South Coast Air Quality Management District
Science and Technology Advancement

Monitoring and Analysis Division
Atmospheric Measurements Branch

STANDARD OPERATING PROCEDURE

FOR

Operations of API/Teledyne 400E Ozone Analyzer

SOP00058
Version 1.1
December 2012

PREPARATION, REVIEWS AND APPROVALS

Standard Operating Procedure for

Standard Operating Procedure for API 400E Ozone Instrument

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REVISION HISTORY

Standard Operating Procedure for API 400E Ozone Instrument

Version	Date
1.0	January 07, 2010
1.1	December 06, 2012

REVISION CHANGES FROM PREVIOUS VERSION

Standard Operating Procedure for API 400E Ozone Instrument

Section	Revisions
4.3	API 200E NO/NOx changed to API 400E O3

TABLE OF CONTENTS

Standard Operating Procedure for API 400E Ozone Instrument

1 General

1.1 Purpose

The purpose of this Standard Operating Procedure (SOP) is to provide a set of written instructions that document routine maintenance and operation procedures for measurement of the (API) Advanced Pollution Instrumentation, Inc., Model 400E Ozone Analyzer

☞ The AQIS Operator is ultimately responsible for the Air Monitoring Site data quality. If a critical failure is being reported or the analyzer is over the "Validation Tolerance" the **AQIS Operator shall "Disable" the onsite Datalogger immediately**. Consultation with the Senior AQIS can be made after the fact.

1.2 Safety

Air Monitoring Stations have a great many reasons for safety concerns. Please see "Station Safety Manual", SOP's for Specific Instrumentation and Manufacture's Instrument Manuals and Recommendations.

1.3 References

- Teledyne - API MODEL 400E Ozone ANALYZER, Instruction Manual
- **"SOP for General Air Monitoring Station Operations"**

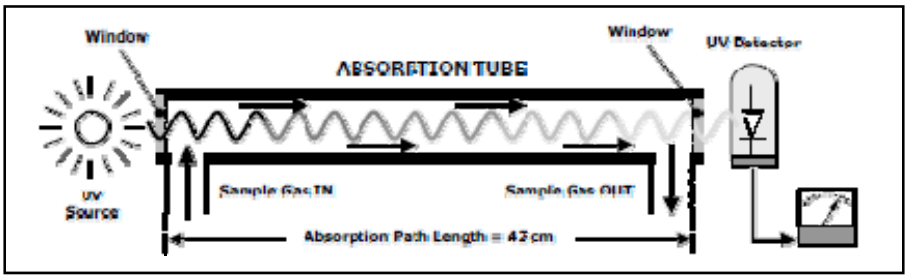
1.4 General Description

Advanced Pollution Instrumentation, Inc., Model 400E Ozone Analyzer is designated as Reference Method Number EQOA-0992-087 as defined in 40 CFR Part 53, when operated under the following conditions:
1. Range: Any range from 100 ppb to 1 ppm.
2. Ambient temperature range of 5 to 40°C.
3. Line voltage range of 105 – 125 and 200 – 240 VAC, 50/60 Hz.
4. With 5-micron PTFE filter element installed in the internal filter assembly.
5. Sample flow of 800 ± 80 cc/min at sea level.
6. Internal or external sample pump.

1.5 Principal Of Operation

The Model 400E Ozone Analyzer is a microprocessor controlled analyzer that determines the concentration of Ozone (O3) in a sample gas drawn through the instrument. It requires that sample and calibration gasses be supplied at ambient atmospheric pressure in order to establish a stable gas flow through the Absorption Tube where the gas' ability to absorb ultraviolet (UV) radiation of a certain wavelength (in this case 254 nm) is measured.

Calibration of the instrument is performed in software and does not require physical adjustments to the instrument. During calibration the microprocessor measures the current state of the UV Sensor output and various other physical parameters of the instrument and stores them in memory. The microprocessor uses these calibration values, the UV absorption measurements made on the Sample Gas in the Absorption Tube along with data regarding the current temperature and pressure of the gas to calculate a final O3 concentration. This concentration value and the original information from which it was calculated are stored in one of the unit's Internal Data Acquisition System (API Model 400E Manual – see Sections 6.11 and 6.12) as well as reported to the user via a Front Panel Display or a variety of digital and analog signal outputs. For more detailed theory of operation see (API Model 400E Manual – see Sections 10.0.0 – 10.5.3)



O3 Absorption Path

2 Sitting and Installation:

2.1 Initial Setup and Installation: Station Operations

- Verify Correct Instrument Installation
- Verify Receipt of Current Instrument Manual
- Verify Receipt of all Instrument Log Books
- Verify Receipt of Instrument Specific Maintenance Sheet

2.2 Physical Instrument Inspection: Station Operations

Verify the Following

- VENTILATION CLEARANCE:
  Whether the analyzer is set up on a bench or installed into an instrument rack, be sure to leave sufficient ventilation clearance.

  Minimum Clearance Area Required
  Back of the instrument 4 in.
  Sides of the instrument 1 in.
  Above and below the instrument 1 in.

- Electrical Connections:
  Verify Clean and professional installation, check for loose wires and connections and proper clearance for instrument inspection and maintenance (Figure 4 & 5) (API Model 400E Manual – Section 3.1.1)
- Pneumatic Connections:
  Verify correct tubing and connection installation, check for clearance and damaged tubing, verify correct inlet/outlet (exhaust) connections (Figure 4 & 5) (API Model 400E Manual – Section 3.1.2)
- Initial Startup:
  Verify initial startup procedure corresponds with factory firmware and calibration (API Model 400E Manual – Section 3.2.0 – 3.2.4)
- Initial Calibration:
  Verify multi-point calibration; verify documentation of calibration in Station Logbook, Instrument Logbook & Monthly Maintenance Sheet
  (API Model 400E Manual – Section 3.3.0)

3 Routine Servicing:

3.1 General Information

Perform the following checks at the intervals specified in the service schedule. The checks may be preformed more frequently but should be preformed at least at the prescribed intervals. Be sure to document all results of maintenance and downtime on the monthly maintenance sheet and downtime log. The Downtime Log, Monthly Maintenance sheet and Maintenance Summary Table are included as attachments.

3.2 Data Validation

Ozone Validation Template

Requirement	Frequency	Acceptance Criteria	Information /Action	
CRITICAL CRITERIA-Ozone				
One Point QC Check Single analyzer	1/ 2 weeks	≤ ±7% (percent difference)	0.01 - 0.10 ppm Relative to routine concentrations 40 CFR Part 58 App A Sec 3.2	
Zero/span check	1/ 2 weeks	Zero drift ≤ ± 2% of full scale Span drift ≤ ± 7 %		

☞ One Point QC Check – *Daily - Required every 2 Weeks*
±07 % = Out of Tolerance – Disable – Report
±05 % = Out of Tolerance Warning – Report

AQIS Operator shall record the current Span readings from the Chessell Video Recorder on the PC/SPAN maintenance sheet. Verify that the readings are within the Acceptance Criteria Range.

Data Validation can be an issue if the Data is outside this range. Perform a visual inspection of all instruments to ensure that they are not damaged and are functioning correctly.

Review the Chessell Video Recorder data for the preceding week to ensure that data appears to follow normal patters and check appropriate box to indicate whether traces are normal on maintenance sheets.

3.3 AM Work Orders

The AQIS Operator shall in the course of duties utilize as explained in the "SOP for General Air Monitoring Station Operations" the "AM Work Order" Procedure.

If a critical failure is being reported or the analyzer is over the "Validation Tolerance" the **AQIS Operator shall "Disable" the on-site Datalogger immediately**. Consultation with the Senior AQIS can be made after the fact.

3.4 Daily* Tasks: Station Operations API 400E O3 Instrument

- Check O3 Instrument Status on Chessell
- Check that instruments in Sample mode
- Check for LED Status (Sample-Green: Cal-Off: Fault-Off: If LED Status Is Other Record in Station Logbook, Instrument Logbook & Monthly Maintenance Sheet & Notify Senior if unable to resolve & Fill Out Downtime Log (Fig 5.1) if necessary
- Record any problems or changes in Station Logbook, Instrument Logbook & Monthly Maintenance Sheet
- Check Sample Instrument Flow is within parameters (Sample Flow 800 ±80cc/min)

*on the day that the operator services the station

3.5 Weekly Tasks: Station Operations API 400E O3 Instruments

- All Checks to be run with Zero Air through gas calibrator for a minimum of 15 minutes: Record downtime in downtime log.
  - Change Filter 5um (Every 2 weeks minimum) & Record
  - Check Clock to ESC (±5 Min)
  - Complete Monthly Maintenance Sheet (Test Keys <>)
    1. Record LED Status (Sample-Green: Cal-Off: Fault-Off: If LED Status Is Other, Record in Station Logbook, Instrument Logbook & Monthly Maintenance Sheet & Notify Senior if unable to resolve & Fill Out Downtime Log (Fig 5.1) if necessary
    2. Record O3 MEAS (2500 – 4800mv)
    3. Record O3 REF (2500 – 4800mv)
    4. Record Pressure (25 – 31 inHg)
    5. Record Sample Flow (800 ± 80cc/min)
    6. Record Sample Temperature (10 – 50°C)
    7. Record Photo Lamp (50°C ± 18°C)
    8. Record Box Temp (± 5°C of room temp)
  - Check Calibration Factors – O3 OFFSET & O3 SLOPE with those recorded in the Instrument Logbook & record on monthly maintenance sheet.

3.6 Monthly Task: Station Operations API 400E O3 Instruments

- **Perform Analog Output Test for Zero & Full Scale**
  (API Model 400E Manual - Sections 6.7.2)
- **Zero Span Check for O3**

Parameters	Response
> or < than +/- 10 PPB	Invalid Data Call in work order
-10 to -5 PPB or 5 to 10 PPB	Perform Manual Zero Adjustment
-5 to 0 PPB or 0 to 5 PPB	No Adjustment Needed

(See Detailed Maintenance & Adjustment Zero Span for procedure on Manual Zero adjustment)

3.7 Semi-Annual Tasks: API 400E O3 Instruments

3.7.1 Station Operator:

Clean Manifold, Probe Inlet & Instrument tubing/lines
Verify Following Task Completion and Documentation of the following

3.7.2 Support Group:

Multi-Point Calibration: (API Model 400E Manual - Sections 7.0.0)
Flow Calibration: (API Model 400E Manual - Sections 9.3.6)
Clean Absorption Tube: (API Model 400E Manual – Sections 9.3.7)

3.8 Annual Tasks: API 400E O3 Instruments

3.8.1 Station Operator:

Verify the Completion and Documentation of the following

3.8.2 Support Group:

- Replace: IZS Zero Air Scrubber (API Model 400E Manual – Sections 9.3.3)
- Inspect & Clean Absorption Tube (API Model 400E Manual – Sections 9.3.7)
- Clean & Examine Pneumatic Lines
- Verify Leak Tight (Vacuum & Pressure leak check) (API Model 400E Manual – Sections 9.3.4)

3.9 Every Two Years Tasks:

3.9.1 Station Operator:

Verify the Completion and Documentation of the following

3.9.2 Support Group:

- Replace Pump Diaphragm (API Model 400E Manual – Sections 9.3.2)
- Replace O3 Scrubber see (API Model 400E Manual - Sections 11.6.3)

4 Documentation:

4.1 Station & Instrument Logbooks

The AQIS Operator shall maintain as explained in the “SOP for General Air Monitoring Station Operations” the Station and Instrument Logbooks.

4.2 Monthly Downtime Log

Complete the Monthly Downtime Log as per instructions in the “SOP for General Air Monitoring Station Operations” Section.4.5 and submit as described.

4.3 Maintenance Sheets

Complete and submit the API 400E O3 Monthly Maintenance sheet in Appendix A to the Senior AQIS for review. Once reviewed, the Senior AQIS submits the maintenance sheet to Data Validation for review.

5 Troubleshooting:

Before starting any troubleshooting procedure, refer to API Model 400E Manual – Section 11.1 for more on specific information.

Check for Leaks at all obvious connections
Check all electrical connections, specifically those at the ESC & Chessell connection, check for proper grounding

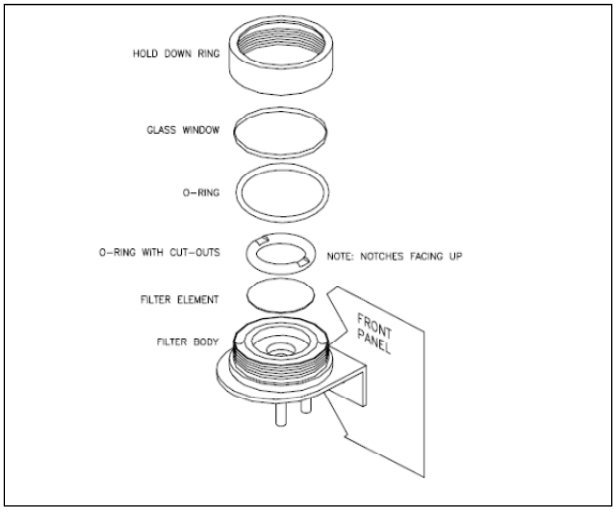
5.1 Detailed Maintenance & Adjustment

5.1.1 Replacing Particulate Filter

The particulate filter should be inspected often for signs of plugging or contamination. The Filter should be replaced a minimum of every two weeks, more often if necessary depending on sample conditions

Replacement Procedure:
Open the M400E's hinged front panel and unscrew the knurled retaining ring on the filter assembly
Carefully remove the retaining ring, PTFE o-ring, glass filter cover and filter element.
Replace the filter, being careful that the element is fully seated and centered in the bottom of the holder.
Re-install the PTFE o-ring with the notches up, the glass cover, then screw on the retaining ring and hand tighten. Inspect the seal between the edge of filter and the o-ring to assure a proper seal.

Figure 1 **Particulate Filter Housing**



5.1.2 Zero Span Check: General

The zero and span check procedure is preformed at the air monitoring site. When completing this procedure the operator will comply with instruction from the manufacturer's operation manual. (API Model 400E Manual – Section 7.2 Zero Air ***only***)

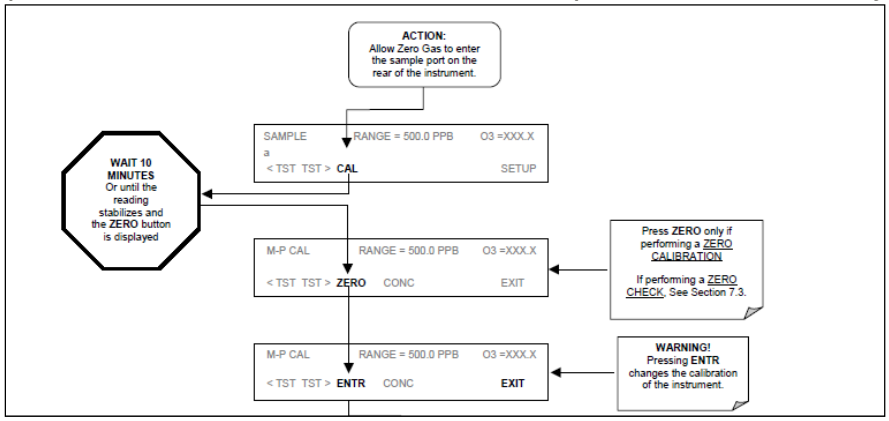
To complete the procedure the operator may examine the nightly span/precision values to verify zero values or the operator use the gas dilution system to zero/span the criteria pollutant analyzers. During the procedure verify the analyzer is in normal operation mode.

- Initiate the flow of zero air through the analyzer until it stabilizes; approximately 15 minutes
- Compare the values from the Chessell or ESC data logger to the table and determine if adjustments are required
- If adjustments are required note the old calibration factors both in the logbook and on the maintenance sheet.
- While running zero air, place the instrument in the calibration mode and run for at least 15 additional minutes.
- Press the "zero mode" function
- Press the "enter button"
- The instrument should now have a new "zero" or "intercept "value"
- Record these new values both in the log book and on the maintenance sheet.

Please be sure to note any additional information regarding erratic instrument behavior.

5.1.3 Zero Span Calibration

(API Model 400E Manual section 7.2 step Three; Zero Air Only)



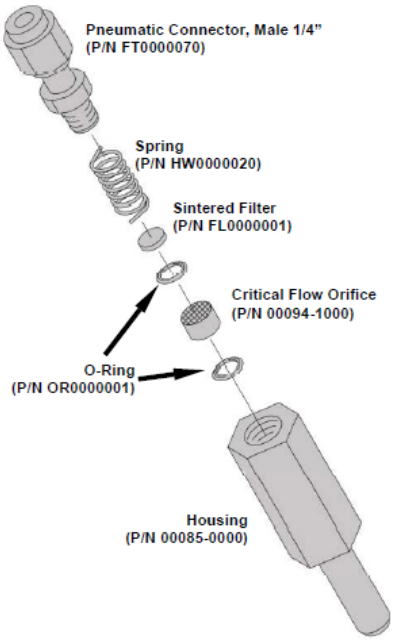
5.1.4 Sintered Filter Replacement

The Critical Flow Orifice is part of the Flow Control Assembly located on the sample pump assembly or optionally in the ozone generator for instruments with the IZS option. The jewel orifice is protected by a sintered filter, so it is unusual for the orifice to need replacing, but it is possible for the sintered filter and o-rings to need replacing.

Procedure:

- Locate the assembly.
- Disconnect the pneumatic fittings.
- Remove the assembly from the sample pump by disconnecting the ¼" tube fitting on the pump inlet elbow.
- The inlet end of the assembly is the straight ¼" tube to 1/8" male NPT fitting. Remove the fitting and the components as shown in the exploded view in the following figure
- Replace the o-rings and the sintered filter.
- If you are replacing the Critical Flow Orifice itself, make sure that the side with the red colored sapphire jewel is facing downstream to the flow gas flow.
- Re-assemble in reverse order.
- After re-connecting the power and pneumatic lines, verify flow rate is between 720 and 880 cc/min.

Figure 2 **Critical Flow Orifice Assembly**



5.1.5 Photo Lamp Adjustment:

Physical Adjustment & Gain Adjustment
(API Model 400E Technical Manual – Sections 12.3.6.2)

WARNING!
UV LIGHT PRESENT
DO NOT REMOVE LAMP FROM HOUSING WHEN ADJUSTING.

Adjust the Physical Positioning of the source lamp, as follows:

- At the front panel of the instrument, Press the **TEST** key until O3 REF=XXXXX is displayed.
- Loosen the UV lamp set-screw and rotate the lamp until the O3 REF reading on display is 4500 mV ± 320 mV. Re-tighten the set-screw. (Note that the full range of lamp adjustment can be achieved within ¼ revolution of the lamp. Note also that the O3 REF display is updated approximately once every six seconds, and slow rotation of the lamp is needed for proper adjustment.)

Adjust the UV Detector Pre-Amp gain as follows:

- At the front panel of the instrument, Press the **TEST** key until O3 REF=XXXXX is displayed.

- Remove the access cap on the Detector cover at the front end of the optical bench, and adjust the pot (R7) until the O3 REF reading on the display is 4500 mV ± 50 mV.

Figure 3 Optical Bench – Lamp Adjustment

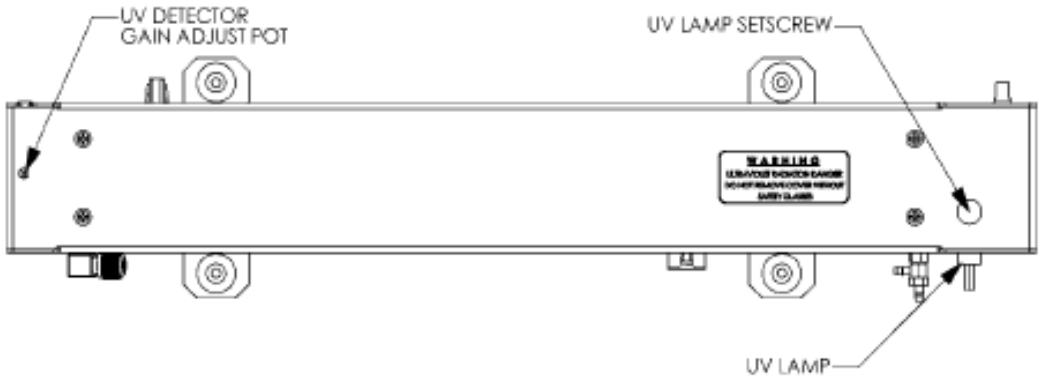


Figure 4 **Front Panel Display**

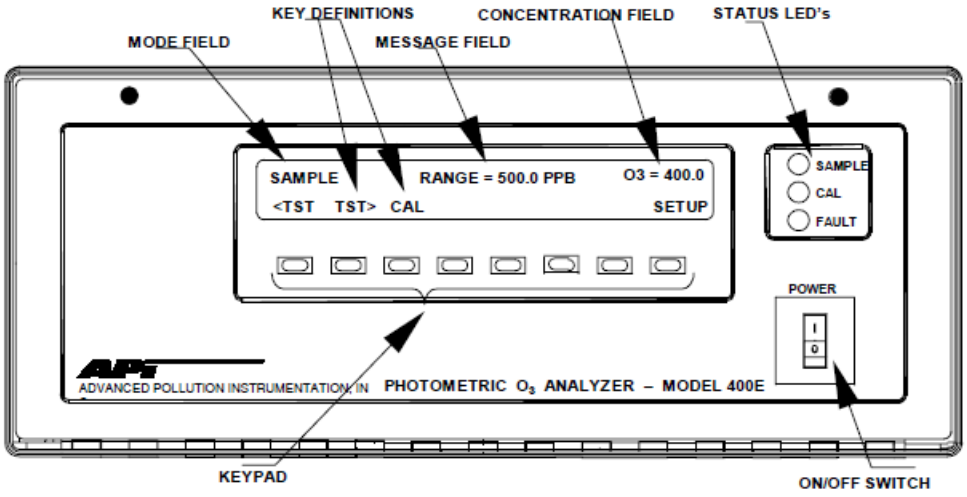


Figure 5 **Rear Panel**

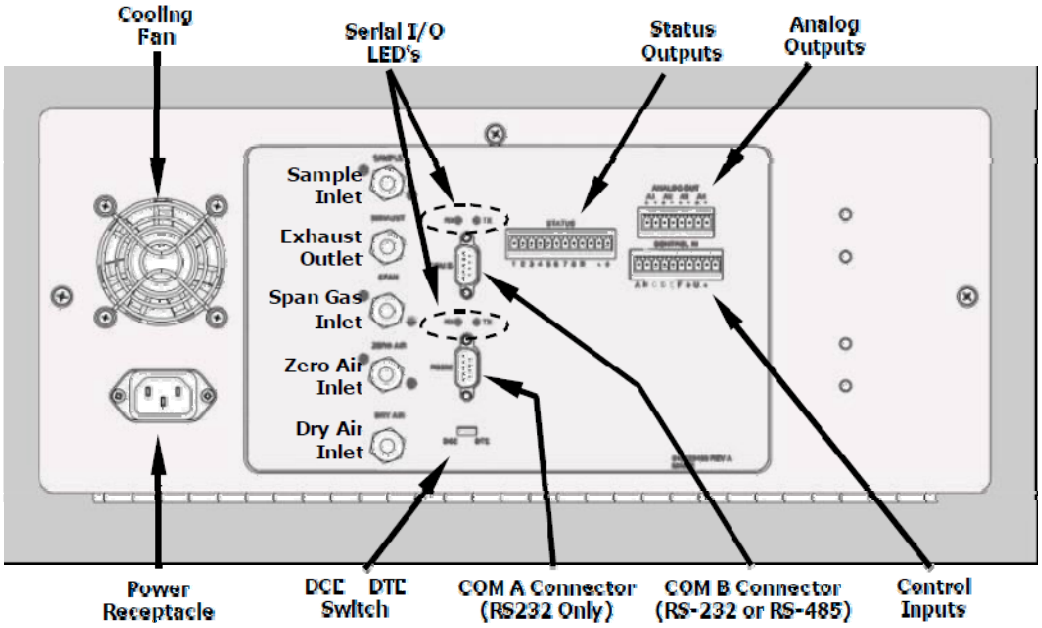


Table 1 **Maintenance Interval**

(API Model 400E Technical Manual – Section 9.1)

Maintenance Summary Table

Interval	Maintenance	Responsibility
Daily	Review all data collected from the previous day for all sites by viewing data remotely or Chessell Video Recorder. Data should be compared to the previous day for consistency. Perform a visual inspection of all instruments to ensure that they are not damaged and are functioning correctly.	Station Operator
Weekly	Complete all weekly maintenance sheet tasks. Record the current readings from the Chessell Video Recorder and data logger in the appropriate columns on the PC/SPAN maintenance sheet. Perform a visual inspection of all instruments to ensure that they are not damaged and are functioning correctly. Review the Chessell Video Recorder data for the preceding week to ensure that data appears to follow normal patters and check appropriate box to indicate whether traces are normal on maintenance sheets. Notify Senior if otherwise.	Station Operator
Monthly	Perform Analog Output Test for Zero & Full Scale	Station Operator
Bi-Annually	Clean Manifold, Probe Inlet, & Instrument tubing/lines	Station Operator
	Multi-Point Calibration, Flow Calibration, Clean Absorption Tube	Repair/Calibration Technician
Annually	Replace the Following Items IZS Zero Air Scrubber, Inspect & Clean Absorption Tube, Clean & Examine Pneumatic lines, Verify Leak Tight	Repair/Calibration Technician
2-Years	Replace the Following Items Pump Diaphragm, O3 Scrubber	Repair/Calibration Technician

Appendix A: API 400E O3 Maintenance Sheet

South Coast Air Quality Management District

Monthly Maintenance Report

API/Teledyne 400E Ozone (O3)

See SOP for Maintenance Sheet Instructions

Location:	Month & Year:
Station #	Technician:
Instrument Serial #	AQMD Property #

DATE:					
TIME:					
Change Filter					
LED Status Sample					
LED Status CAL					
LED Status Fault					
O3 MEAS (2500-4800mV)					
O3 REF (2500-4800mV)					
Pressure (25-31 inHg)					
Sample Flow (800±80cc/m)					
Sample Temp (10-50°C)					
Photo Lamp (50°C ±18°C)					
Box Temp(± 5°C ambient)					
Offset (1±5.0) (Zero)					
Slope (1±0.15) (Span)					

Monthly: Perform Analog Output Test (± 1% Full Scale)

DATE:	TELEMETRY		CHESSEL	
	ZERO	SPAN	ZERO	SPAN

Comments:

Calibration Date: _____ Reviewed BY _____

API Teledyne 400E O3 maint sheet.xls