





Maintenance Procedures For Audit Equipment

Volume V
Audit Procedures Manual for Air Quality Monitoring

QMB SOP Appendix AL
Revision 2

Quality Assurance Section
Quality Management Branch
Monitoring and Laboratory Division

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Disclaimer: Mention of any trade name or commercial product in this standard operating procedure does not constitute endorsement or recommendation of this product by the California Air Resources Board. Specific brand names and instrument descriptions listed in the standard operating procedure are for equipment used by the California Air Resources Board's Quality Assurance Section. Any functionally equivalent instrumentation is acceptable.

PERFORMANCE AUDIT PROCEDURES
FOR AUDIT VEHICLE MAINTENANCE

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FOR AUDIT VEHICLE MAINTENANCE

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ACRONYMS AND DEFINITIONS

Acronym	Definition
AIS	Audit Information System
AQS	Air Quality System (U.S. EPA database)
AQSB	Air Quality Surveillance Branch
BP	Barometric Pressure
CARB	California Air Resources Board
CTS	Collocated Transfer System method
°C	Degrees Celsius
DAS	Data Acquisition System
HWS	Horizontal Wind Speed
inHg	inches of mercury
IT	Indoor Temperature
km/h	kilometers per hour
LCD	Liquid Crystal Display
m	meters
mb	millibars
MET	Meteorological
mmHg	millimeters of mercury
MLD	Monitoring and Laboratory Division
MQO	Measurement Quality Objectives
m/s	meters per second
NCore	National Core (network)
NIST	National Institute of Standards and Technology
OT	Outdoor (or Ambient) Temperature
PAMS	Photochemical Assessment Monitoring Stations (network)
P/N	Part Number
PSD	Prevention of Significant Deterioration (network)
QAS	Quality Assurance Section
QMB	Quality Management Branch
RH	Relative Humidity
SI	International System of Units (metric system)
SIP	State Implementation Plan
SLAMS	State or Local Air Monitoring Stations (network)
SOP	Standard Operating Procedure
U.S. EPA	United States Environmental Protection Agency
ZAG	Zero Air Generator

AL.1.0 **INTRODUCTION**

Ambient air monitoring stations collecting pollutant data for comparison with national standards must be independently assessed annually on the performance of the analyzers, samplers and sensors. To fulfill this requirement, mobile laboratories or audit vans are constructed to house and transport the necessary instrumentation and equipment. The confidence in the assessment or audit results is greatly dependent upon ensuring that equipment calibration and maintenance is performed at designated intervals, audit standards are traceable to a higher authoritative reference, and strict tolerance limits are followed. Accordingly, the equipment and analyzers in the California Air Resources Board (CARB) audit vans are regularly maintained, calibrated, and verified to be configured and operating to manufacturer's specifications and regulatory requirements.

AL.2.0 **SUMMARY OF METHOD**

The key components of audit van instrumentation and equipment maintenance are having valid certifications that verify performance within accepted criteria, adhering to service/repair schedules, and ensuring all instruments are free of any contaminants and in proper working order. To maintain credibility of the audit results, it is not acceptable to utilize standards or instruments that have expired certifications or have not been calibrated within the required period.

Dedicated maintenance periods for the analytical equipment and vehicles are included with the field audit schedule for the calendar year, and are normally at the end of each quarter. Depending on the interval during the year, analytical instrumentation and equipment may be removed from the audit van for completion of an independent calibration or certification, replaced to replenish inventory, serviced with replacement of consumable items, confirmed to be configured within acceptable limits and diagnostic settings, and inspected to be free of leaks, contaminants and debris in the sample and delivery lines.

Additionally, during this time, the vehicle and onboard electrical generators are subject to a safety inspection and/or routine maintenance by a certified service facility.

NOTE: Unless specified in an approved procedure, audit instrumentation and equipment is not to be serviced or adjusted while in the field.

AL.3.0 **INTERFERENCES**

Any contamination in the sample train of gaseous analyzers may result in inaccurate results. Leaks in any of the audit systems or flow devices can cause inaccurate test results. Fluctuations in temperature in the audit vehicle can cause unstable results. Low voltage or depleted batteries in equipment can cause inaccurate results.

NOTE: It is highly recommended that equipment that draws power in fluctuations, such as the cycling of the Zero Air Generator, be placed on a separate power circuit from the rest of the analyzers, as the power fluctuations can affect the instruments' accuracy.

AL.4.0 **PERSONNEL QUALIFICATIONS**

All new CARB auditors undertake a one-year training program that is documented and monitored by the Quality Assurance Section (QAS) manager. The training includes in-office reading and coursework, hands-on field experience conducting audits, and shadowing an experienced auditor for one year along with several in-field evaluations by the QAS manager.

The United States Environmental Protection Agency (U.S. EPA) reviews CARB's training program regularly for approval as an equivalent to U.S. EPA's national certification and recertification courses. Auditors should be familiar with the regulations and guidance cited in the references section (AL.11.0) prior to conducting any audits without supervision. Each auditor is expected to have a minimum level of on the job training and familiarity with the audit equipment prior to conducting the audit(s).

AL.5.0 **HEALTH, SAFETY, AND CAUTIONS**

All personnel must follow any general health and safety guidelines as described by the facility where the audit is conducted. All audit equipment, including audit vehicles, should be used only for the purpose and in the manner described in this Standard Operating Procedure (SOP) and in the appropriate operator's manual.

Gases from the compressed cylinders and equipment's vent and exhaust ports may contain harmful compounds, which are known to cause health effects. Care should be taken to ensure that cylinders, fittings and plumbing lines are leak free and to vent excess test gas outside of the

enclosed work space of the audit van and away from buildings whenever possible. All compressed gas cylinder valves are to remain closed when not needed for operation of the audit analytical equipment.

Falls from portable ladders are one of the leading causes of occupational fatalities and injuries. Appropriate safety precautions should be taken and auditors should be familiar with, and trained on, proper ladder usage.

AL.6.0 EQUIPMENT AND SUPPLIES

Equipment and supplies needed to conduct audit equipment maintenance can be found in the QAS vehicle supplies cabinet or in the CARB stock room. Required supplies are:

- Charcoal
- Purafil®
- Air Filter; 2" Diameter (ZAG)
- Millipore; 47mm, 1 and 5 micron filters
- Batteries
- QAS Toolbox
- Engine/Generator Oil
- Jumper Cable
- Portable Battery Charger

AL.7.0 VEHICLE INSPECTION

Audit vehicles should be inspected before every audit to ensure the vehicle is road-worthy and safe to drive. Audit vehicle parameters to be inspected are:

- Generator Oil Level
- Engine Oil Level

- Tire Pressure
- Fresh Water
- Grey Water
- Black Water

The generator oil and engine oil levels should be checked and replenished as indicated by the dip stick. The fresh water tank should be filled as needed. The Grey/Black water tanks should be checked and emptied when needed at proper disposal sites, which can be located at specific gas stations or rest stops. The audit vehicles should be taken in for routine maintenance as needed, typically in between quarters.

The generators must also be serviced semi-annually, or earlier if needed. Generator maintenance is typically done in June and December. It is the duty of every auditor to ensure the audit vehicles are clean and ready for the next team to take out. Any issues with the audit vans should be noted in the vehicle logbook and relayed to the rest of the team.

AL.8.0

GENERAL INSTRUMENT MAINTENANCE PROCEDURES

It is important that ambient air analyzers generating pollutant data and other audit measuring devices verifying the operation of samplers and sensors are tested, inspected, operated and maintained in accordance with established criteria and accepted practices. Every piece of equipment has an expected life span. Through proper testing, inspection, and maintenance programs, users can be assured that equipment continues to be capable of operating at acceptable performance levels.

The laboratory compartment of the audit van contains all the standards needed to perform full audits of air monitoring stations and mass analysis facilities. This allows for challenging and verifying the responses of the station's gaseous analyzers, PM samplers, MET sensors, and laboratory weigh rooms. The gaseous analyzers and associated instrumentation, chart recorder, barometer, and inside temperature meter in the audit van are mounted in racks secured to the vehicle, while the other measuring devices are placed in sturdy carrying cases or cabinets for safe transport. Compressed gas cylinders are secured to the vehicle and stored in accordance with acceptable safety guidance. The air sampling configuration includes manifolds and tubing for analysis and delivery of

gaseous samples to the station. The compartment is climate controlled to ensure the analytical equipment is operated within the required temperature range. A typical set-up of the instrument rack is shown in Figure AL.1.



Figure AL.1 Audit Van Instrument Rack

Any maintenance performed on the components of the audit apparatus, including tests, repairs, certifications, calibrations, or changes made to the instruments, should be noted, in detail, in an appropriate logbook dedicated to the audit van laboratory compartment. If a maintenance record or check sheet is used, it should be referenced in the logbook. Logbooks and maintenance records are periodically reviewed by the Section Manager.

AL.8.1 MAINTENANCE PROCEDURES FOR GASEOUS INSTRUMENTS

The objective of this section is to provide standard maintenance procedures for specific instruments and equipment used for gaseous performance audits. The basic audit apparatus may include calibration/dilution system, ozone analyzer and transfer standard, carbon monoxide analyzer, zero air generator, compressed gas cylinders, data recorder, temperature sensor, thermostat, manifolds, tubing and a presentation line. Other analyzers can be included for verifying audit sample concentrations and troubleshooting. The instruments will be maintained in accordance with the SOP developed by Air Quality Surveillance Branch (AQSB). The SOPs are available on the internet at: <https://ww2.arb.ca.gov/index.php/resources/documents/standard-operating-procedures-ambient-air-monitoring>.

Most of the gaseous ambient air instruments used by QAS to conduct performance audits are Teledyne API analyzers. The Teledyne API analyzers incorporate a series of test functions accessible at the front panel. These parameters provide information about the present operating status of the instrument and are useful during troubleshooting. The analyzers also incorporate automated diagnostic utilities, including failure warnings and alarms built into the firmware of each analyzer, warning the operator that the instrument is operating outside normal parameters. The test functions can also be used to predict failures by observing how the instrument values change over time.

The instruments mounted in the audit vehicles operate in a unique environment, which is sealed from ambient air and samples only clean zero air and pollutants from compressed gas cylinders or an ozone generator. To ensure the integrity of the audit apparatus sample train, the sample lines and manifolds are to be routinely inspected and cleaned as needed.

NOTE: Electronic versions of Teledyne's instrument manuals are available at <http://www.teledyne-api.com/service-support/product-manuals>.

AL.8.1.1 TELEDYNE API MODEL 701H ZERO AIR MODULE MAINTENANCE PROCEDURES

Annually, maintenance is to be conducted by a qualified auditor as assigned by the QA manager. Annual maintenance consists of: (Ref: Teledyne API 701H Operation Manual).

- Replacing the charcoal in the charcoal scrubber.
- Replacing the Purafil® in the NO - NO₂ scrubber.
- Replacing the particulate filter on the rear panel.
- Inspecting the water trap for excessive corrosion and replace if necessary.
- Inspecting internal tubing for signs of abrasion caused by vibration of the compressor and replace as needed.
- Verifying leak integrity of the unit.
- Cleaning the inside and outside of the unit of any excessive dirt or dust.

Once the maintenance is complete, the Maintenance Form for the API 701/701H Zero Air Generator (ZAG) (Figure AL.2) must be filled out and submitted for manager approval. Once approved the form is recorded in the appropriate electronic logbook.

Subsequent to the maintenance, the quality of the zero air generator is to be verified by a comparison with an Ultrapure cylinder to the ozone analyzer. This is to be conducted in accordance with the U.S. EPA Guidance for Verification of Zero Air Generators (Quality Assurance Handbook for Air Pollution Measurement Systems Volume II, Appendix K (March, 2017)). The results of the comparison are to be noted in the Logbook.

**MONITORING AND LABORATORY DIVISION
 QUALITY ASSURANCE SECTION
 MAINTENANCE RECORD**

Audit Vehicle: _____

API 701/701H Zero-Air Generator

ARB Barcode #:

Before performing any maintenance, cycle the power OFF and drain any water that may be present. Refer to specific instructions in the Manufacturer's Operation Manual.

Maintenance (perform annually)

Date Performed:				
Replace Charcoal				
Replace Purafil				
Replace Filter (rear panel)				
Performed By:				

Cleaning (perform as needed)

1. Occasionally, depending upon the local conditions, check the inside of the 701/701H for excessive dirt or dust.
2. Particularly, check the cooling fan, cooling coil and compressor fan inlet.
3. Remove any dirt or dust with a vacuum cleaner. Do not use an air jet. This will only redistribute the dirt and will not remove it.

Checking the tubing

1. Under the vibration of the compressor, it is possible for some parts of the TFE tubing to abrade against nearby objects. This is most likely to occur with the tubing directly attached to the compressor.
2. Check to see if any signs of abrasion are present, and, if so, re-dress the tubing.
3. If any section of tubing appears to be heavily abraded, remove and replace it.

Manager's Review:				
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Figure AL.2 API 701/701H Maintenance Sheet

AL.8.1.2 TELEDYNE API MODEL T700U DILUTION CALIBRATOR MAINTENANCE PROCEDURES

The API T700U dilution calibrator is not required to be certified; however, it is good practice to conduct routine maintenance and certify the instrument to produce accurate gas concentrations. Annual maintenance of the instrument consists of:

- Ozone Photometer Verification
- Mass Flow Controllers (MFCs) Verification/Adjustment
- Ozone Generator Calibration
- In-Line Particulate Filter Change

The instrument is to be removed from the audit vehicle and taken to the CARB Standards Laboratory for certification. The Standards Lab must be contacted, prior to drop off, to schedule a certification on the unit. Once the unit is certified, it can be reinstalled in the audit vehicle. Removal and return of the instrument should be recorded in the logbook.

Quarterly, record the test parameters on form MLD/QAS-T700U (Figure AL.3). The inline particulate filter should be inspected quarterly and changed as needed based on visible observations of deterioration or contaminant loading. The filters are to be changed annually at a minimum.

NOTE: The inline particulate filters are located behind the front panel for Teledyne API analyzer models T200U, T300U, and T400. Replace the used filters with Millipore™ 47 mm diameter Teflon particulate filter with a 5-micron pore size filters. Containers of new filters are available in MLD's supply room.

NOTE: Record the test parameters for Teledyne API instrument models T700U, T200U, T300U, and T400 on the appropriate forms. Using the "Test" button of the front panel of each analyzer, begin with the "Current Time" and then record each displayed parameter on the form. The forms match the parameter readouts. If the analyzer has NUMA View software installed, the parameters can be found in the dashboard.

QUALITY ASSURANCE SECTION - EQUIPMENT MAINTENANCE LOG

Teledyne API T700U Dilution Calibrator	Instrument ID	Location	Ambient <input type="checkbox"/>
			Zero Air <input type="checkbox"/>
			Span Gas <input type="checkbox"/>

T700U	Checked by:					
	Date:					
Test Parameter	Nominal Value	Observed Values				
A-CAL	TARG CAL ± 1%					
T-CAL	0.001 – 0.100 SLPM					
A-DIL	TARG DIL ± 1%					
T-DIL	0.01 – 10 SLPM					
O3GEN FRAC	REFERENCE ONLY					
O3GENREF	0 – 5000mV					
O3FLOW	0.100 ± 0.025 SLPM					
O3LAMPTMP	48 ± 1°C					
CAL PRES	25 – 35PSI					
DIL PRES	25 – 35PSI					
REG PRES	8 ± 1PSI					
T-FLW						
BOX TMP	AMBIENT ± 5°C					
PH MEAS	2500 – 4800mV					
PH REF	2500 – 4800mV					
PH FLW	0.720 – 0.880LPM					
PH LTEMP	58 ± 1°C					
PH PRES	AMBIENT ± 1 IN-HG					
PH STEMP	AMBIENT ± 3°C					
PH SLOPE	0.85-1.15					
PH OFFST	0 ± 10 PPB					
Filter Change Date						
Date of last Zero/Span adjustment						
Comments/Notes						

Manager's Review:					
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Figure AL.3 Teledyne API T700U Equipment Maintenance Log

AL.8.1.3 TELEDYNE API MODEL T400 OZONE ANALYZER MAINTENANCE PROCEDURES

The API T400 Ozone analyzer is certified every quarter. The analyzer is to be removed from the audit vehicle and taken to the CARB Standards Laboratory for certification. The Standards Lab must be contacted, prior to drop off, to schedule an ozone certification on the unit. Once the unit is certified, it can be reinstalled in the audit vehicle. Removal and return of the analyzer should be recorded in the Logbook.

Quarterly, record the test parameters on form MLD/QAS-T400, Figure AL.4. The inline particulate filter should be changed annually, or earlier as needed. The completed check sheet and any maintenance activities are to be recorded in the Logbook.

**QUALITY ASSURANCE SECTION
 EQUIPMENT MAINTENANCE LOG**

Teledyne API T400 Ozone Analyzer	Instrument ID	Location
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03	Checked by:					
	Date:					
Test Parameter	Nominal Value	Observed Values				
TIME	Current (PST)					
RANGE						
STABIL	≤ 1 ppb w/ zero air					
O3 MEAS	2500 – 4800 mV					
O3 REF	2500 – 4800 mV					
PRES	≈ -2" ambient absolute					
SAMP FL	800 ± 10%					
SAMPLE TEMP	10 – 50° c					
PHOTO LAMP	58 ± 1° c					
BOX TEMP	10 – 50° c					
SLOPE	1.0 ± 0.15					
OFFSET	0.0 ± 5.0 ppb					
	Filter Change Date					
	Date of last Zero/Span adjustment					
	Comments/Notes					

For troubleshooting purposes only; values found in the Signal I/O menu						
REF 4096 MV	4096 ± 2 mV (STABLE)					
REF GND	0 ± 0.5 mV (STABLE)					

Manager's Review:					
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Figure AL.4 Teledyne API T400 Equipment Maintenance Log

AL.8.1.4 TELEDYNE API MODEL T703U OZONE TRANSFER STANDARD
MAINTENANCE PROCEDURES

The API T703U Ozone Transfer Standard is certified every quarter in accordance with NPAP requirements. The instrument is to be removed from the audit vehicle and taken to the CARB Standards Laboratory for certification. The Standards Lab must be contacted, prior to drop off, to schedule an ozone certification on the unit. Once the unit is certified, it can be reinstalled in the audit vehicle. Removal and return of the instrument is to be recorded in the Logbook.

Quarterly, record the test parameters on form MLD/QAS-T703U, Figure AL.5. The inline particulate filter should be changed annually, or earlier as needed. The completed check sheet and any maintenance activities are to be recorded in the Logbook.

NOTE: The API T703U Ozone Transfer Standard certification is valid for six months for audits that do not require NPAP standards.

**MONITORING AND LABORATORY DIVISION
 QUALITY ASSURANCE SECTION
 MAINTENANCE RECORD**

Audit Vehicle: _____

Year: _____

API T703 Ozone Transfer Standard

ARB No: _____

Checked by:				
Check Dates				

Test Parameters		Readings			
ACT	1% of TARG				
TARG	50-1000 ppb				
OUTPUT FLOW	2 – 5 LPM				
REG PRESSURE	15 ± 2 PSIG @ 5 LPM				
BOX TEMP	20 - 35 °C				
O3 GEN REF ¹	0-5000 mV				
O3 GEN DRIVE ¹	0-5000 mV				
O3 LAMP TEMP ¹	48 ± 1 °C				
PHOTO MEASURE ²	2500 – 4700 mV				
PHOTO REFERENCE ²	2500 – 4700 mV				
PHOTO FLOW ²	0.720 – 0.880 LPM				
PHOTO LAMP TEMP ²	58 ± 1 °C				
PHOTO SPRESS ²	-1" AMBIENT IN-HG-A				
PHOTO STEMP ²	25 - 48 °C				
PHOTO SLOPE ²	1 ± 0.15				
PHOTO OFFSET ²	0 ± 10 PPB				
Inline Particulate Filter Changed:					
Calibration Date:					

Depending on options installed, not all test parameters shown will be available. ¹ If ozone generator option installed.
² If photometer option installed.

Operator Instructions:

- Quarterly: Record test parameters.
- Semi-annually: Re-certification (Standards Lab).
- Yearly: Change inline particulate filter.

Manager's Review: _____

California Air Resources Board

MLD/QAS-T703 (Rev. 05/2012)

Figure AL.5 Teledyne API T703U Maintenance Record

AL.8.1.5 TELEDYNE API MODEL T300U CARBON MONOXIDE ANALYZER
MAINTENANCE

Certification of the analyzer can be requested from the CARB Standards Lab on an as needed basis. Due to audit procedures, AIS calculations, and the use of NIST traceable gas cylinders, the API T300U CO analyzer is not required to be regularly certified.

Quarterly, record the test parameters on form MLD/QAS-T300U, (Figure AL.6). The inline particulate filter should be changed annually, or earlier as needed. The completed check sheet and any maintenance activities are to be recorded in the Logbook.

AL.8.1.6 PICARRO G2401 GAS CONCENTRATION ANALYZER

As stated in the Picarro user manual, the unit is not serviceable by the end user, with the exception of the particulate filter. Due to audit procedures, AIS calculations, and the use of NIST traceable gas cylinders, the Picarro CO analyzer is not required to be regularly certified. It is verified every audit as compared to the NIST certified cylinders.

The inline particulate filter should be changed annually, or more frequently as needed. Any maintenance activities are to be recorded in the logbook.

NOTE: Always have external filter.



Figure AL.7 Picarro G2401 Analyzer

AL.8.1.7 TELEDYNE API MODEL T200U NO_x ANALYZER MAINTENANCE PROCEDURES

Audit values for NO₂ are derived directly from NO and NO_x concentrations based on their ratio with CO in the super blend cylinder

and the CO analyzer measurement. Therefore, the NO/NO_x analyzer is strictly used to observe stability in the sample values and is under no requirement to be certified on an annual basis.

Quarterly, record the test parameters on form MLD/QAS-T200U (Figure AL.8). The inline particulate filter should be changed annually, or earlier as needed. The completed check sheet and any maintenance activities are to be recorded in the Logbook.

QUALITY ASSURANCE SECTION - EQUIPMENT MAINTENANCE LOG

Teledyne API T200U Oxides of Nitrogen Analyzer	Instrument ID	Location	Ambient <input type="checkbox"/>
			Zero Air <input type="checkbox"/>
			Span Gas <input type="checkbox"/>

NO2	Checked by:				
	Date:				
Test Parameter	Nominal Value	Observed Values			
Box Temp	ambient ± 5° C				
Conv Eff A	96 – 104				
Conv Eff A Range 2	96 – 104				
Driver Version					
HVPS	400 – 900 v				
Manifold Temp	40 ± 1° C				
Moly Temp	315 ± 5° C				
NO Norm Offset	-50 to 50				
NO Slope	1.0 ± 0.3				
Norm PMT	<i>see manual</i>				
NOx Norm Offset	-50 to 50				
NOx Slope	1.0 ± 0.3				
O3 Flow	80 cm ³ ± 15				
Package Version					
PMT Signal	-20 to 150 w/ zero air				
PMT Temp	5 ± 2° C				
PreReact	-20 to 150 mV				
Rx Cell Press	< 4 IN-HG-A (CONSTANT)				
Rx Cell Temp	40 ± 1° C				
Sample Flow	1000 cm ³ ± 100				
Sample Press	-1-5 IN-HG-A (CONSTANT)				
	Filter Change Date				
	Date of last Zero/Span adjustment				
	Comments/Notes				

Manager's Review:				
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Figure AL.8 Teledyne API T200U Equipment Maintenance Log

AL.8.1.8 COMPRESSED GAS CYLINDERS

All regulators, compressed gas cylinders containing the pollutant blends, calibration references and Ultra-Pure air must be inspected to be properly secured, connected and free of leaks. Cylinders with expired or expiring certifications, or those with pressures below 500 psi should be replaced during the maintenance period. Removal and return of cylinders is to be recorded in the logbook.

In addition to following all safety precautions when working with compressed gas cylinders, regulator installation should be performed carefully to prevent ambient air in detached regulators from back flowing into gas cylinders, contaminating the cylinder. Entrainment of ambient air into the standard cylinders will change the certified concentrations of the standard gases, resulting in errors when conducting audits. To prevent this situation, purging of the regulator is to be completed as follows:

Ensure the cylinder valve and the regulator output valve are closed and both gauges read zero pressure.

Open the cylinder valve, while leaving the regulator valve closed, allowing pressure to build in the regulator. Then close the cylinder valve.

Adjust the output regulator pressure to 25 psi using the regulator adjustment nob.

With the cylinder valve closed, open the regulator valve and use a purge valve to relieve the cylinder pressure in short bursts. Continue until the cylinder pressure is around 200 psi.

Then close the regulator valve and repeat the process 5 more times.

Regulators should be purged any time they are removed and installed on a cylinder. When installing a regulator, be sure to inspect the O-rings for any cracks or tears, as they can create a leak. Replace any damaged O-rings as needed.

CAUTION: Do not over tighten valves!

AL.8.1.9 AUDIT VAN TEMPERATURE SENSOR

The temperature sensor located on the instrument rack is to monitor the climate of the audit van laboratory compartment to verify the gaseous analyzers are operated within the 20 to 30 degree Celsius temperature range. The temperature measurements are continuously recorded.

During each quarterly maintenance period, the sensor accuracy will be verified against a temperature reference standard. For this procedure, the sensor and reference standard are to be collocated and the laboratory compartment is to remain closed. Allow at least 3- 5 minutes for the interior temperature to stabilize prior to recording the temperature from each device. Should the two readings differ by more than $\pm 2^{\circ}\text{C}$, replace or calibrate the sensor and re-test. The results of the verification and replacement of the sensor are to be recorded on the ozone line loss worksheet.

AL.8.1.10 MAINTENANCE PROCEDURES FOR SAMPLE LINES AND MANIFOLDS

All sample lines and manifolds in the audit vehicle are to be inspected annually for entrainment of contaminants such as dust or debris, loss of integrity such as cracks, holes and kinks, and compromised connections. Any suspect condition observed with the sample lines and manifolds are to be addressed by cleaning or replacement as appropriate. Completion of the inspection along with any repairs completed are to be recorded on the Line Loss Sheet and the Audit Vehicle Logbook.

The audit vehicle's gaseous system is sealed and isolated from ambient contaminants. The only inputs are via the API 701H Zero Air Generator, ozone generator or certified gas concentration cylinders. Therefore the lines and manifolds are not susceptible to contaminants that exist in ambient air, which potentially cause inaccurate measurements. As such the audit vehicles sample lines and manifolds are to be cleaned or replaced on an as needed basis.

AL.8.1.11 MAINTENACE PROCEDURES FOR LINE LOSS

The amount of ozone scavenging or scrubbing caused by the transition of the sample through the length of the audit delivery path is known as line loss. A determination for the amount of line loss is conducted on a quarterly basis by an auditor with the proper training. The line loss

procedure is described in the Through-The-Probe Criteria Pollutant Audit Procedures SOP.

AL.8.1.12 EUROTHERM PAPERLESS GRAPHIC RECORDER

The paperless chart recorder is used to record the audit van's instrument responses for each pollutant being audited along with temperature and time stamps. Data files are stored on a memory card and then transferred to the online Cabinet for archival purposes. (Ref: Eurotherm Manual, at S:\General Shared\Instrument Manuals)

AL.8.1.13 EUROTHERM TOUCH SCREEN CLEANING

The touch-sensitive screen used in the graphic recorder is designed for use by hand or by the stylus supplied only. The use of sharp or pointed implements such as pens, keys, and fingernails to operate the instrument must be avoided, or irreparable damage will be done to the surface material. When cleaning the touch-screen, a moist cloth should be used, if necessary with a minimal amount of mild soap solution.

CAUTION: ALCOHOLS SUCH AS ISOPROPYL ALCOHOL MUST NEVER BE USED ON THE SCREEN.

AL.8.1.14 EUROTHERM BATTERY REPLACEMENT

Battery replacement in the graphic recorder is recommended at least every three years. Low battery voltage is indicated when the current date and time functions are not held following the restoration of AC power. Reference the user manual for instructions on battery replacement.

NOTE: It is recommended that the battery, BR2330, be purchased from a retailer prior to installation and it is not necessary that they be stockpiled.

NOTE: All battery backed RAM data is lost during battery change. See the Eurotherm manual, Annex A for details of restoring data in the graphic recorder.

AL.8.2 MAINTENANCE PROCEDURES FOR METEOROLOGICAL EQUIPMENT

The following meteorological support equipment must be certified and/or calibrated annually. The normal period for yearly maintenance is December. If necessary, create service contracts early.

AL.8.2.1 WIND SPEED ANEMOMETER DRIVE

The wind speed anemometer is a part of the Meteorological (MET) Kit and is the only component that is certified annually. The CARB Standards Laboratory is the primary re-certification facility for a wind speed anemometer. Contact the Standards Laboratory to schedule a certification. The MET Kit contains a variety of parts and tools to adapt to different types of sensors. It should be inspected and cleaned annually. Any missing or broken pieces should be replaced.

AL.8.2.2 DIGITAL THERMOMETER

The CARB Standards Laboratory is the primary re-certification facility for temperature standards (Figure AL.9). Contact the Standards Laboratory to schedule an annual certification.



Figure AL.9 Digital Thermometer

AL.8.2.3 BAROMETRIC PRESSURE SENSOR

The CARB Standards Laboratory is the primary re-certification facility for barometric pressure sensors (Figure AL.10). Contact the Standards Laboratory to schedule an annual certification.



Figure AL.10 Barometer

AL.8.3 MAINTENANCE PROCEDURES FOR FLOW DEVICES

All standards for volumetric air flow must be certified or calibrated on an annual basis. These standards are usually sent out for calibration in December. A contract for outside vendors must be obtained before servicing the units.

The manufacturer is the primary re-calibration facility for BGI DeltaCal, TetraCal, and Hi-Vol calibrators. Should an agreement with the original manufacturer not be possible, other vendors will need to be solicited; but confirm that they are qualified to calibrate and adjust all sensors on the device, including flow, temperature, and pressure. The calibration report from the manufacturer should be reviewed and the information uploaded into AIS. Take note of any adjustments that were made to the unit. If any parameter was out of specification or had a significant adjustment, a corrective action will have to be issued to ensure the validity of previous audit results in which the affected unit was used.

NOTE: The manufacturer performs calibrations and, therefore, the slope and intercept for the device's certification equation should be 1 and 0 respectively.

AL.8.3.1 BGI DELTACAL / TETRACAL

Maintenance for these units (Figure AL.11 and Figure AL.12) includes cleaning and inspecting of O-rings and orifices. Any damaged O-rings should be replaced and any debris cleaned. Batteries should always be checked and replaced as needed. The instrument case should be kept in an orderly fashion and verified to include:

- Leak Check Valve
- PM 2.5 Filter Cassette (Blue/White)
- Spare Filters
- Green aluminum Leak Check Disc
- Spare Batteries
- DC Power Supply

NOTE: Replacement O-rings and batteries can be found in the QA supply cabinet or the MLD stockroom.



Figure AL.11 TetraCal



Figure AL.12 DeltaCal

AL.8.3.2 BGI HIGH-VOLUME CALIBRATOR (HI-VOL)

Maintenance for BGI Hi-Vol kits (Figure AL.13) includes cleaning and inspecting of gaskets, orifices, and tubing. Tubing should be checked for any kinks or loose wiring. Any damaged gaskets should be replaced, and any debris cleaned. The connection between the orifice and the plate should be checked to ensure it is not loose or stripped. Batteries should always be checked and replaced as needed. The instrument case should be kept in an orderly fashion and inspected to include:

- PM 10 Hi-Vol Filters
- Dixon Charts
- Spare Batteries

NOTE: Replacement gaskets and batteries can be found in the QA supply cabinet or the MLD stockroom.



Figure AL.13 BGI Variable Orifice

AL.8.3.3 ECOTECH HI-VOL CALIBRATOR

Maintenance for the Ecotech Hi-Vol Calibrator (Figure AL.14) consist of certifying the orifice plate and manometer and inspecting the gasket and tubing. The primary certification facility for the orifice plate is the manufacturer, which issues a certification that is valid for 5 years. The CARB Standards Lab is the primary re-certification facility for the manometer, which is required to be certified on an annual basis. The gasket and tubing should be inspected for cracks and replaced as needed.



Figure AL.14 Ecotech Hi-Vol Orifice Plate

AL.8.4 MAINTENANCE PROCEDURES FOR MASS ANALYSIS LABORATORY EQUIPMENT

The laboratory weights (Figure AL.15) and devices must be certified and/or calibrated annually. The normal period for yearly maintenance is December. If necessary, create service contracts early.

AL.8.4.1 PM MASS ANALYSIS WEIGHTS

A vendor must re-certify the weights using National Institute of Standards and Technology traceable standards and methods. This recertification is done under contract with a vendor and must be renewed on an annual basis. CARB often has one contract with the vendor which is used by various different sections.

The weights should be handled with caution when being transported or in use. Gloves and tweezers should be used when handling the weights. They should be kept away from magnetic or statically charged surfaces. These procedures are necessary to maintain the integrity of the certification.

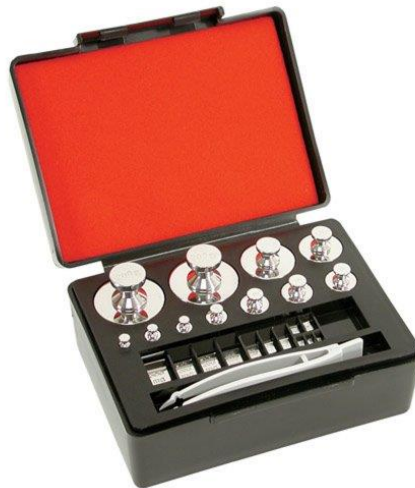


Figure AL.15 Mass Analysis Weights

AL.8.4.2 TEMPERATURE/HUMIDITY PROBES

The CARB Standards Laboratory is the primary re-certification facility for temperature and humidity standards. Contact the Standards Laboratory to schedule a certification. If they are unable to provide the service, purchasing new meters is a feasible option to having the units re-

certified. Maintenance for these sensors includes checking and replacing batteries as needed and cleaning or replacing dust filters.



Figure AL.16 Rotronic Hygropalm

AL.9.0 DATA MANAGEMENT AND RECORDS

In order to ensure the integrity of the audit system, it is important to track and document all vehicle maintenance and certifications. Each audit vehicle will have an electronic logbook with tabs for all equipment assigned to the vehicle. Each tab includes any certification and data sheets for the instrument. All hard copy certification sheets and maintenance logs are stored in the Standards File binder. Any general maintenance performed is to be logged in the vehicle logbook.

AL.9.1 GENERAL MAINTENANCE DATA

All maintenance, changes, or special events are to be logged in the Vehicle Logbook. This may include:

- Removal and return of all equipment
- Cleaning and checking of sample lines / manifold
- Maintenance of Analyzers and equipment
- Internal Temperature Checks
- Ozone Line Loss

AL.9.2 SPECIFIC MAINTENANCE DATA

All maintenance data specific to any analyzer is to be recorded on the given instrument's data sheet. This includes all internal test parameters and any calibrations performed on the instrument.

AL.9.3 AUDIT INFORMATION SYSTEM

All instrument and cylinder certification information is uploaded to AIS via a standards file every quarter to ensure the proper correction equations and cylinder concentrations are used in audit calculations.

AL.10.0 QUALITY ASSURANCE AND QUALITY CONTROL

It is important to maintain the highest level of quality control in all aspects of the program. This is accomplished by regularly performing maintenance and frequently checking the diagnostics of our analyzers. All gas analyzers are to be inspected and diagnostics recorded on the instrument check sheets. Table AL.1 below outlines the typical maintenance schedule at quarter (Q) end.

AL.10.1 FREQUENCY OF MAINTENANCE

Table AL.1 Maintenance Schedule

Q1	Q2	Q3	Q4
Line Loss	Line Loss	Line Loss	Line Loss
Internal Temperature Sensor Verification	Internal Temperature Sensor Verification	Internal Temperature Sensor Verification	Internal Temperature Sensor Verification
Gas Analyzers Check Sheets	Gas Analyzers Check Sheets	Gas Analyzers Check Sheets	Gas Analyzers Check Sheets
Ozone Standard Certification	Ozone Standard Certification	Ozone Standard Certification	Ozone Standard Certification
	Zero Air Generator Maintenance		Replace Filters for All Analyzers
	Zero Air Generator Verification		Inspect and Clean Sample Lines and Manifolds
			Flow, Temperature, Pressure, and RH Standards Certification

			Dilution Calibrator Verification
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AL.10.2 LIMITS AND CRITERIA

Control limits for all test parameters on gas analyzers can be found on the instrument's check sheet. Should any test parameter be outside of the specified control limits as designated by the manufacturer, the instrument is to be inspected and troubleshot by an experienced auditor. If the instrument requires extensive repair it should be returned to the manufacturer for repair, or replaced.

AL.10.3 CORRECTIVE ACTIONS

A corrective action may be issued if there are any missed maintenance procedures or certifications. Additionally, a corrective action may be issued if there is a parameter found to be out of specification on the check sheet for the given analyzer. The issuance of a corrective action ensures any data in question is reviewed and validated.

AL.11.0 REFERENCES

California Air Resources Board. (March 2021). Air Monitoring Quality Assurance Manual, Volume V, Appendix E. Through-the-Probe Criteria Pollutant Performance Audit Procedures, Revision 10.
https://ww2.arb.ca.gov/sites/default/files/2021-03/SOP-QAS-Through_The_Probe_Audits-vpapxe_wa.pdf

California Air Resources Board. (December 2019). Air Monitoring Quality Assurance Manual, Volume V, Appendix S. Performance Audit Procedures for Meteorological Sensors, Revision 3.
https://ww2.arb.ca.gov/sites/default/files/2020-07/v5apxs_wa.pdf

California Air Resources Board. (November 2020). Air Monitoring Quality Assurance Manual, Volume V, Appendix AN. Corrective Action Notification (CAN).
https://ww2.arb.ca.gov/sites/default/files/2020-11/can_sop.pdf

California Air Resources Board. (June 2017). Air Monitoring Quality Assurance Manual, Volume V, Appendix AO. Air Quality Data Action Request (AQDA).
https://ww2.arb.ca.gov/sites/default/files/2020-10/v5apxao_wa.pdf

NOTE: Instrument Manuals for equipment listed in this SOP can be found in the MLD Shared Drive at S:\General Shared\Instrument Manuals

AL.12.0 REVISION HISTORY

Subject	Revision 3 (2021)
New or Revised Sections	<ul style="list-style-type: none"> • Acronyms and Definitions (New) • AL.1.0 Introduction (Revised) • AL.2.0 Summary of Method (New) • AL.3.0 Interferences (New) • AL.4.0 Personnel Qualifications (New) • AL.5.0 Health, Safety, and Cautions (New) • AL.6.0 Equipment and Supplies (New) • AL.7.0 Vehicle Inspection (New) • AL.8.0 General Instrument Maintenance Procedures (Revised)

	<ul style="list-style-type: none">• AL.8.1 Maintenance Procedures for Gaseous Instruments (Revised)• AL.8.1.1 Teledyne API 701H Zero Air Module (Revised)• AL.8.1.2 Teledyne API T700U Dilution Calibrator (New)• AL.8.1.3 Teledyne API T400 Ozone Analyzer (Revised)• AL.8.1.4 Teledyne API T703U Transfer Standard (New)• AL.8.1.5 Teledyne API T300U Carbon Monoxide Analyzer (Revised)• AL.8.1.6 Picarro G2401 Gas Concentration Analyzer (New)• AL.8.1.7 Teledyne API T200U NO_x Analyzer (Revised)• AL.8.1.8 Compressed Gas Cylinders (New)• AL.8.1.9 Audit Van Temperature Sensor (New)• AL.8.1.10 Maintenance Procedures for Sample Lines and Manifolds (New)• AL.8.1.11 Maintenance Procedures for Line Loss (New)• AL.8.2.1 Wind Speed Anemometer Drive (Revised)• AL.8.3 Maintenance Procedures for Flow Devices (Revised)• AL.8.3.1 BGI DeltaCal / TetraCal (Revised)• AL.8.3.2 BGI High-Volume Calibrator (Revised)• AL.8.3.3 Ecotech Hi-Vol Calibrator (New)• AL.8.4.1 PM Mass Analysis Weights (Revised)• AL.9.0 Data Management and Records (New)• AL.9.1 General Maintenance Data (New)• AL.9.2 Specific Maintenance Data (New)• AL.9.3 Audit Information System (New)• AL.10.0 Quality Assurance and Quality Control (New)• AL.10.1 Frequency of Maintenance (New)• AL.10.2 Limits and Criteria (New)• AL.10.3 Corrective Actions (New)
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	<ul style="list-style-type: none">• AL.11.0 References (New)
New Equipment	<ul style="list-style-type: none">• AL.8.1.2 Teledyne API T700U Dilution Calibrator• AL.8.1.6 Picarro G2401 Gas Concentration Analyzer• AL.8.3.3 Ecotech Hi-Vol Calibrator
Calibration and Audit Criteria	<ul style="list-style-type: none">• Criteria for Teledyne API T400 Ozone Analyzer Revised to Quarterly certifications.• Line Loss Criteria Added