STATE OF CALIFORNIA

AIR RESOURCES BOARD

QUALITY ASSURANCE

VOLUME II

STANDARD OPERATING PROCEDURE

FOR

AIR QUALITY MONITORING

APPENDIX S

DASIBI MODEL 3008 CARBON MONOXIDE ANALYZER

MONITORING AND LABORATORY DIVISION

JANUARY 1992

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STATION OPERATOR'S PROCEDURES
FOR THE
DASIBI MODEL 3008 CARBON MONOXIDE ANALYZER

MONITORING AND LABORATORY DIVISION

JANUARY 1992

S.1.0 GENERAL INFORMATION

S.1.0.1 THEORY OF OPERATION

The Dasibi Carbon Monoxide (CO) Analyzer measures the amount of infrared light absorbed by CO in a sample of ambient air. The quantity of light absorbed is proportional to the concentration of CO in the air sample. A detailed discussion of the analyzer's measurement principle is contained in the Manufacturer's Instruction Manual. This appendix supplements the Manufacturer's Manual with instructions for servicing and troubleshooting the analyzer. Separate appendices are available for the analyzer acceptance test and calibration.

S.1.0.2 ANALYTICAL CYCLE

The analyzer determines the concentrations of CO in ambient air by passing nondispersive single beam infrared (IR) radiation through a rotating gas filter wheel to the sample cell and then the detector. The wheel contains two different entrapped gases: CO and nitrogen. The CO side of the wheel acts to produce a reference beam which cannot be further affected by CO in the sample cell. The nitrogen side of the filter wheel is transparent to the IR radiation and therefore produces a measure beam which can be absorbed by CO in non-linear proportion to the CO concentration. The detector converts the light to electrical energy, and the signal processing electronic system manipulates the electrical information and displays the CO concentration. Figure S.1.0.1 illustrates the analyzer flow. For further details, refer to the Manufacturer's Instruction Manual.

S.1.0.3 CAUTIONS

1. Prior to cleaning the analyzer, place the MAIN and PUMP power switches to the OFF position, and unplug the power cord. Avoid the use of chemical agents which might damage components.

2. Use a third wire ground on this analyzer.

3. Adhere to general safety precautions when using compressed gas cylinders (e.g. secure cylinders, vent exhaust flows).

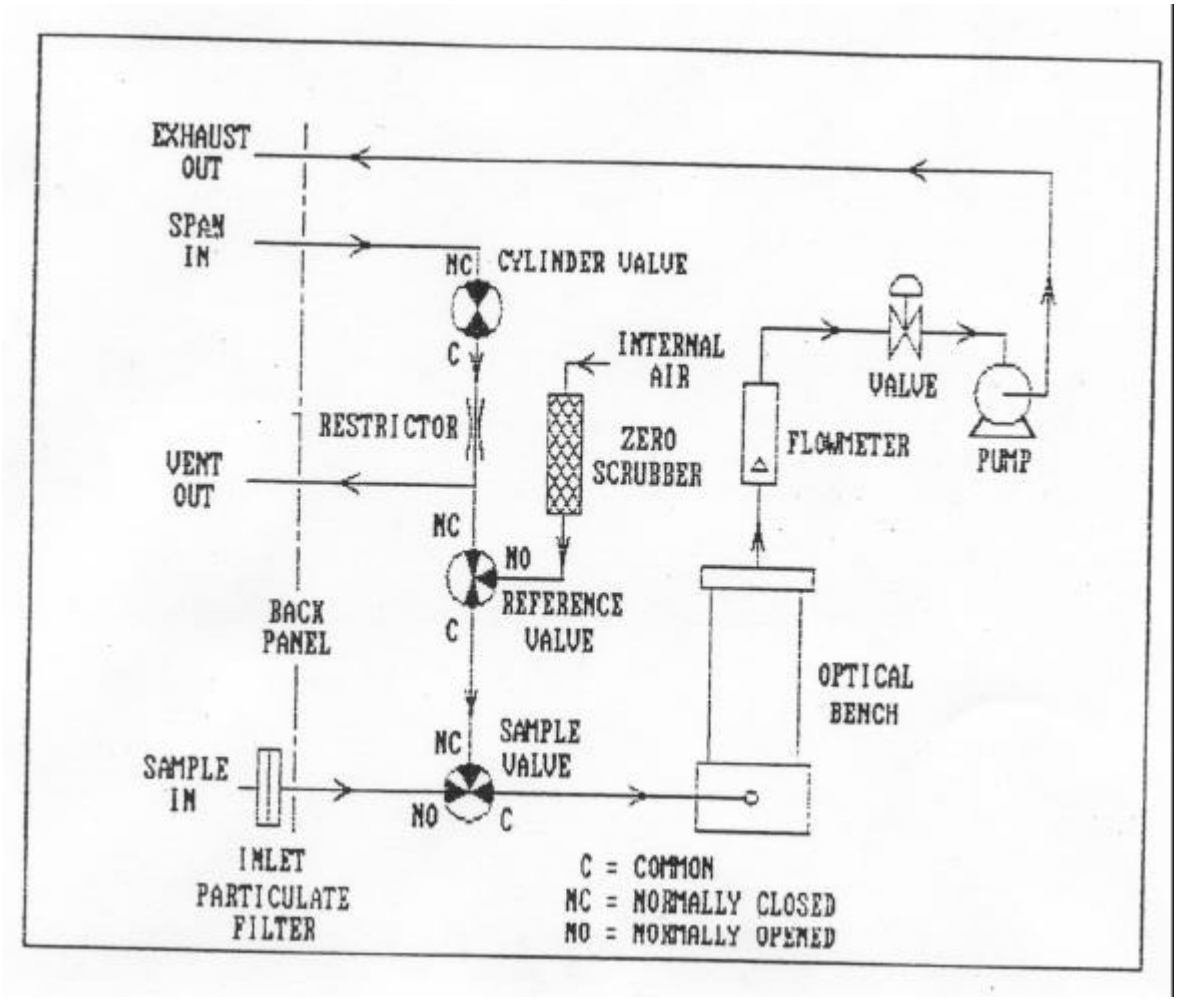

Figure S.1.0.1
Gas Flow Diagram

S.1.1 INSTALLATION PROCEDURE

S.1.1.1 PHYSICAL INSPECTIONS

1. Unpack the analyzer and check it for shipping damage.

2. Remove the cover by loosening the two thumbscrews at the back of the cover, and sliding the cover back and up. Check the plumbing for tightness. Make sure that all printed circuit boards are firmly seated, and that other components have not become loose or damaged in shipment. Replace the cover and tighten the thumbscrews.

S.1.1.2 INITIAL START-UP

1. Connect the sample line and span gas to the proper fittings on the back of the analyzer. Connect the "VENT" to an appropriate vent.

   NOTE: Do not pressurize this port.

2. Connect a recorder and the data acquisition system to the back of the analyzer.

3. Turn on the analyzer in accordance with the procedure outlined in the Manufacturer's Manual. Observe that the power indicator lamp is illuminated. If not illuminated, find and correct the malfunction.

4. Turn on the pump switch and adjust knob on flow meter to 1.0. If there is no flow indication, refer to the troubleshooting section.

5. Adjust the "AUTO" thumbwheel setting to 6 and the diagnostic thumbwheel setting to 0. (This gives an auto zero adjustment to the analyzer every 24 hours.) Ensure that this is done at a time when a peak ambient "event" is least likely to occur in your location.

S.1.1.3 ANALYZER ALIGNMENT - SEE SECTION S.1.3.4

S.1.1.4 CO SCRUBBER EFFICIENCY TEST AND CALIBRATION - SEE APPENDIX S.3

S.1.2 ROUTINE SERVICE CHECKS

S.1.2.1 GENERAL INFORMATION

The following routine service checks are performed in accordance with the maintenance schedule (Table S.1.2.1). Perform the checks at least at the prescribed intervals. A Monthly Quality Control (QC) Maintenance Checksheet (Figure S.1.2.1) should be completed weekly and the original forwarded monthly to the station operator's supervisor.

S.1.2.2 DAILY CHECKS

The front panel flow meter should indicate the flow representing approximately 1.0 slpm as indicated on the most recent calibration report. Adjust, if necessary. Check the recorder chart for indication of analyzer malfunction. Check the digital display for any flashing diagnostic message.

S.1.2.3 WEEKLY CHECKS - All initial and final readings should be recorded on the Monthly Quality Control Maintenance Checksheet.

1. Zero - Check the analyzer zero using the procedure given in the Manufacturer's Manual. Adjust the zero if the deviation is greater than $\pm$0.5% full scale (FS).

2. Span - Check the analyzer span using the procedure given in the Manufacturer's Manual. Adjust the span if the deviation is greater than $\pm$1.0% FS.

3. Sample Flow - The front panel flow meter should indicate a flow representing approximately 1.0 slpm. Adjust, if necessary.

S.1.2.4 MONTHLY CHECKS

1. Monthly Quality Control Maintenance Checksheet - Monthly, forward the checksheet to your supervisor.

2. Change the inlet particulate filter (see the maintenance section of the Manufacturer's Manual).

S.1.2.5 SEMI-ANNUAL CHECKS

1. Perform a CO scrubber efficiency test and multi-point calibration as outlined in Section S.3.0.

Table S.1.2.1

MAINTENANCE SCHEDULE FOR THE
DASIBI MODEL 3008 CARBON MONOXIDE ANALYZER

	Daily*	Weekly	Monthly	Semi-Annual
Sample Flow	X			
Chart Trace	X			
Flashing Message	X			
Zero Check		X		
Span Check		X		
Leak Check		X		
Inlet Particulate Filter Change			X**	
Quality Control Checksheet		X	X	
Clean Optics	As Required			
IR Source Replacement	As Required			
CO Scrubber Efficiency Test				X
Calibration				X

* Or each day on which an operator is in attendance.

** Environmental conditions may require more frequent change.

CALIFORNIA AIR RESOURCES BOARD
MONTHLY QUALITY CONTROL MAINTENANCE CHECKSHEET
DASIBI MODEL 3008 CARBON MONOXIDE ANALYZER

LOCATION:_____ MONTH/YEAR:_____

STATION NUMBER:_____ TECHNICIAN:_____

ANALYZER PROPERTY NUMBER:_____ AGENCY:_____

	READING: DIAL/CHART				GAS CYLINDER CONCENTRATION		SAMPLE FLOW SETTING	
DATE	ZERO		SPAN		CYL #	CYL #	AS FOUND	FINAL
	AS FOUND	FINAL	AS FOUND	FINAL	ZERO	SPAN		
	/	/	/	/				
	/	/	/	/				
	/	/	/	/				
	/	/	/	/				
	/	/	/	/				

Operator Instructions:

1) Daily Checks: Air Flow (Record Weekly), Chart Trace.
2) Weekly Checks: Zero and Span.
3) Monthly Intervals: Change Inlet Particulate Filter.
   Date Last Changed: _____
4) Semi-Annual Checks: CO Scrubber Efficiency Test and Calibration (Linearity)
   Date of Last Calibration: _____
5) As Required: Clean Optics and replace IR source.

DATE	COMMENTS OR MAINTENANCE PERFORMED:

MLD-100 (8/91) Reviewed By:_____ Date:_____

Figure S.1.2.1
Monthly Quality Control Maintenance Checksheet

S.1.3 DETAILED MAINTENANCE PROCEDURES

S.1.3.1 CHANGING THE INLET SAMPLE FILTER

Use the procedure outlined in the Manufacturer's Instruction Manual.

S.1.3.2 SERVICING THE SAMPLE PUMP

Use the procedure outlined in the Manufacturer's Instruction Manual.

S.1.3.3 CLEANING THE OPTICS

Use the procedure outlined in the Manufacturer's Instruction Manual.

S.1.3.4 ADJUSTING THE ANALYZER ALIGNMENT

Use the procedure outlined in the Manufacturer's Instruction Manual.

S.1.3.5 REPLACING THE IR SOURCE - See Figure S.1.3.1.

1. Obtain a replacement IR source unit.
2. Make sure that the power to the analyzer is turned off.
3. Remove the analyzer cover by means of two thumbscrews at the rear of the analyzer.
4. Remove the IR source unit by means of two screws that straddle the power connections.
5. Unplug the IR source unit power connector, and discard the entire unit.
6. Replace the old source with a new one. Make sure that the bare wire resistance turns face the optical bench, and not the motor.
7. Reconnect mounting screws and power cord.

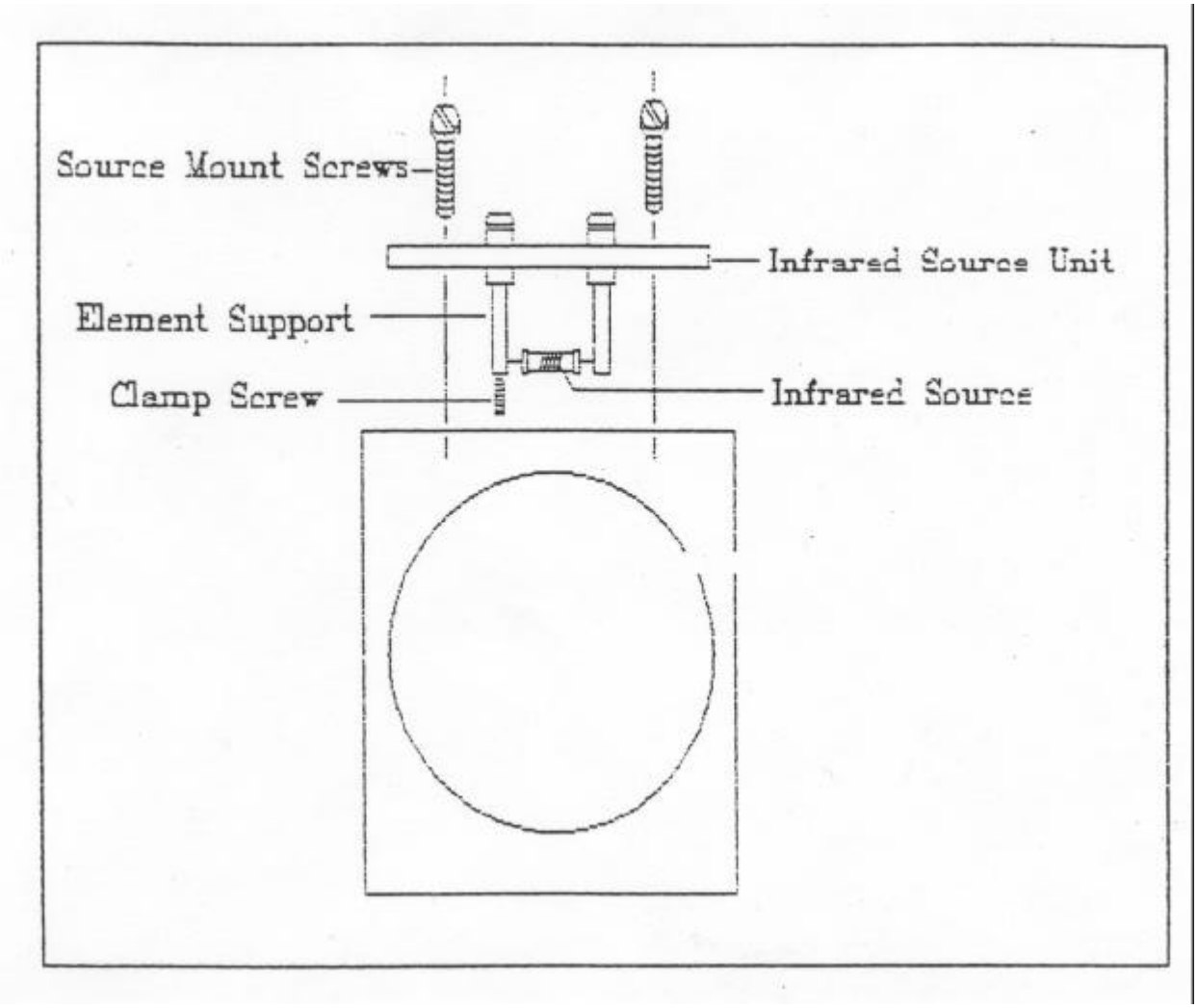

Figure S.1.3.1
Source Module Assembly

S.1.4 TROUBLESHOOTING

S.1.4.1 GENERAL INFORMATION

The Manufacturer's Instruction Manual contains information pertaining to troubleshooting and should be your first source of information. Additional problems which may occur are outlined below. Space is provided on the Monthly QC Checksheet for recording malfunctions, causes, fixes, and actions taken to prevent recurrence.

Cautions listed in Section S.1.0.3 should be observed. Additionally, when moving or installing printed circuit boards or other components, turn the analyzer off and unplug the power cord.

S.1.4.2 ELECTRONIC MALFUNCTIONS

Problem	Probable Cause	Solution
Large negative CO readings (Flashing Message- Source Failure)	Infrared source burned out	Replace infrared source
Negative CO motor readings (Flashing Messsage- Dif Sig Failure)	Chopper motor not rotating	Replace chopper
Unusually high CO readings on the recorder	Chopper motor not rotating	Replace chopper motor
Constant zero CO readings (Flashing Message- Zero Sig Failure)	Chopper motor not rotating	Replace chopper motor
Constant zero CO readings (Flashing Message- Dif Sig Failure)	Chopper motor not rotating	Replace chopper motor
Noisy Recorder Trace	Dirty optical bench	Clean optical bench

.	Flashing Message not previously mentioned		See the Manufacturer's Instruction Manual for detail

S.1.4.3 FLOW MALFUNCTION

Problem	Probable Cause	Solution
Incorrect sample flow rate as indicated on the flow meter	Leak in system	Find and stop the leak Troubleshoot the Cause

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ACCEPTANCE TEST PROCEDURE
FOR THE
DASIBI MODEL 3008 CARBON MONOXIDE ANALYZER

MONITORING AND LABORATORY DIVISION

JANUARY 1992

S.2.0 ACCEPTANCE TEST PROCEDURE

S.2.0.1 GENERAL INFORMATION

The Manufacturer's Manual should be read thoroughly before beginning analyzer acceptance testing. In addition, a maintenance log book and an Acceptance Test "Mini Report" (Figure S.2.0.1) should be initiated and pertinent information should be recorded.

S.2.0.2 PHYSICAL INSPECTIONS

Unpack the analyzer and check for physical damage if this has not already been done. Verify that the analyzer is complete and includes all options and parts required by the purchase order. Remove the top cover from the analyzer and perform the following checks:

1. Make sure that all circuit boards are properly seated in their connectors by removing and reinserting each board.

2. Check for correct power cord phasing; standard wiring configuration has the black wire connected to the brass terminal of the plug, white to the copper terminal, and green to earth ground.

3. Start up the analyzer following the procedures in the manufacturer's manual and verify that all switches and controls operate properly.

4. Leak check the analyzer using appropriate methods for the type of sampling system used.

5. Measure the output of each power supply and record the voltages in the comment section of the acceptance test mini report.

S.2.0.3 OPERATIONAL TESTS

Perform the following operational tests using a strip chart recorder connected to the analog output and record the results on the mini report. Cut the recorder charts in 24-hour segments and label the bottom of the chart with the following:

Test performed (across the bottom of chart).

Date.

Make, model number, and serial number of test analyzer.

Range on which test is performed.

Recorder trace color identification if appropriate.

Recorder identification.

Clear precise notations should be entered on the chart indicating when the tests were started and ended, pertinent information regarding sample flow, gas concentrations, voltages, interferent gases, etc., and any unusual conditions observed. Tests should be run in the range normally used in field operations. All tests should be run in parallel with a control analyzer and recorder whose charts are labeled as above.

A. Initial Start Up - See Section S.1.1.2.

B. Analyzer Alignment - See Section S.1.3.4.

C. Zero and Span Stability - Using a Dasibi 1005CA Calibration (CAL II) and an appropriate gas standard (super blend) adjust the zero and span controls of the analyzer for proper response. Manually or by using the CAL II timer program, run the zero and 80% span points. If performed manually, record mass flow controller readings on the recorder strip chart. After 24 and 72 hours, repeat the zero and span using the same CAL II settings. Using the stability test stamp record the readings on the chart at the end of each test period. Record the changes in zero and span on the mini report. Compare the responses of the test analyzer to the purchase specifications.

D. Linearity - Using the CAL II remote program #8 perform a linearity test at 80, 40, 20, 10, 8, 6, 4, 2% of full scale. The predicted response is calculated using the responses of the control analyzer as illustrated by the following table (typical responses of the Teco 14 B/E control analyzer are shown in column 2; typical responses of the CO analyzer under test are shown in column 3).

Level	Control Net %FS Chart	Test Net %FS Chart	Predicated (Calculated)	Non-linearity %FS (Calculated)
80	83.1	82.5	--	----
40	41.6	41.0	41.3	-0.3
20	20.5	20.6	20.4	+0.2
--	--	--	--	--
--	--	--	--	--
2	1.8	1.9	1.9	0.1

i.e. the predicted value at the 40 level =

$$\frac{41.6}{83.1} \times 82.5 = 41.3$$

The non-linearity at this level is 41.0 - 41.3 = -0.3%

Record the test results on the chart using the rubber stamp form and transfer the non-linearity numbers to the mini report. Compare the responses of the test analyzer to the purchase specifications.

E. Temperature and Voltage Stability - Place the test analyzer in the Thermotron environmental chamber and connect the analyzer power cord to the variable voltage power strip. Connect the sample inlet to the sample manifold supplied with the CAL II output. The control analyzer should remain external to the chamber running on normal house power. Run a temperature/voltage run using Thermotron program number 7 while the test and control analyzer are sampling zero air. Repeat the temperature/voltage run while the analyzers are sampling a concentration equal to 80% of full scale. Record the tests results on the chart using the rubber stamp form. Compare the responses of the test analyzer to the purchase specifications. Transfer the tests results to the mini report.

F. Noise - The peak to peak noise during any of the tests should be less than 2 x the specification. Record the maximum peak to peak noise during the zero and span stability tests on the mini report.

G. CO Scrubber Efficiency - Perform an efficiency test on the CO converter using the procedure outlined in Appendix S.3.

H. Calibration - Perform a multipoint calibration on the analyzer using the calibration procedures outlined in Appendix S.3.

NOTE: Analyzer must be calibrated for the range on which it will be operated.

S.2.0.4 FINAL REVIEW

If acceptance tests are satisfactory, an equipment relocation notification tag should be completed, and pertinent information such as final sample flow, zero, and span settings, etc. should be recorded in the log book and on the Acceptance Test "Mini Report." The analyzer is ready for field use.

DASIBI MODEL 3008 CARBON MONOXIDE ANALYZER
ACCEPTANCE TEST "MINI REPORT"

Date _____ Serial No. _____ Reviewed by _____
By _____ ARB No. _____ Date of Acceptance _____

I. PHYSICAL INSPECTIONS

	Pass	Fail	Final OK
A. Checked for shipping damage.....			
B. Checked all electrical wiring...			
C. Checked all plumbing for leaks..			
D. Analyzer complete upon receipt..			

II. OPERATIONAL TESTS (All tests performed on 0-50 ppm range)

A. Acceptable Diagnostic Values. (See Analyzer Manual)

	% FS Dev.	Pass	Fail	Final OK
B. Zero and Span Drift				
1. 24 Hour Zero Drift.....				
2. 24 Hour Span Drift@ _____ppm.....				
3. 72 Hour Zero Drift.....				
4. 72 Hour Span Drift@ _____ppm.....				
C. Line Voltage Test (105-125 VAC @ _____ ppm).....				
D. Temperature Test				
1. Zero Shift: Step 1 _____°C to _____°C.....				
Step 2 _____°C to _____°C.....				
Step 3 _____°C to _____°C.....				
2. Span @_____ppm Step 1 _____°C to _____°C.....				
Step 2 _____°C to _____°C.....				
Step 3 _____°C to _____°C.....				
E. Sample Flow Variation Test @_____ slpm.....				
F. CO Scrubber Efficiency Test.....				
G. Linearity				
1. 80% Full Scale @ _____ppm.....				
2. 40% Full Scale @ _____ppm.....				
3. 20% Full Scale @ _____ppm.....				
4. 10% Full Scale @ _____ppm.....				

H. Final Analyzer Readings
Sample Flow: _____sccm @ _____ Flow Setting; Span Pot: _____; Range: _____

III. SPECIAL TESTS

IV. COMMENTS/ MAINTENANCE PERFORMED

MLD-114 (12/91)

Figure S.2.0.1
Acceptance Test "Mini Report"

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CALIBRATION PROCEDURES
FOR THE
DASIBI MODEL 3008 CARBON MONOXIDE ANALYZER

MONITORING AND LABORATORY DIVISION

JANUARY 1992

S.3.0 CALIBRATION PROCEDURE

S.3.0.1 INTRODUCTION

The Air Resources Board calibrates carbon monoxide (CO) analyzers using a precise quantitative dilution, with air, of a compressed cylinder of known CO gas. A compressed gas cylinder of CO is diluted with zero air. Zero air is mixed with the CO using a calibrated dilution apparatus to provide five concentrations from 0 to 90% of the analyzer's operating range. The CO standard is initially certified against a NIST-SRM and thereafter recertified annually. The dilution apparatus (mass flow controller, etc.) is also certified and recertified every three months against laboratory flow standards. The procedures described herein were written for the Dasibi Model 3008 CO analyzer but may be adapted to any CO analyzer.

S.3.0.2 APPARATUS

Figure S.3.0.1, a diagram of a typical CO dynamic calibration system. Connections between components in the calibration system downstream from the CO cylinder should be of glass FEP Teflon*, or other non-reactive material.

1. Dilution apparatus including two calibrated mass flow controllers (MFCs), two digital panel meters (DPM), manual or solenoid valves for positive gas shut-off, such as a Dasibi 1009 MC Calibrator or equivalent.

2. CO Standard - Certified and traceable to a NIST CO Reference Material.

3. Zero Air - Air containing <0.1 ppm CO provided by the Aadco zero air system, CSI calibration unit, or zero air cylinder.

4. One-quarter or one-eighth inch FEP Teflon tubing for airflow connections. All fittings in contact with CO must be made of 316 stainless steel or FEP Teflon.

5. Calibration Datasheet (Figure S.3.0.2)

---

* Trademark of Dupont Corporation.

S.3.0.3 AS IS CALIBRATION

Other than routine daily checks, analyzer repairs or adjustments should not be made prior to the As Is calibration.

1. Record analyzer parameters and site conditions on the Calibration Datasheet (Figure S.3.0.1).

2. Check the CO scrubber efficiency.

   a. Establish a zero reading on the analyzer using the diluent gas employed for the multipoint calibration. This is conveniently done by having the AUTO thumbwheel switch on POSITION 9, so that the ZERO solenoid is not activated in the process of setting the display to zero.

   b. Set the AUTO thumbwheel switch back to 0, and press the front panel ZERO pushbutton so that zero gas from the scrubber is sampled.

   c. Allow the scrubbed air from the catalytic CO scrubber to be sampled long enough to assure a stable reading (at least five minutes). Do not during this time, press the sample button. This will cause the panel display to go to zero.

   d. The value for CO that the internal scrubber registers on the display or recording device should not exceed +0.5 ppm. It should be recorded along with other calibration data, and should be constant from one calibration interval to another. If it does not, the scrubber needs regeneration and instructions for doing this are given in the manufacturer's instruction manual.

3. Precautions must be taken to remove contaminants from the CO pressure regulator:

   a. Purge the regulator and delivery system with CO to a safe vent after opening the cylinder valve.

b. If possible, leave the regulator on the cylinder between calibrations (only if there is no transport involved).

4. Find the CO operating range.

5. Using FEP Teflon tubing, connect the CO and zero air to the appropriate inlet fittings on the Dasibi 1009.

6. Disconnect the analyzer's sample probe at the station's sampling manifold and connect it to the outlet manifold of the dilution system apparatus. Cap the open port on the station's sampling manifold.

7. If using a zero air cylinder, attach and flush the zero air regulator, being careful not to introduce contamination.

8. Once the dilution air flow rate is chosen, determine the required flow of CO gas to obtain approximately 90% of full scale. (Use the following equation and those provided with the mass flow meter transfer standards. Record the mass flow meter equations on the Calibration Datasheet). Do not adjust either MFC to less than 10% of full scale.

$$F_{CO} = \frac{(C_O)(F_a)}{C_{CO} - C_O}$$

where: F_{CO} = CO flow, sccm

F_a = Air flow, sccm

C_{CO} = CO cylinder concentration, ppm

C_O = desired concentration (diluted CO concentration, ppm)

9. Press the SAMPLE pushbutton switch on the front panel. Open the air regulator outlet valve on the dilution apparatus; set the flow so that when the CO gas flow rate is at its maximum, the diluted CO concentration is calculated to be approximately 90% of full scale. The total flow must exceed the total

demand of the analyzer(s) connected to the calibrator's output manifold to insure that no ambient air is pulled into the manifold vent (see caution note below). Allow the analyzer to sample zero air until a stable zero response is obtained. Adjust the analyzer's zero control to obtain the required zero set point on the chart recorder and again allow the analyzer to stabilize. Obtain approximately 10 minutes of stable recorder trace and record the response on the Calibration Datasheet.

10. Adjust the CO gas flow (F_{CO}) to the value calculated in Step 8 with the MFC potentiometer set to obtain approximately 90% of full scale. It may require an hour or more for the reading to stabilize as the MFC, dilution apparatus, and analyzer must be conditioned to the calibration gas.

    CAUTION: Vent or scrub the excess CO from the outlet manifold to the outside using a large diameter vent line.

11. After the recorder chart response has stabilized, record the MFC displays and calculate actual sccm for the CO gas and dilution air flow, and the recorder chart response on the Calibration Datasheet.

12. Reset the CO MFC potentiometer to obtain responses of approximately 50%, 20%, and 10% of full scale. After the analyzer has stabilized for each point, record the MFC displays and calculate actual sccm and the corresponding recorder chart response on the Calibration Datasheet.

13. Repeat the zero reference point (Step 9). Allow the zero trace to stabilize on the recorder chart. The zero response should reproduce the original zero within 1% of full scale. If it does not, determine the cause and correct the problem before continuing (refer to Section S.1.4.2, Electronic Malfunctions).

14. Calculations:

    NOTE: The calculations assume that the CO analyzer is linear, i.e the calibration curve of the net chart recorder response versus concentration is a straight line within 1% of full scale at each point. If it is not, troubleshoot the analyzer and calibration system and correct the problem before continuing.

a. Calculate the CO and dilution air flow rates, sccm, using the certification equations provided.

b. Using the flow rates calculated for Steps 7 and 11, in sccm, calculate the true CO concentration for each calibration point. Record under "[CO]" on the Calibration Datasheet.

$$\text{True CO, ppm} = \left[\frac{(C_{CO})\,(F_{CO})}{F_{CO} + F_a} \right]$$

c. Determine the net DAS response in ppm subtracting the average DAS zero response.

d. Calculate the deviation from true CO concentrations:

$$\%\ \text{Dev} = \left[\frac{\text{CO Net DAS}}{[CO]_{out}} \right] - 1 \quad X\ 100\%$$

Where Net DAS = Net Data Acquisition System

NOTE: Data for the above equations are recorded on Calibration Datasheet.

e. Calculate the least square linear regression coefficients (slope and intercept) using all calibration points including zero points and record on the Calibration Datasheet.

$y = mx + b$

Where x = true CO concentration, ppm = $[CO]_{out}$
y = Net DAS, ppm
m = slope (unitless)
b = y-intercept, ppm

f. Calculate the "As Is" change from the previous calibration:

g. Plot the CO calibration curve, Net DAS or net chart versus $[CO]_{out}$.

h. If the slope, m, is between 0.95 and 1.05, and b agrees with the zero reading within 1% of full scale, then the analyzer is in calibration, and no further adjustments are needed.

S.3.0.4 FINAL CALIBRATION

If the slope, m, calculated in Step 14e is less than 0.95 or greater than 1.05, an adjustment and "final" calibration are necessary. Adjust the CO analyzer to correct the deviation as follows:

1. Repeat the 90% of full scale span concentration (Section S.3.0.3, Step 8).

2. Adjust the front panel thumbwheel switch until the analyzer reads the true CO concentration.

   NOTE: Increasing the thumbwheel switch number increases the analyzer's response.

   Decreasing the thumbwheel switch number decreases the analyzer's response.

3. Repeat the zero reference point (Section S.3.0.3, Step 9).

4. Repeat Steps 1 to 3 in this section until no further adjustments are needed.

5. Repeat calibration points (90%, 50%, 20% and 10% of full scale) for the final calibration. Complete the Calibration Datasheet and a calibration curve.

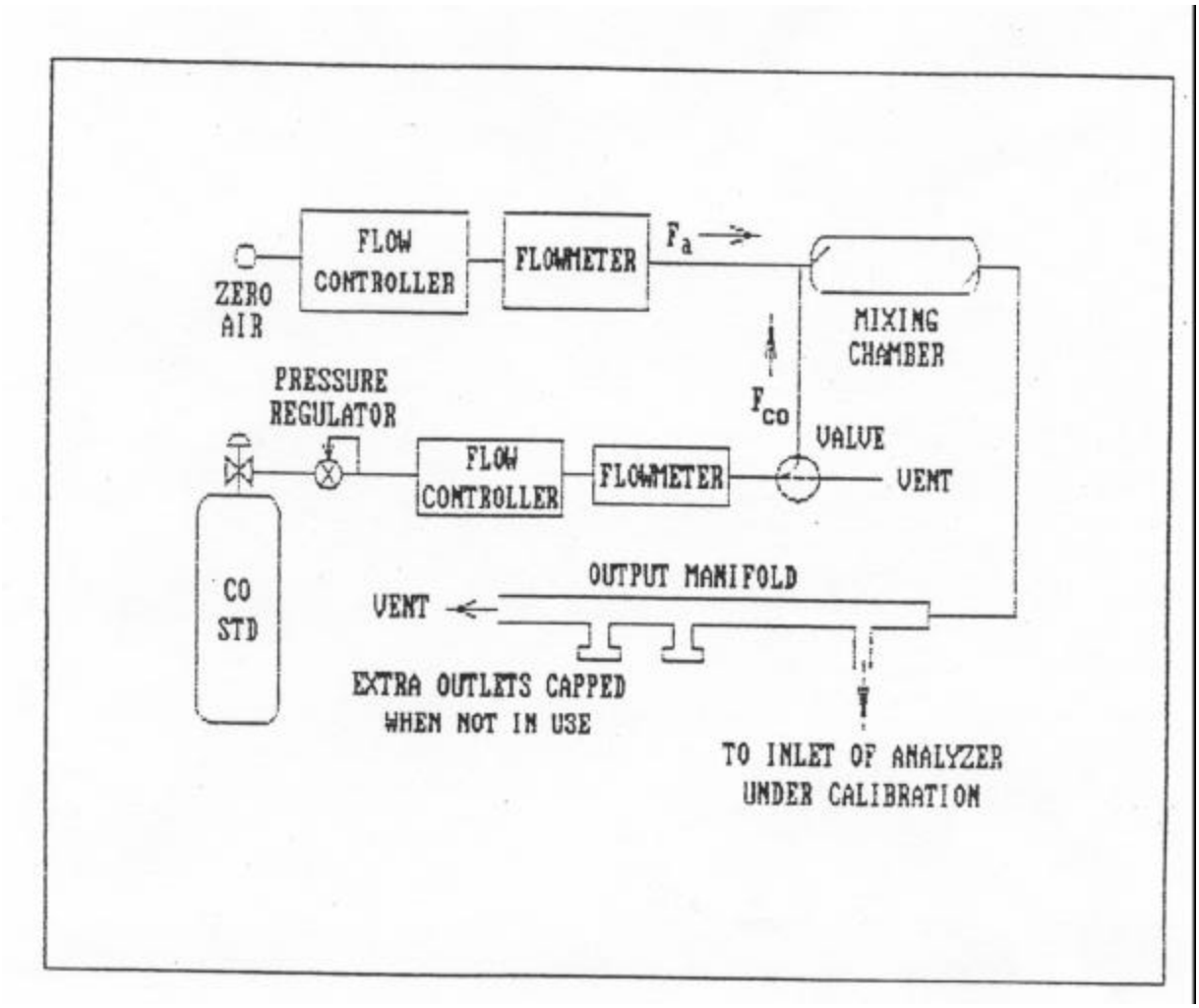

Figure S.3.0.1
Diagram of a Typical CO Dynamic Calibration System

CALIFORNIA AIR RESOURCES BOARD
DYNAMIC CO CALIBRATION DATA SHEET

Site Name _____ Calibration: As Is _____ Final _____
Site No. _____ Date _____ Log No. _____
Site Temperature _____ Barometric Pressure _____ Site Elevation _____

INSTRUMENT: Make and Model _____ Property No. _____
Serial No. _____ Span _____ Zero _____
Range _____ Airflow _____ slpm. at _____ setpoint
Primary Data Acquisition System (DAS): Make and Model _____
Property No. _____ Serial No. _____

TRANSFER STANDARD: Make and Model _____ Property No. _____
Serial No. _____ Date Certified _____ Cert. Expires _____
0-100 sccm MFC: Airflow = _____ Display ± _____ sccm (CO gas)
0-10 slpm MFC: Airflow = _____ Display ± _____ slpm (dilution)

COMPRESSED GAS CYLINDER: Cylinder No. _____ Cylinder Pres. _____ psi
Assay _____ ppm. Date Certified _____ Cert. Expires _____
Outlet Pressure _____ psi

DILUTION AIR: Source _____ Property No. _____
Outlet Pressure _____ psi

Transfer Standard					$[CO]_{out}$	Instrument		
CO Gas Flow		Dilution Flow		Total Flow		Chart	DAS	Net
Display	sccm	Display	sccm	sccm	(ppm)	(% FS)	(ppm)	DAS
				Σ			Σ	

Percent deviation from true: $\left[\frac{\Sigma \text{CO Net DAS}}{\Sigma [CO]_{out}} - 1\right] \times 100\% =$ _____ %

Linear regression: Analyzer response, ppm = (_____) × $[CO]_{out}$ ± (_____)
Slope Intercept

As is change from previous calibration, dated _____ :

$\left[\frac{\text{As is Slope} - \text{Old Slope}}{\text{Old Slope}}\right] \times 100\% =$ (_____) × 100% = (_____) :

Comments: _____
Calibrated by: _____ Checked by: _____

Figure S.3.0.2
CO Calibration Datasheet