

**STANDARD OPERATING PROCEDURES**  
**TELEDYNE – ADVANCED POLLUTION INSTRUMENTATION**  
**MODEL 100AS TRACE LEVEL**  
**SULFUR DIOXIDE INSTRUMENT**  
**Version 2.0**



## **Section 1.1 Acknowledgments**

This Standard Operating Procedure (SOP) for Sulfur Dioxide – Trace Level is the product of EPA’s Office of Air Quality, Planning and Standards. The following individuals are acknowledged for their contributions.

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**STANDARD OPERATING PROCEDURES  
TELEDYNE – ADVANCED POLLUTION INSTRUMENTATION  
MODEL 100AS TRACE LEVEL SULFUR DIOXIDE INSTRUMENT**

### 3.0 PROCEDURES

#### 3.1 Scope and Applicability

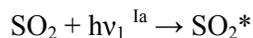
Sulfur Dioxide (SO<sub>2</sub>) is a colorless, nonflammable gas that has a strong suffocating odor. SO<sub>2</sub> originates from fuel containing sulfur (mainly coal and oil) burned at power plants and during metal smelting and other industrial processes. High levels of SO<sub>2</sub> can result in temporary breathing impairment for asthmatic children and adults who are active outdoors. Long-term exposure to high levels of SO<sub>2</sub>, in the presence of high levels of particulate matter, may aggravate existing cardiovascular disease and respiratory illness.

The Teledyne-Advanced Pollution Instrumentation (T-API) model 100AS combines proven detection technology for the determination of trace levels of SO<sub>2</sub>. This SOP will detail the operation, preventive maintenance, cautions and health warnings.

The Detection Limit (DL) for a non-trace level SO<sub>2</sub> analyzer is 10 parts per billion (ppb) (*Code of Federal Regulations*, Volume 40, Part 53.23c, or, in the shortened format used hereafter, 40 CFR 53.23c)<sup>3</sup>. However, the T-API model 100AS has an estimated DL of 100 parts per trillion (ppt), which is accomplished by an increased detector sensitivity, as well as increasing the length of the standard instrument's optics bench. This document will discuss the Trace Level (TL) operating procedures in detail.

#### 3.2 Summary of Method

The Model 100AS Trace Level operating principle is based on measuring the emitted fluorescence of SO<sub>2</sub> produced by the absorption of ultraviolet (UV) light. The UV lamp emits ultraviolet radiation which passes through a 214 nm band pass filter, excites the SO<sub>2</sub> molecules, producing fluorescence which is measured by a photomultiplier tube (PMT) with a second UV band pass filter. SO<sub>2</sub> absorbs in the 190 nm – 230 nm region free of quenching by air and relatively free of other interferences. The equations describing the above reactions are as follows:



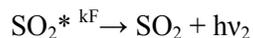
The excitation ultraviolet light at any point in the system is given by:

$$I_a = I_0[1 - \exp(-ax(\text{SO}_2))]$$

where:

I<sub>0</sub> = UV light intensity,  
a = the absorption coefficient of SO<sub>2</sub>  
x = the path length  
SO<sub>2</sub> = concentration of SO<sub>2</sub>

The excited SO<sub>2</sub> decays back to the ground state emitting a characteristic fluorescence:



When the SO<sub>2</sub> concentration is relatively low, the path length of exciting light is short and the background is air, the above expression reduces to:

$$F = k(\text{SO}_2)$$

where:

F = amount of fluorescent light given off

k = rate at which SO<sub>2</sub>\* decays into SO<sub>2</sub>

The 100AS instrument operates in the following fashion:

1. In sample mode, the sample is drawn into the analyzer through the SAMPLE bulkhead. The sample flows through a hydrocarbon “kicker,” which operates on a selective permeation principle, allowing only hydrocarbon molecules to pass through the tube wall. The driving force for the hydrocarbon removal is the differential partial pressure across the wall. This differential pressure is produced within the instrument by passing the sample gas through a capillary tube to reduce its pressure and feeding it into the shell side of the hydrocarbon kicker. The SO<sub>2</sub> molecules pass through the hydrocarbon “kicker” unaffected.
2. The sample flows into the fluorescence chamber, where UV light is focused through a narrow 214 nm band pass filter into the reaction chamber, exciting the SO<sub>2</sub> molecules; the molecules then give off their characteristic decay radiation. A second filter allows only the decay radiation to fall on the PMT. The PMT transfers the light energy into the electrical signal which is directly proportional to the light energy in the sample stream being analyzed. The preamp board converts this signal into a voltage which is further conditioned by the signal processing electronics.
3. The UV light source is measured by a UV detector. Software calculates the ratio of the PMT output and the UV detector in order to compensate for variations in the UV light energy. Stray light is the background light produced with zero ppb SO<sub>2</sub>. Once this background light is subtracted, the CPU will convert this electrical signal into the SO<sub>2</sub> concentration which is directly proportional to the number of SO<sub>2</sub> molecules.

### 3.3 Definitions

Here are some key terms for this method.

**Table 3-1, Definitions of Key Terms**

<u>Term</u>	<u>Definition</u>
DAS	Data acquisition system. Used for automatic collection and recording of Sulfur Dioxide concentrations.
Interferences	Physical or chemical entities that cause Sulfur Dioxide measurements to be higher (positive) or lower (negative) than they would be without the entity. (See Section 3.6).

### 3.4 Health and Safety Warnings

To prevent personal injury, please heed these warnings concerning the T-API 100AS.

1. Always use a third ground wire on all instruments.
2. Always unplug the analyzer when servicing or replacing parts.
3. If it is mandatory to work inside an analyzer while it is in operation, use extreme caution to avoid contact with high voltages. The analyzer has a 110 volt Volts Alternating Current (VAC) power

- supply. Refer to the manufacturer's instruction manual and know the precise locations of the VAC components before working on the instrument.
4. Avoid electrical contact with jewelry. Remove rings, watches, bracelets, and necklaces to prevent electrical burns.

### 3.5 Safety Precautions

To avoid damaging internal components of the T-API 100AS, the following precautions should be taken:

1. Wear an anti-static wrist strap that is properly connected to earth ground (note that when the analyzer is unplugged, the chassis is not at earth ground);
2. If an anti-static wrist strap is not available, be sure to touch a grounded metal object before touching any internal components;
3. Handle all printed circuit boards by the edge;
4. Carefully observe the instructions in each procedure specified in Section 8 of the manual;
5. Normally, if Teflon™ filters are used in the sample train, cleaning the optical bench will not be required. However, in the event that the bench is cleaned, be careful to avoid damaging the interior of the sample chamber. Use extreme caution when cleaning or servicing the sample chamber(s). In addition the mirrors are very fragile; avoid dropping the instrument. This may damage, misalign or crack the mirrors and cause expensive repairs;
6. Keep the interior of the analyzer clean;
7. Inspect the system regularly for structural integrity;
8. To prevent major problems with leaks, make sure that all sampling lines are reconnected after required checks and before leaving the site;
9. Inspect tubing for cracks and leaks;
10. It is recommended that the analyzer be leak checked after replacement of any pneumatic parts;
11. If cylinders are used in tandem with Mass Flow Control (MFC) calibrators, use and transport is a major concern. Gas cylinders can sometimes contain pressures as high as 2000 pounds per square inch (psi). Handling of cylinders must be done in a safe manner. If a cylinder is accidentally dropped and valve breaks off, the cylinder can become explosive or a projectile;
12. Transportation of cylinders is regulated by the Department of Transportation (DOT). It is strongly recommended that all agencies contact the DOT or Highway Patrol to learn the most recent regulations concerning transport of cylinders;
13. It is possible (and practical) to blend other compounds with SO<sub>2</sub>. If this is the case, it is recommended that MSDS for all compounds be made available to all staff that use and handle the cylinders or permeation tubes; and
14. Shipping of cylinders is governed by the DOT. Contact the DOT or your local courier about the proper procedures and materials needed to ship high-pressure cylinders.

### 3.6 Interferences

The most common source of interference is from other gases that fluoresce in a similar fashion to SO<sub>2</sub> when exposed to UV light. The most significant of these is a class of hydrocarbons called polynuclear aromatic hydrocarbons (PAH); of which naphthalene is a prominent example. Xylene is another hydrocarbon that can cause interference. These hydrocarbons are removed via the hydrocarbon “kicker” (see section 3.2 for explanation on the hydrocarbon “kicker”).

Nitrogen oxide (NO) fluoresces in a spectral range close to SO<sub>2</sub>. Interference from NO is addressed by the presence of the band pass filter, which allows only the wavelengths emitted by the excited SO molecules to reach the PMT.

### 3.7 Personnel Qualifications

The person(s) chosen to operate the T-API 100AS should have a minimum of qualifications. The understanding of basic chemistry and electronics are a must. The understanding of digital circuitry is helpful, but not required. Also, courses in data processing and validation are also welcome.

### 3.8 Equipment and Supplies

**Monitoring Apparatus:** The T-API 100AS combines proven detection technology with advanced diagnostics for greater flexibility and reliability. A diagram of the T-API 100AS instrument is described in Figure 3-1. The three main components are:

- Pneumatic System: Consists of sample inlet line, particulate filter, reaction chamber, flowmeter, and pump, all used to bring ambient air samples to the analyzer inlet.
- Analytical System: This portion of the instrument consists of the UV lamp, mirrors, photo-detector and band pass filter.
- Electronic Hardware: The part of the analyzer that generally requires little or no maintenance. If the T-API 100AS is operated above the manufacturer's recommended temperature limit, however, individual integrated chips can fail and cause problems with data storage or retrieval.

Other apparatus and equipment includes the following.

**Instrument Shelter:** A shelter is required to protect the analyzer from precipitation and adverse weather conditions, maintain operating temperature within the analyzer's temperature range requirements, and provide security and electrical power. The recommended shelter temperature range is 20-30°C.

**Spare Parts and Incidental Supplies:** See the T-API 100AS manual, Section 10, for a list of recommended spare parts.

**Calibration System:** A system that creates concentrations of SO<sub>2</sub> of known quality is necessary for establishing traceability. This is described in detail in the Environics Series 9100 Computerized Ambient Monitoring Calibration System SOP. Please reference this document.

**DAS:** A data acquisition system is necessary for storage of ambient and ancillary data collected by the T-API 100AS. This is detailed in the "Data Acquisition and Management SOP."

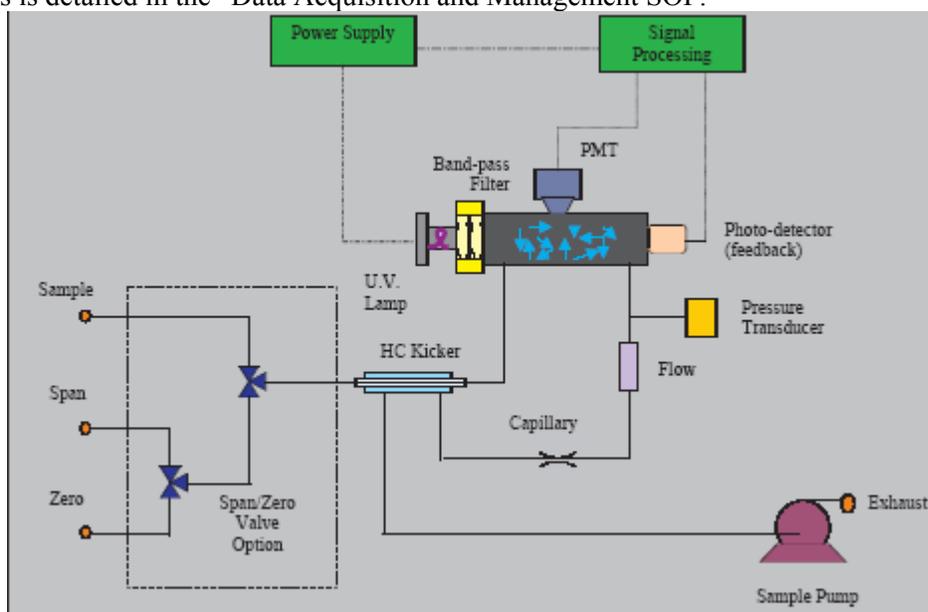


Figure 3-1, T-API Model 100AS Flow Diagram

**Wiring, Tubing and Fittings:** Teflon™, stainless steel, and borosilicate glass are inert materials that should be used exclusively throughout the intake system. Stainless steel tubing should be avoided because it is expensive, hard to clean, and can develop micro-cracks that are difficult to detect. Teflon™ tubing is the best choice for the connection between the intake manifold and the T-API 100AS inlet. Examine and discard if particulate matter collects in the tubing. All fittings and ferrules should be made of Teflon™ or stainless steel. Connection wiring to the DAS should be shielded two strand wire or RS-232 cables for digital connections.

**Reagents and Standard:** The T-API 100AS does not require any reagents since the instrument uses photometry to analyze for sulfur dioxide. All standards for the SO<sub>2</sub> method can be obtained in compressed cylinders and must be NIST traceable. Please see the EnviroNics Series 9100 Computerized Ambient Monitoring Calibration System SOP.

### 3.9 Procedure

**3.9.1 Sample Collection:** Sampling for trace level SO<sub>2</sub> is performed by drawing ambient air through a sample manifold directly into the analyzer continuously via a vacuum pump. All inlet materials must be constructed from Teflon™, or borosilicate glass. The siting criteria for SO<sub>2</sub> Trace Level instruments is detailed in 40 CFR 58, appendix A<sup>4</sup>.

**3.9.2 Sample Handling and Preservation:** SO<sub>2</sub> samples receive no special preparation prior to analysis. Therefore this SOP does not need a section on Sample Handling and Preservation.

### 3.9.3 Instrument Operation , Startup and Maintenance

This section discusses startup, operation and maintenance of the T-API 100AS. The T-API 100AS has a digital front panel screen with pushbuttons below. This allows the user to check functions, switch operating parameters, and adjust zero and span. Recommend at start-up of instrument and after a warm-up period for the instrument, run through the menu items and record the current settings. **It is extremely important that the user familiarize themselves with the menus available. Inadvertently changing parameters within the analyzer can damage the instrument and possibly invalidate data as well. Please reference the T-API 100AS owner's manual and read it carefully before adjusting any parameters that are set by the factory.**

#### 3.9.3.1 Start up

1. Before the instrument is operated, inspect the instrument for any damage. If damage is observed to the shipping box or the instrument, contact your shipping personnel.
2. Carefully remove the cover and check for internal damage. Please see Section 2 of the T-API 100AS manual.
3. Remove the red shipping screws that hold down the internal bench and parts. See Section 2 of the T-API 100AS manual.
4. Once you have removed the shipping screws and performed your inspection, replace the cover.
5. Plug the instrument into a grounded power strip that has surge protection. It is also advisable to purchase an Uninterrupted Power Supply (UPS). An UPS will protect the T-API 100AS from power surges and keep the unit operating until an operator can shut it down.
6. Check to see that the 100AS has enough clearance so that it gets proper ventilation. Check the T-API 100AS manual, Section 2.
7. Connect the output of the analog to a DAS via shielded two wire cable. Please see EPA SOP on "Data Management" for details.
8. Connect the digital RS-232 port to an appropriate cable and connect it to the DAS. Please see EPA SOP on "Data Management" for further details.
9. Connect the sample inlet port to the station intake manifold.
10. Press the power rocker switch to "ON."

### 3.9.3.2 Operation and Range Setting

1. The exhaust fan will start and the display will come on. The Central Processing Unit (CPU) will boot the system and load the firmware. You will see in the upper right hand corner that the fault warning light will be flashing red. This is letting you know that the analyzer has been off.
2. To clear the fault warning, press the "CLR" button below the display. This will clear the warning and the sample green light will flash.
3. Once the red fault light is cleared, the operator will see the main menu. At this time, the time of day and date must be verified and reset if necessary.
4. From main menu press the toggle button under the "SETUP" label.
5. In this menu, you will see "8 1 8" on the bottom of the display. This is the default password. In addition, you will see on the top of the display the words "ENTER SETUP PASS: 818."
6. At this time, press the toggle under "ENTR."
7. This will bring up the "PRIMARY SETUP MENU" screen.
8. In this menu, press the toggle button under "CLK."
9. In the next menu, press the "TIME" toggle switch.
10. In the next menu, you will see the time above 3 or 4 toggle switches. Adjust these toggles so that the time is correct. Press the "ENTR" toggle switch.
11. This returns you to the "TIME OF DAY CLOCK" menu. Press the toggle switch under "DATE."
12. This will put you in the date menu. You should see the day (digits), month and year (digits) above 5 toggle switches. Adjust these toggles until the correct date is obtained. Press the "ENTR" toggle switch. Press the "EXIT" toggle switch twice. This returns you to the main menu.
13. The range should be illustrated in the top middle of the main menu. This value should be set to 100 ppb. If it is not set to this range, then it must be reset.
14. To change the range of the instrument, press the toggle under "SETUP." If the password is correct, then press "ENTR."
15. In this menu, you will see "8 1 8" on the bottom of the display. This is the default password. In addition, you will see on the top of the display the words "ENTER SETUP PASS: 818."
16. At this time, press the toggle under "ENTR."
17. This will bring up the "PRIMARY SETUP MENU" screen.
18. Press the toggle switch under the "RNGE."
19. This is the "RANGE CONTROL MENU." Press the toggle switch under the "UNIT."
20. This display will show the range options. Press the toggle under the "PPB." Press the toggle under the "ENTR."
21. This will put you into the "RANGE CONTROL MENU." Press the toggle switch under the "SET."
22. This display will show the full scale range value. Press the toggles under the digits to adjust the instrument to the full scale value desired. Press the toggle under the "ENTR."
23. Press the "EXIT" toggle switch twice.
24. The instrument is now set with the appropriate time, date and full scale range.
25. It is recommended that you allow the T-API 100AS 24 hours before you attempt function checks or calibration.

If your DAS does not have RS-232 capabilities, then proceed to the next section, Diagnostic Checks/Manual Checks. If you have connected the T-API 100AS to a computer or DAS, review the Diagnostic Check from your computer screen. T-API offers API.COM, a computer program that allows the operator to log the diagnostic data that is collected by the T-API 100AS CPU. Several DAS manufacturers offer this type of software as well.

### 3.9.3.3 Diagnostic Checks/Manual Checks

To determine whether the T-API 100AS is working properly, the field operators should perform the Diagnostic Checks every time they visit the monitoring station. It is good practice for the operator to check these Diagnostic Checks either by the computer or manually. Below are instructions on how to

perform this manually. Please note that the T-API 100AS has set upper and lower ranges for some of these Diagnostic checks. Please reference the owner's manual for these ranges.

1. If you observe the display, it should show "Sample" in the left hand corner, "Range" in the middle of the display and "SO<sub>2</sub>= XX.X." Below this line there should be one line that read "<TST", "TST>", "CAL" and "SETUP."
2. There is a series of toggle switches/ buttons below the display. These correspond to the bottom row of the display.
3. If you press the button below the left hand "<TST," you will toggle the display into function check tree in one direction. The button under the "TST>," will allow you to access the function check tree in the opposite direction.
4. Toggle through the function check tree. The following table illustrates the functions that should be recorded. Please see the T-API 100AS manual for more details. A maintenance checklist is attached in Appendix A of this SOP.

**Table 3-2 Diagnostic Checks**

Check	Explanation
Range	The full scale limit at which the reporting range of the instrument's analog outputs are currently set.
Stability	The standard deviation of SO <sub>2</sub> concentrations for the last 25 readings.
Pressure	The current pressure of the sample gas as it enters the sample chamber.
Sample flow	The flow rate of the sample gas through the sample chamber.
PMT	The raw output voltage of the PMT.
Norm PMT	The output voltage of the PMT after normalization.
UV lamp	The output voltage of the UV reference detector.
Lamp ratio	The current output of the UV reference detector divided by the reading stored in the CPU's memory from the last time a UV lamp calibration was performed.
Stray light	The offset due to stray light recorded by the CPU during the last zero-point calibration.
Dark PMT	The PMT output reading recorded the last time the UV source lamp shutter was closed.
Dark lamp	The UV reference detector output reading recorded the last time the UV source lamp shutter was closed.
Slope	The sensitivity of the instrument as calculated during the last calibration.
Offset	The overall offset of the instrument as calculated during the last calibration.
HVPS	The PMT high voltage power supply.
DCPS	The composite of the +5 and $\pm$ 15 VDC supplies.
RCell temp	The current temperature of the sample chamber.
Box temp	The ambient temperature of the inside of the analyzer case.
PMT temp	The current temperature of the PMT.

Once the Diagnostic checks have been established and recorded for the T-API100AS, it is time to calibrate the instrument. Please refer to section 3.9.4 of this SOP.

### 3.9.3.4 Preventive Maintenance

Preventive maintenance should **prevent** down-time and data loss. Table 3.3 lists the preventive maintenance items that are listed in the T-API 100AS manual, Section 8.

**Table 3-3 Preventive Maintenance Schedule for the 100AS**

<b>Item</b>	<b>Schedule</b>
Visual inspection and cleaning	Bi-annually
Sample particulate filter inspection	Weekly
TEST Functions	Weekly
Perform Level I calibration	Daily
Pneumatic sub-system	Annually, or after repairs
PMT sensor hardware calibration	On PMT or preamp changes
Sample chamber windows and filters	As necessary
Leak check	Annually
Pump diaphragm	Change annually
Factory calibration	Annually, or after repairs

### **3.9.3.5 Instrument Troubleshooting**

The T-API 100AS manual has an excellent troubleshooting guide in Section 9.

### **3.9.4 Calibration and Standardization**

The calibration of the T-API 100AS is performed by comparing the output of the instrument against standardized gases of known quality. Generation of these gases is detailed in the Environics Series 9100 Computerized Ambient Monitoring Calibration System SOP. This section will detail how to adjust the T-API 100AS to the standardized gases. Once the calibration has been performed, compare the response of your DAS to the calculated “source” value. If this is outside of +/-10%, then adjust the instrument response as detailed in the next sections.

#### **3.9.4.1 Adjustment to Zero Air**

Before running the zero air through the T-API 100AS, ensure that the zero air is free from contaminants. One way to determine if the zero air is free from contaminants is through the use of multiple zero air sources, and determining which source produces the lowest response.<sup>5</sup>

To adjust the output of the T-API 100AS to zero air, perform the following:

1. Allow the instrument to sample zero air from a manifold that is at or near atmospheric pressure for a minimum of 15 minutes.
2. On the bottom of the front panel screen there is a toggle switch/ button that is beneath the “CAL” label. Press this button.
3. This next screen is the “M-P CAL” screen. In this screen press the button below the “ZERO” label.
4. The next screen will show an “ENTR, SPAN and CONC” above the toggle switches on the bottom of the panel. Press the button below the “ENTR” label. This operation changes the calculation equation and zeros the instrument.

Press the button below the “EXIT” label. This returns the operator to the main “SETUP” menu.

### 3.9.4.2 Adjustment to Calibration Gas

It is desirable, but not essential, to calibrate the T-API 100AS at low SO<sub>2</sub> levels (typically, less than 20 ppb). However, fluorescence SO<sub>2</sub> analyzers have been shown to be inherently linear over a wide dynamic range. If low concentration SO<sub>2</sub> calibration cylinders (less than 50 ppm) are used, there is the potential for contamination by back diffusion from a poorly purged regulator. Contamination with even a small amount of moisture from back diffusion can cause the SO<sub>2</sub> concentration to become unstable; the lower the cylinder concentration, the more susceptible it is to any contamination from “abuse” in the field<sup>5</sup>. The best way to ensure low concentration cylinders are not contaminated by back diffusion is to make sure whenever the cylinder valve is open, there is gas flow out of the cylinder.

To adjust the output of the T-API 100AS to NIST traceable calibration gas, perform the following:

1. Switch the calibration unit to generate a known concentration of SO<sub>2</sub>. Allow the instrument to sample calibration gas from a manifold that is at near atmospheric pressure for a minimum of 15 minutes.
2. On the bottom of the front panel screen of the main menu there is a button that is beneath the “CAL” label. Press this button.
3. This next screen is the “M-P CAL” screen. The next screen will show an “ENTR, SPAN and CONC” above the toggle switches on the bottom of the panel. Press the button below the “CONC” label. On the bottom line, there will be digits below each toggle button. In order to change the concentration, toggle each digit before and after the decimal place to get the concentration that is being generated in the manifold by the calibrator. At this time, press the “ENTR.”
4. At this time, press the toggle below the “SPAN” switch.
5. This operation changes the calculation equation and adjusts the slope of the instrument.

Press the button below the “EXIT” label. This returns the operator to the main “SETUP” menu.

### 3.10 Data Analysis and Calculations

Data analysis for this analyzer is detailed in the “Data Acquisition and Management SOP.”

## 4.0 QUALITY CONTROL AND QUALITY ASSURANCE

The following section has brief definitions of the QA/QC indicators. Table 4-1 has the Measurement Quality Objectives (MQOs) of the T-API 100AS. Please note that this section details primarily with the QA indicators. Quality Control for continuous electronic instruments, such as the T-API 100AS consists of performing the diagnostic checks, maintenance and calibrations. These procedures are detailed in sections 3.9.3 and 3.9.4: Instrument Operation, Startup and Maintenance and Calibration and Standardization. Appendix A has an example of a Quality Control and Maintenance Record developed by the EPA for this instrument.

### 4.1 Precision

Precision is defined as the measure of agreement among individual measurements of the same property taken under the same conditions. For SO<sub>2</sub>, this refers to testing the SO<sub>2</sub> analyzer in the field at concentrations between 0.0003 and 0.005 ppm. The test must be performed, at a minimum, once every two weeks. Calculations for Precision can be found in Reference item 3.

## 4.2 Bias

Bias is defined as the degree of agreement between a measured value and the true, expected, or accepted value. Quantitative comparisons are made between the measured value and the true, standard value during audits. Generally, three upscale points and a zero point are compared. Two audit types commonly used for SO<sub>2</sub>, direct comparison and blind, are discussed below. The SOP should discuss plans for each type of audit.

- **Direct Comparison Audits:** An independent audit system is brought to the monitoring location and produces gas concentrations that are assayed by the monitoring station's SO<sub>2</sub> analyzer. In most cases, a person outside of the agency or part of an independent QA group within the agency performs the audit. The responses of the on-site analyzer are then compared against the calculated concentration from the independent audit system and a linear regression is generated
- **Blind Audits:** In blind audits (also called performance evaluation audits); agency staff are sent an audit device, such as the National Performance Evaluation Program (NPEP). The agency staff does not know the SO<sub>2</sub> concentrations produced by the audit equipment. Responses of the on-site analyzer are then compared against those of the generator and a linear regression is calculated.

## 4.3 Representativeness

Representativeness refers to whether the data collected accurately reflect the conditions being measured. It is the data quality indicator most difficult to quantify. Unless the samples are truly representative, the other indicators are meaningless. Since the NCORE Level I and II siting criteria are urban and regional, the trace level SO<sub>2</sub> criteria are the same. Please reference the National Monitoring Strategy<sup>5</sup> for a discussion of NCORE Level II SO<sub>2</sub> monitoring scale.

## 4.4 Completeness

Completeness is defined as the amount of data collected compared to a pre-specified target amount. For SO<sub>2</sub>, EPA requires a minimum completeness of 75% (40 CFR 50, App.H.3). Typical completeness with the T-API 100AS values can approach 90-93%.

## 4.5 Comparability

Comparability is defined as the process of collecting data under conditions that are consistent with those used for other data sets of the same pollutant. The MQOs for a trace level SO<sub>2</sub> instrument are still to be determined. Please see Table 4-1.

## 4.6 Method Detection Limit

The method detection limit (MDL) or detectability refers to the lowest concentration of a substance that can be determined by a given procedure. The T-API 100AS must be able to detect a minimum value of 300 ppt of SO<sub>2</sub>.

**Table 4-1 Measurement Quality Assurance Objectives**

<b>Requirement</b>	<b>Frequency</b>	<b>Acceptance Criteria</b>	<b>Reference</b>	<b>Information or Action</b>
Bias	NCORE, once per year	To be determined.	40 CFR Pt.58	To be determined.
Precision	1 every 2 weeks	Concentration: 0.0003 -0.005 ppm, Coefficient of Variance: To be determined.	40 CFR Pt.58 Appendix A	To be determined.
Completeness	Quarterly, Annually	NCORE, 75%	National Monitoring Strategy.	If under 75%, institute Quality Control Measures
Representativeness	N/A	Neighborhood, Urban or Regional Scale	40 CFR 58	N/A
Comparability	N/A	Must be a Trace Level instrument. See Sections 3.1 and 3.2 of this document.	National Monitoring Strategy.	N/A
Method Detection Limit	N/A	300 ppt	National Monitoring Strategy	Testing is performed at the factory.

**5.0 REFERENCES**

1. Code of Federal Regulations, Title 40, Part 53.23c
2. Code of Federal Regulation, Title 40, Part 58, Appendix A
3. The National Air Monitoring Strategy, Final Draft, 4/29/04,  
<http://www.epa.gov/ttn/amtic/monstratdoc.html>
4. Instruction Manual, T-API Model 100AS Trace Level SO<sub>2</sub> Analyzer.
5. Trace SO<sub>2</sub> Monitoring Guidance for the MANE-VU Regional Aerosol Intensive Network (RAIN) program, Draft (dated March 7, 2005).

**Appendix A**

Environmental Protection Agency  
 Monthly Quality Control and Maintenance Records  
 Teledyne – API 100AS Ultra-Sensitivity SO<sub>2</sub> Analyzer

Site Name/Location \_\_\_\_\_

Technician \_\_\_\_\_

Month/Year \_\_\_\_\_

Serial Number \_\_\_\_\_ Range \_\_\_\_\_

Date Time				Parameters Acceptance Criteria
Range				
Stability				
Pressure				
Sample flow				
PMT				
Norm PMT				
UV lamp				
Lamp ratio				
Stray light				
Dark PMT				
Dark lamp				
Slope				
Offset				
HVPS				
DCPS				
RCell temp				
Box temp				
PMT temp				
Other Tests				
ETest				
OTest				

Date	Comments and Notes

**Figure A-1 T-API 100AS Quality Control and Maintenance Record**