					X
O3 Gen Calibration	None					X

Table3: Maintenance Schedule

*** Daily indicates that for each working day where the site technician visits the station, this check should be performed.**

6.2 Daily (or Each Visit) Checks:

Daily (or each site visit) review instrument diagnostic and concentration data, automated calibration values and chart recorders (if used) for any indication of analyzer malfunction. Review autoQC checks for values being flagged invalid. Check the instruments for any error messages. ***Note: The T400/T400IZS CARBLogger driver clears warning messages, therefore, warning messages will not be displayed on the instrument front panel.***

6.3 Weekly Checks:

Record test parameters on the AQSB QC Form 002 (API 400E/T400) check sheet. Change the particulate filter located inside the instrument.

6.4 Monthly Checks:

Complete and submit the AQSB QC Form 002 (API 400E/T400) check sheet to your immediate supervisor along with station data.

6.5 As Required Checks:

Clean optical chamber and adjust photo lamp when O3 reference value is less than 2500 mV. In the event that this needs to be done, the instrument will require recalibration. Complete an ozone generator calibration upon completion of instrument calibrations, flow adjustments, pump changes or photometer and ozone generator lamp replacements.

6.6 Semiannual Checks:

Perform instrument multi-point calibration using the calibration sheet.

7.0 MAINTENANCE AND PROCEDURES

7.1 General Information:

The instrument is designed to operate unattended for long periods of time. Other than the routine service checks outlined in section 6.0 of this SOP, the 400E/T400 need very little maintenance. However, preventative maintenance requirements may vary from instrument to instrument, thus operators should refer to the instrument instruction manual to become familiar with maintenance requirements.

If station operators cannot repair an instrument using procedures stated in the instruction manual, contact the Operation Data Support Sections Instrument Laboratory.

8.0 TROUBLESHOOTING

8.1 General Information:

The API 400E and API T400 have been designed to rapidly detect possible problems and allow for their quick evaluation and repair. During operation, the analyzer continuously performs self-test diagnostics and provides the ability to monitor the key operating parameters of the instrument without disturbing monitoring operations. If being run with CARBLogger, any diagnostic parameters which drift outside of the acceptable range will cause and alert to be emailed to the site operator.

Should instrument malfunctions occur and troubleshooting is required to determine the problem, operators should refer to Chapter 11, “Troubleshooting and Repair Procedures” in the 400E/T400 instruction manual.

REFERENCES

- AQSB QC Form 002 (API 400E/T400) Check Sheet
  http://arb.ca.gov/airwebmanual/amwmn.php?c=0&t=chk
- Primary Quality Assurance Organization (PQAO) website
  http://www.arb.ca.gov/aaqm/qa/qa.htm