

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
200A NO/NOX/NO₂

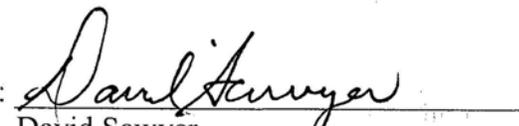
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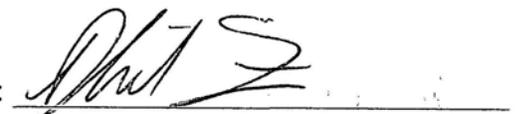
PREPARATION, REVIEWS AND APPROVALS
Standard Operating Procedure for API 200A NO/NOX/NO2 Instrument

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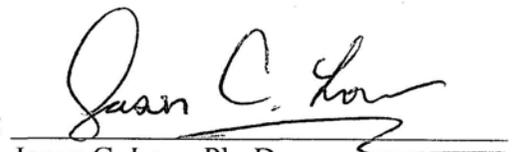
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Standard Operating Procedure for API 200A NO/NOX/NO2 Instrument

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Standard Operating Procedure for API 200A NO/NO_x/NO₂ Instrument

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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 Advanced Pollution Instrumentation, Inc. (API) Model 200A Nitrogen Oxides 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 200A NITROGEN OXIDES ANALYZER, Instruction Manual
- "SOP for General Air Monitoring Station Operations"

1.4 General Description

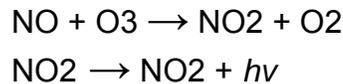
Advanced Pollution Instrumentation, Inc. (API) Model 200A Nitrogen Oxides Analyzer is designated as Reference Method Number RFNA-1194-099 as defined in 40 CFR Part 53, when operated under the following conditions:

1. Range: Any range from 50 parts per billion (ppb) to 1 ppm.
2. Ambient temperature range of 5 to 40°C.
3. Line voltage range of 105-125 VAC, 60Hz; 220-240 VAC, 50Hz.
4. With 5-micron TFE filter element installed in the internal filter assembly.
5. Sample flow of 500 ± 50 cc/min.
6. Vacuum pump (internal or external) capable of 10"Hg Abs pressure @ 2 slpm or better.
7. Software settings:
 - A. Dynamic span OFF
 - B. Dynamic zero OFF
 - C. Cal-on-NO2 OFF
 - D. Dilution factor OFF
 - E. Auto Cal ON or OFF

F. Independent range	ON or OFF
G. Autorange	ON or OFF
H. Temp/Pressure compensation	ON
I. Converter Efficiency	Acceptable values of 0.96 to 1.02

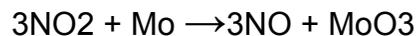
1.5 *Principal of Operation*

The Teledyne/API Model 200A Analyzer is designed to measure the concentration of nitric oxide [NO], total oxides of nitrogen [NOX] and, by calculation, nitrogen dioxide [NO₂]. The instrument measures the light intensity of the chemiluminescent gas phase reaction of nitric oxide [NO] and ozone [O₃] as follows:



The reaction of NO with ozone results in electronically excited NO₂ molecules as shown in the first equation above. The excited NO₂ molecules release their excess energy by emitting a photon and dropping to a lower energy level as shown in the second equation. It has been shown that the light intensity produced is directly proportional to the [NO] concentration present.

The Analyzer samples the gas stream and measures the [NO] concentration by digitizing the signal from the Analyzer's photomultiplier tube (PMT). A valve then routes the sample stream through a converter containing heated molybdenum to reduce any NO₂ present to NO by the following reaction:



The Analyzer now measures the total NOX concentration. The [NOX] and [NO] values are subtracted from each other by the built-in computer yielding the [NO₂] concentration. The three results [NO], [NOX], and [NO₂] are then further processed and stored by the computer yielding several instantaneous and long term averages of all three components. These readings are also stored internally in the M200A's data acquisition system (DAS).

The software uses an adaptive filter to accommodate rapid changes in concentration. The algorithm monitors the rate of change in concentration for both the NO and NOX channels. When a change in concentration is detected, the software changes the sample filters to rapidly respond to the change. The filters are adjusted to minimize the errors introduced by the time delay between the NOX and NO channel measurements; this assures accurate NO₂ measurements. When the rate of change decreases, the filters are lengthened to provide good signal/noise ratio. The parameters used to operate the adaptive filter have been tuned to match the electrical and pneumatic characteristics of the M200A.

2 Siting 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*

- Sufficient space in front of and behind the instrument for service and maintenance routines
- Electrical Connections:
Verify Clean and professional installation, check for loose wires and connections and proper clearance for instrument inspection and maintenance (Figure 3)
(API Model 200A Manual – Section 2.2)
- Pneumatic Connections:
Verify correct tubing and connection installation, check for clearance and damaged tubing, verify correct inlet/outlet (exhaust) connections (Figure 3)
(API Model 200A Manual – Section 2.2)
- Initial Startup:
Verify Initial startup procedure corresponds with factory firmware and calibration
(API Model 200A Manual – Section 2.3)
- Initial Calibration:
Verify multi-point calibration; verify documentation of calibration in Station Logbook, Instrument Logbook & Monthly Maintenance Sheet
(API Model 200A Manual – Section 7.0)

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

NO ₂ Validation Template			
Requirement	Frequency	Acceptance Criteria	Information /Action
CRITICAL CRITERIA- NO₂			
One Point QC Check Single analyzer	1/2 weeks	≤ ±10% (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 ± 3% of full scale Span drift ± 10 %	

- ☞ *One Point QC Check - Daily - Required every 2 Weeks*
 ±10 % = Out of Tolerance - Disable - Report
 ±07 % = 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 patterns 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 200A NO/NOX Instrument

- Check NO/NOX Instrument Status on Chessell
- Check that Instrument is in Sample mode
- Check for LED Status (Sample-Green: Cal-Off: Fault-Off: Record in Station Logbook, Instrument Logbook & Monthly Maintenance Sheet & Notify Senior if unable to resolve
- Record any problems or changes in Station Logbook, Instrument Logbook & Monthly Maintenance Sheet fill out down time log if necessary
- Check Sample Instrument Flow & O3 Flow are within parameters (Sample Flow 500±50cc/min; O3 Flow 60-90cc/min)
 *on the day that the operator services the station

Front Panel LED Status:

LED	State	Meaning
Green	On	Monitoring normally, taking DAS data
	Off	NOT monitoring, DAS disabled
	Blinking	Monitoring, DAS in HOLDOFF mode (1)
Yellow	Off	Auto cal. disabled
	On	Auto/Dynamic cal. enabled
	Blinking	Calibrating
Red	Off	No warnings exist
	Blinking	Warnings exist

(1) This occurs during Calibration, DAS holdoff, power-up holdoff, and when in Diagnostic mode.

3.5 Weekly Tasks: Station Operations API 200A NO/NOX Instrument

- 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 (Minimum Every Two Weeks) (see detailed Maintenance & Adjustment)
 - 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 if necessary
 2. Record O3 Flow (60 - 90 cc/min)
 3. Record Sample Flow (500 ± 50 cc/min)
 4. Record RCEL Pressure (4 – 10 inHg)
 5. Record Moly Temperature (315°C ± 5)
 6. Record PMT Temperature (7°C ± 1)
 - Check Calibration Factors – NO/NOX Offset (Zero) & NO/NOX Slope (Span) with those recorded in the Instrument Logbook & record on monthly maintenance sheet

3.6 *Monthly Tasks: Station Operations API 200A NO/NO_x Instrument*

- Perform Analog Output Test for Zero & Full Scale (API 200A Manual 9.1.3.5)
 - Zero Span Check for NO_x/NO
- | Parameters | Response |
|------------------------------|---------------------------------|
| > or < than +/- 15 PPB | Invalid Data Call in work order |
| -15 to -5 PPB or 5 to 15 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 200A NO_x Instruments*

3.7.1 Station Operator:

Clean Manifold, Probe Inlet and instrument lines; Verify multi-point calibration & NO₂ Converter Efficiency check; verify documentation of calibration in Station Logbook, Instrument Logbook & Monthly Maintenance Sheet and Downtime Log

3.7.2 Support Group:

Multi-Point Calibration & NO₂ Converter Efficiency
(API Model 200A Manual - Section 7.0.0)

Check RCEL Pressure and repair or replace pump as necessary
(API Model 200A Manual - Section 9.3.10.2)

3.8 *Annual Tasks: API 200A NO_x Instruments*

3.8.1 Station Operator:

Verify the Completion and Documentation of the following

3.8.2 Support Group:

- Replace: Ozone Scrubber (API Model 200A Manual – Sections 8.3)
- Cleaning the Reaction cell & Replacing the Sintered filter and O-rings (API Model 200A Manual - Section 8.7)
- Examine Pneumatic Lines & Check for Leaks (API Model 200A Manual – Sections 8.8 & 8.9)

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 200A NO/NO_x Monthly Maintenance sheet 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 200A Manual – Section 9 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

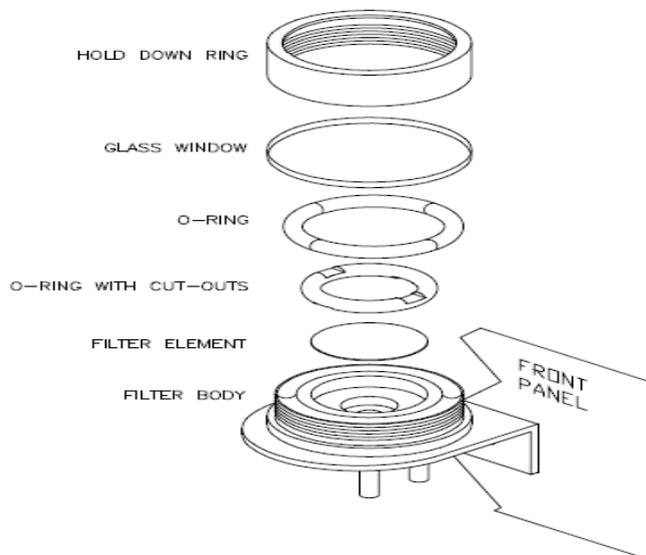
(API Model 200A Manual – Section 8.2)

The particulate filter should be inspected often for signs of plugging or contamination. It is also common for dirt particles to absorb NO₂, thus causing those readings to be low.

To check and change the filter:

1. Fold down the M200A front panel.
2. Locate the filter on the left side of the analyzer front panel. See Figure 1 for an exploded view of the filter assembly.
3. Visually inspect the filter through the glass window.
4. If the filter appears dirty, unscrew the hold-down ring, remove the teflon o-ring and then the filter.
5. Replace the filter, being careful that the element is fully seated in the bottom of the holder. Replace the Teflon o-ring, then screw on the hold-down ring and hand tighten.

Figure 1 Particulate Filter Housing



5.1.2 Zero Check Procedure: General

The zero and span check procedure is performed at the air monitoring site. When completing this procedure the operator will comply with instruction from the manufacturer's operation manual.

(API Model 200A Manual – Section 7.1 Table 7-7-3)

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 - Zero Gas thru Sample Port.

(API Model 200A Manual – Section 7.1 Table 7-7-3)

1. Press CAL
The M200A enters the calibrate mode from sample mode. The zero gas must come in through the sample port.
2. Wait 10 min
Wait for reading to stabilize at zero value.
3. Press ZERO
If you change your mind after pressing ZERO, you can still press EXIT here without zeroing the instrument.
4. Press ENTR
Pressing ENTR actually changes the calculation equations.
5. Press EXIT
M200A returns to sampling. Immediately after calibration, data is not added to the DAS averages.

Figure 2 Front Panel

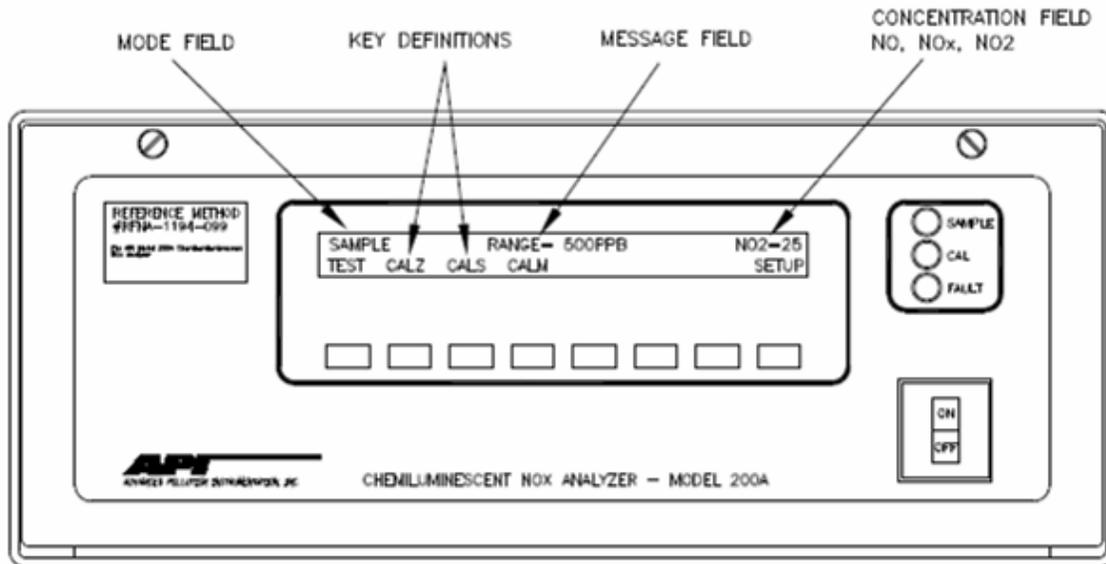


Figure 3 Back Panel

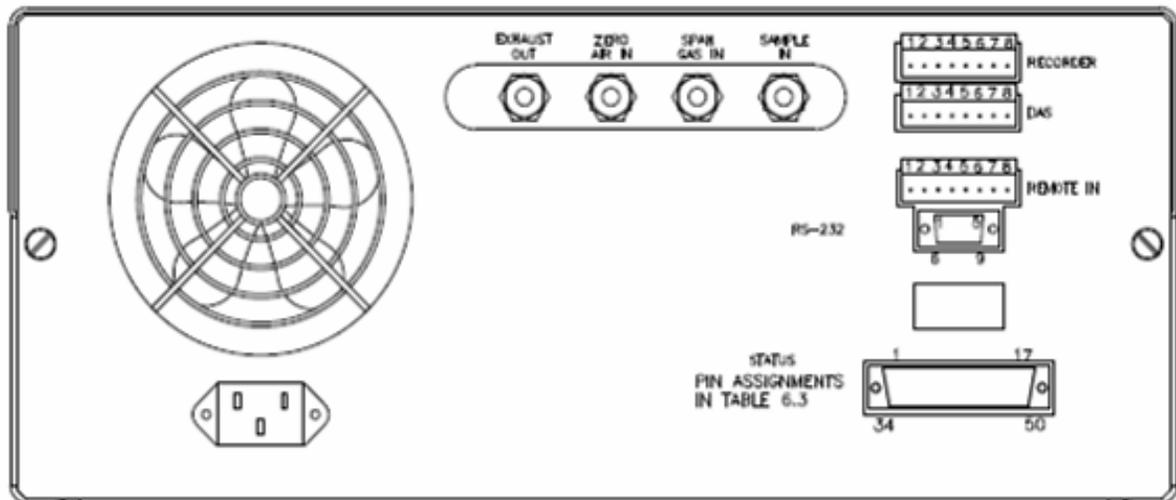


Table 1 Maintenance Interval
 (API Model 200A Technical Manual – Section 8.1)

Maintenance Summary Table

Daily	Review all data collected from the previous day for all sites by viewing data remotely or Chessell strip chart. 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. Notify Senior if otherwise	Station Operator
Weekly	Complete all weekly maintenance sheet tasks. Record the current readings from the Chessell strip chart 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 strip chart data for the preceding week to ensure that data appears to follow normal patterns 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, Zero Span Check	Station Operator
Semi - Annually	Clean Manifold, Probe Inlet, & Instrument tubing/lines	Station Operator
	Multi-Point Calibration & NO2 Converter Efficiency, Check RCEL Pressure and repair or replace pump as necessary	Repair/Calibration Technician
Annually	Replace the Ozone Scrubber, Clean the Reaction cell & Replace the Sintered filter and O-rings, Clean & Examine Pneumatic lines, Leak Check	Repair/Calibration Technician

Appendix A: API/Teledyne 200A NO/NOx Maintenance Sheet

South Coast Air Quality Management District
 Monthly Maintenance Report
 API/Teledyne 200A NO/NO₂/NO_x

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					
Sample Flow (500 ± 50cc/m)					
O3 Flow (60 - 90 cc/min)					
PMT Temp (7°C ±1)					
RCEL Pressure (4 - 10inHg)					
Moly Temp (315°C ±5)					
NOX Slope (Span)					
NOX Offset (Zero)					
NO Slope (Span)					
NO Offset (Zero)					

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

DATE:		TELEMETRY	CHESSELL	
<input style="width: 100%;" type="text"/>		ZERO	SPAN	ZERO
	NO			
	NO _x			

Comments:

Calibration Date: _____ Reviewed BY: _____