STATE OF CALIFORNIA

AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME II

STANDARD OPERATING PROCEDURES
FOR
AIR QUALITY MONITORING

APPENDIX G

DASIBI MODEL 1005 C_2 GAS CALIBRATION SYSTEM

MONITORING AND LABORATORY DIVISION
APRIL 1989

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VOLUME II

STANDARD OPERATING PROCEDURES
FOR
AIR QUALITY MONITORING

APPENDIX G.1

STATION OPERATOR'S PROCEDURES FOR DASIBI MODEL 1005 C_2 GAS CALIBRATION SYSTEM

MONITORING AND LABORATORY DIVISION

APRIL 1989

G.1.0 GENERAL INFORMATION

A detailed discussion of the calibrator is contained in the manufacturer's instruction manual. Separate appendices are available for calibrating the system and for reviewing the collected data.

This appendix supplements the manufacturer's manual with instructions for installing, servicing, and troubleshooting the calibrator.

G.1.0.1 SYSTEM DESCRIPTION

The Dasibi Model 1005 C_2 Gas Calibration System is capable of providing known, ambient level concentrations of pollutant gas by using:

1. precise dilutions with zero air of a high concentration compressed gas (CO, NO, SO_2 , and CH_4 in N_2) or ozone from an ozone generator,

2. gas phase titration of nitric oxide with ozone to produce nitrogen dioxide, or

3. permeation tubes.

The calibrator has four operating modes (also see Programming):

1. Timer mode - This mode has a four-step automatic program initiated every 24 hours by an internal timer (timer program).

2. Auto mode - This mode has a four-step automatic program and is initiated every 7 days by a separate internal timer (auto program).

3. Manual mode - This mode allows complete operator control of air and gas flows and ozone concentrations to produce desired concentrations of pollutants. It is initiated by the manual actuation of the front panel "MANUAL" mode switch and is controlled by operator adjustment of the front panel thumbwheel adjustments.

4. Remote mode - This mode has 8, separate, pre-programmed calibration sequences that are typically actuated by a signal from the remote telemetry central. This program was designed for verification of analyzer response before and after air pollution episodes.

G.1.0.2 PHYSICAL DESCRIPTION

The calibrator consists of two separate chassis: an electronics chassis, which contains the control circuitry plus the power supplies for the entire system; and a pneumatics chassis, which contains the solenoid valves, two mass flow controllers (.6-30 SLPM and 2-100 SCCM), permeation tube oven, ozone generator, and reaction chamber. (At this time, the permeation tube oven is not being used.) The two chassis are interconnected by an umbilical cable.

G.1.0.3 PROGRAMMING

Listed below are the programs that the ARB uses for its calibrators. Actual concentrations and flowrates may differ from those given below due to expected variations in the final mass flow controller and ozone generator calibrations and the concentrations of pollutant gas contained in the compressed gas cylinder. Step times are estimated at 20 minutes but may be varied depending upon the needs of each particular station (see Section G.1.3.1). The programs are based on the following analyzer ranges: CO 0-50 ppm, CH_4 0-50 ppm, NO/NO_x 0-1 ppm, and SO_2 0-.5 ppm.

Verify that the step time is sufficient to achieve a stable trace. Verify that the auto program has enough time to complete all steps. The Cal II daily timer program (zero and span check) will be standardized to begin at 3:45 a.m. PST and will not be changed to reflect seasonal variations, except in special situations resulting from atypical diurnal pollutant patterns. The Cal II daily timer program will operate Monday through Saturday. The Cal II Auto Program (precision check) will operate every Sunday at 3:45 a.m. PST, except in the special atypical situation mentioned above.

1. Timer Program

Step No.	Air Flow (SLPM)	Gas Flow (SCCM)	Concentrations (ppm) CO	CH_4	SO_2	NO	NO_2	O_3	Cumulative Time (minutes)
1	15.0	0	0	0	0	0	0	0	20
2	15.0	99.0	36	16	.36	.70	0	0	40
3	15.0	99.0	36	16	.36	.20	.50	0	60
4	15.0	0	0	0	0	0	0	.50	80

System Stop

2. 4-Step Auto Program*

Step No.	Air Flow (SLPM)	Gas Flow (SCCM)	CO	CH_4	SO_2	NO	NO_2	O_3	Cumulative Time (minutes)
			Concentrations (ppm)						
1	15.0	0	0	0	0	0	0	0	20
2	15.0	25.0	9	4	.09	.18	0	0	40
3	15.0	25.0	9	4	.09	.09	.09	0	60
4	15.0	0	0	0	0	0	0	.09	80
System Stop									

*This program is designed to provide for automatically generating the U.S. EPA precision test concentrations of CO, SO_2 , NO_2 , and O_3.

G.1.0.4 CAUTIONS

1. The secondary winding of the UV lamp high voltage transformer contains 1400 VAC. Use normal high voltage precautions when working on the calibrator. Do not work on the calibrator with the power on unless the test absolutely requires it, and then only after removing all your watches, rings, etc.

2. The ozone generator contains an ultraviolet lamp, which emits UV light that can cause burns to the cornea. Use UV safety glasses to view the lamp, or look at it only for a second from a distance over three feet.

3. The calibrator contains open terminals and conductor paths carrying 120 VAC.

4. Destruction of the integrated circuits may occur if the printed circuit boards, internal connectors, or umbilical cable are disconnected while power is applied to the calibrator. Destruction of the integrated circuits will occur if the electronics chassis is operated without the pneumatics chassis connected via the umbilical cable.

5. Operate the calibrator with the covers on each chassis.

6. The UV lamp high voltage transformer on the pneumatics motherboard is extremely sensitive. To avoid damage to this transformer, handle this section carefully, avoiding sudden jolts or jars.

G.1.1 INSTALLATION PROCEDURE

G.1.1.1 PHYSICAL INSPECTIONS

Unpack the calibrator and check for external shipping damage. Remove the covers and check for loose PC boards, relays, etc. Check all fittings for tightness.

G.1.1.2 INITIAL SET-UP (SEE FIGURE G.1.1.1)

1. Rack mount the calibrator in close proximity to the end of the sampling manifold and, when available, the Monitor Labs Model 9300 or 9400. Where a rack is not available, set the chassis side-by-side on a flat, level table.

2. Connect the umbilical cable from the pneumatic chassis to the electronic chassis. Connect the power cord from the calibrator to the appropriate AC outlet.

3. Depress the "POWER" mode select switch. At this point, the "POWER" lamp, "STOP" lamp, and "NON-OP" lamp will light. The "NON-OP" lamp will remain on for approximately 30 minutes while the permeation oven and ozonator reach their operating temperatures. Calibrators with serial numbers greater than 0022 have an LED number in the right hand display. The number “7” will appear when the calibrator is ready for operation.

4. Connect the "VENT" output at the rear of the pneumatics chassis to a vent, which exhausts external to the station at a point where the sampling probe will not draw in the vented gases. Use 1/4" O.D. tubing and the shortest length possible.

G.1.1.3 THE 24-HOUR TIMER

The 24-hour timer is located at the rear of the electronic chassis. The timer activates the calibrator timer program. Upon installation, you must set the desired starting time of the timer program, set the timer to Pacific Standard Time (PST), and arm the timer (or enter the program into memory). Instructions for both types of timers follow.

1. Mechanical Timer

    a. Set Starting and Ending Times - There are two tabs on the timer, an orange one that is labeled "on" and a black one labeled "off".

Set the two tabs side-by-side with the orange tab first as the clock rotates clockwise (tabs can be moved by depressing the tabs and rotating). Set the Timer program start time by rotating the orange and black tabs together until the mark line on the orange tab coincides with the desired starting time. The starting time should be set to minimize the loss of ambient air quality data (i.e., set 10 minutes before the hour) and to avoid interruption of maximum hourly average values.

b. Set Time of Day - Rotate the timer wheel clockwise until the actual time of day (PST) is indicated opposite the large arrow. If the front panel TIMER indicator light has gone on during this operation, depress the STOP switch.

c. Arm the Timer - Verify that the front panel TIMER indicator light is off. Depress the 24-hour timer on-off switch once. Wait 5 seconds while observing the front panel. If the TIMER indicator light does not go on, the timer is armed and no further action is needed. If the TIMER indicator light does go on, depress the STOP switch and depress the 24-hour timer on-off switch again.

2. Electronic Timer

a. Set Time of Day - Press the top left button. The clock will halt. Set the actual time using the "h" and "m" buttons. Note the clock runs on military time (2 a.m. is 2:00 and 2 p.m. is 14:00). Set the day of the week using the "1-7" button. A solid bar will appear over the day number (1 = Sunday, 2 = Monday, etc.). Press the program button "pr". The time is now set and running. This will be indicated by the blinking colon (:) between the hour and minute digits.

b. Set Starting and Ending Times - Press the I/O button once. The upper display will read 0:00. Set the "on" time using the "h" and "m" buttons. Select the day or days of the week by using the "1-7" button. Press the "q" button after each selected day. Do not press the "q" button after days you wish to skip. A solid bar will remain above each selected day. Press the "I/O" button again. The lower display will read: 0 0:00. Set the off time using the "h" and "m" buttons. Select the days that the off command should occur using the "1-7" and "q" buttons. Note it is necessary to enter one off day for each on day entered (e.g. if you have the on time programmed to occur three times a week, it is required that there are three off days selected).

c. The timer has two switches: S1 (auto) and S2 (TIMER). Each switch must be engaged by pressing "q" in order to store the program.

NOTE: If for any reason the program on the display is incomplete, the processor will not accept it and will flash the incorrect or missing information.

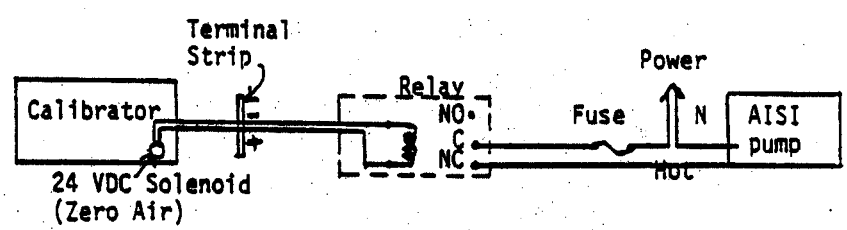
d. To Review Programs Stored in Memory - Press the "ch" button twice. The display will show the first program in the memory. To check the next program, depress the "ch" button once more. This procedure can be continued to check all programs stored. Depress the "pr" button to return to clock display.

e. To Change a Program Stored in Memory - Depress the "ch" button as often as necessary to display the program you wish to alter. To eliminate the entire program, depress the recessed "C" button. Enter in the new program as instructed above.

G.1.1.4 MANIFOLD CONNECTION

1. Connect the calibrator outlet to the sample manifold farthest from the end of the probe inlet so that the calibrator output will purge the manifold. If there is a pump pulling on the manifold, a three-way solenoid valve should be installed on the calibrator. The solenoid valve should be connected, so that it actuates in conjunction with the calibrator sample output solenoid valve. Connect the common port to the pump and the normally open port to the sample manifold. Leave the normally closed port open to room air (see Figure G.1.1.1). All tubing in contact with the calibration gas should be Teflon or stainless steel; all fittings should be stainless steel.

2. If there is an AISI sampler on the manifold, the AISI pump should be turned off during calibrator operation due to its excessive flow requirements. This can be accomplished by wiring a 24 VDC relay (8 amp, single throw, single pole, normally closed) in line with the AISI pump and the 24 VDC calibrator zero air solenoid. The connections are shown below.



3. Place the calibrator in "MANUAL ZERO" and set the zero air thumbwheel to 15.0 representing 15.0 SLPM. Disconnect the manifold at a point upstream of all the analyzers. Connect a flowmeter to the manifold and verify that there is excess flow at this point. If there is no excess flow, contact your supervisor for further instructions.

G.1.1.5 COMPRESSED GAS CYLINDER CONNECTION

A compressed gas cylinder containing a high concentration mixture of CO/SO /NO/CH in nitrogen and a stainless steel regulator (CGA 660) are provided with the calibrator. SINCE THIS CYLINDER CONTAINS HIGH CONCENTRATIONS OF POLLUTANT GASES, EXTREME CAUTION SHOULD BE EXERCISED IN ITS USE. Typical gas concentrations in this mixture are listed in Table G.1.1.1.

The connection procedure is:

1. Secure the gas cylinder as close to the calibrator as possible.

2. Connect the two-stage stainless steel pressure regulator (CGA 66O) to the gas cylinder. (Note: Use this regulator only on high concentration compressed gas cylinders.)

3. Run a length of copper tubing from the safety relief valve on the second stage of the regulator to an appropriate vent. Set the safety relief valve for 70 psig. Secure the copper tubing to a wall or other suitable fixed structure. Using copper tubing and securing the tubing prevents the tubing from separating from its connections in the event of a sudden pressure release.

4. Connect a section of 1/8-inch stainless steel tubing from the regulator to the calibrator NO input. Use all stainless steel fittings. After tightening, turn the gas cylinder on. Set the output pressure to approximately 30 psig. Leak check the regulator and lines up to the input of the calibrator carefully and secure any leaks. Reduce the output pressure to approximately 15 psig.

G.1.1.6 MONITOR LABS MODEL 9400 DATA LOGGER CONNECTION

1. General Information - The Monitor Labs Model 9400, Telemetry System Data Logger, operating with the complete ADAM III computer program, can be instructed to perform certain functions upon command from the telemetry central. These functions include the closing of certain relay

contacts and the transmitting of relay status information to the telemetry central. This function is called Supervisory Control, and it can be used to control the Dasibi Model 1005 C_2 Gas Calibration System from the telemetry central in Sacramento.

2. Installation - The Dasibi Gas Calibration System is connected to the Monitor Labs Model 9400 Data Logger through interface cable #CB-3. A complete wiring diagram is shown in Figure G.1.1.2 and a cable diagram is shown in Figure G.1.1.3. The interconnecting cable has three plugs on one end and one plug on the other end. The single plug is connected to the "REMOTE" connector on the rear of the electronic chassis of the Dasibi Gas Calibration System. The three plugs on the other end of the cable are connected to the Contact Closure Input Card (#940B0217) and the Contact Closure Output Card (#940D0212) at the rear of the Model 9400 Data Logger, in the following manner. The plug marked "P1-CCI-940B0217" must be connected to the CCI card (with terminals #A and #1 on top), and the plugs marked "P1-CCO-940D0212" and "P2-CCO-940D0212" must be connected to the CCO card (with terminals #A and #1 on top). The "P1-CCO" plug is connected to the top connector on the CCO card, and the "P2- CCO" plug is connected to the bottom connector on the CCO card.

3. Check-out - After a data logger is connected to the calibrator, contact the Instrumentation and Operations Support Section at (916) 323-5926 in Sacramento. They will check the supervisory control function from the telemetry central and verify that correct analyzer status is being transmitted to the telemetry central.

G.1.1.7 MONITOR LABS MODEL 9300 DATA LOGGER CONNECTION

1. General Information - The Monitor Labs Model 9300 Data Logger and the Tektronix Model 4923 Digital Tape Recorder may be used at air qua1ity monitoring stations to scan, average, and record ambient air quality and calibration data. The data will be recorded on magnetic tape to be hand-carried, transmitted by modem, or mailed to PTSD headquarters in Sacramento for analysis and evaluation.

   The Dasibi Gas Calibration System and the Model 9300 Data Logger can be interfaced with the Automatic Gas Calibration System to achieve proper flagging of calibration data. This is achieved by connecting interface cable CB-4 between the Dasibi Automatic Calibration System and the Model 9300 Data Logger.

Table G.1.1.1

Approximate Cylinder Concentrations
For Specific Analyzer Ranges

Group Number	Pollutant	Analyzer Range (ppm)	Compressed Gas Concentration (ppm)	ARB Part No.
1.	CO	0-50	5,420	11-01600
	SO_2	0-.5	55	
	NO	0-1	106	
	CH_4	0-50	2,426	

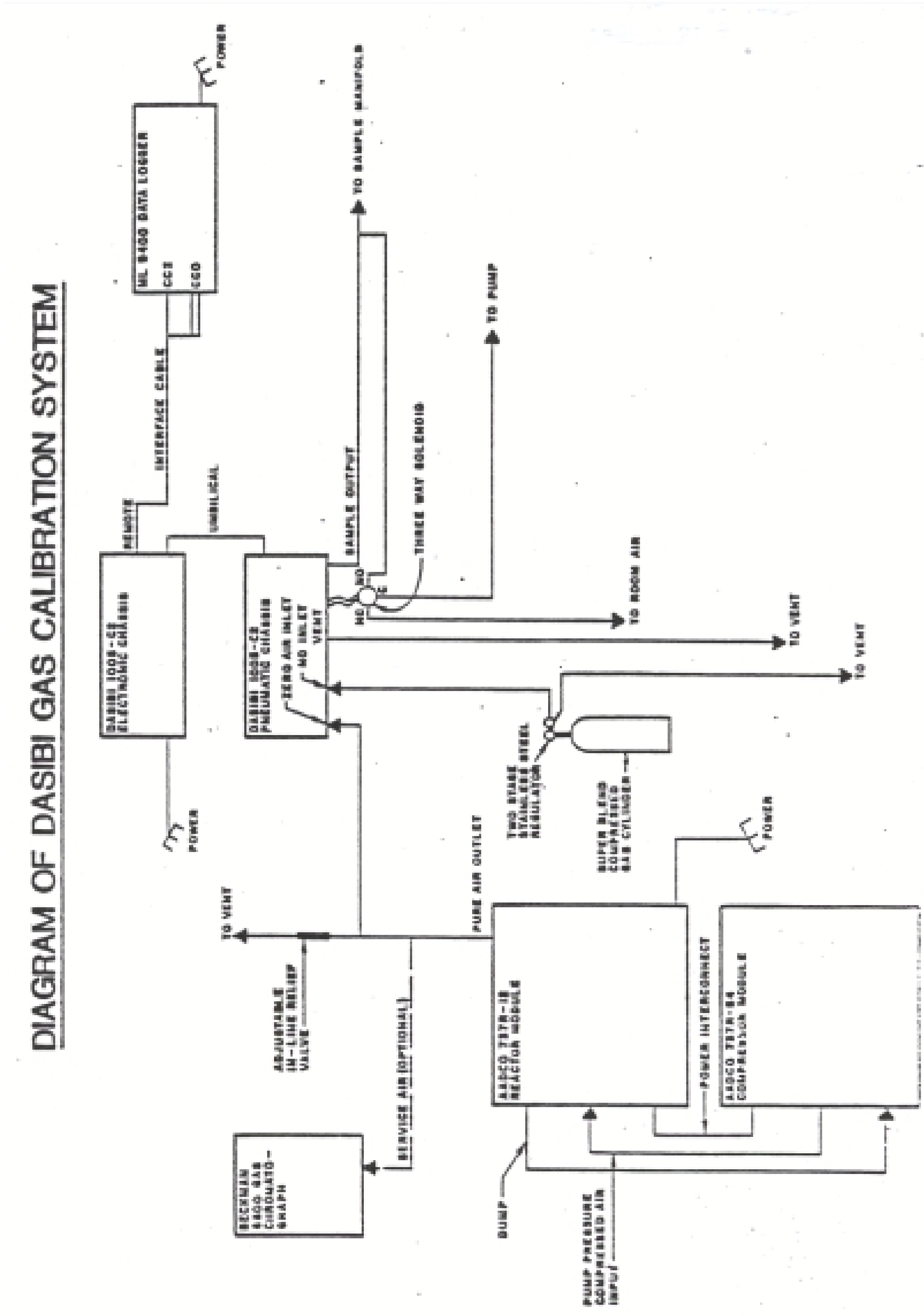


Figure G.1.1.1
Diagram of Dasibi Gas Calibration System

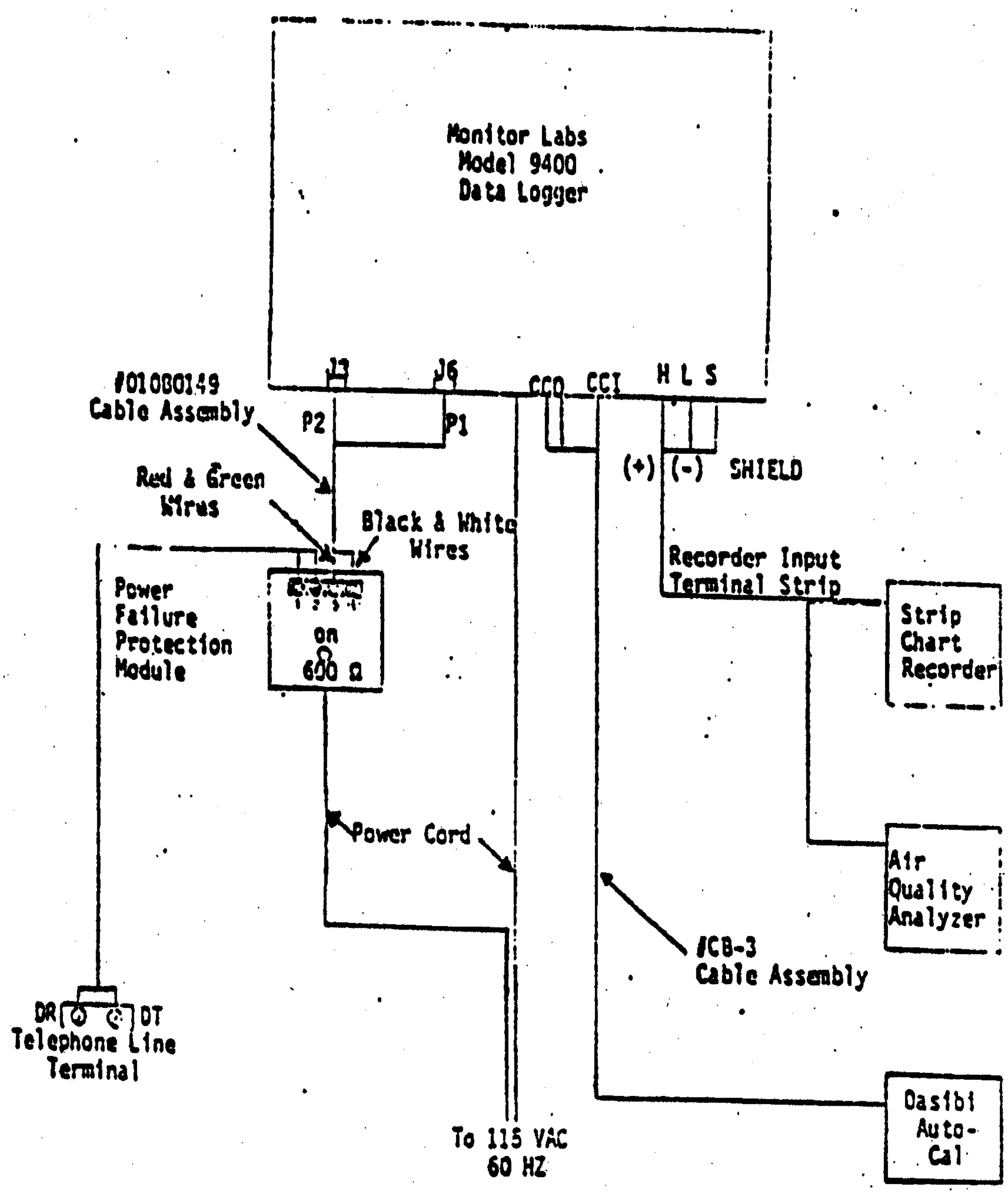


Figure G.1.1.2
Monitor Labs Model 9400 Telemetry System Data Logger Wiring System

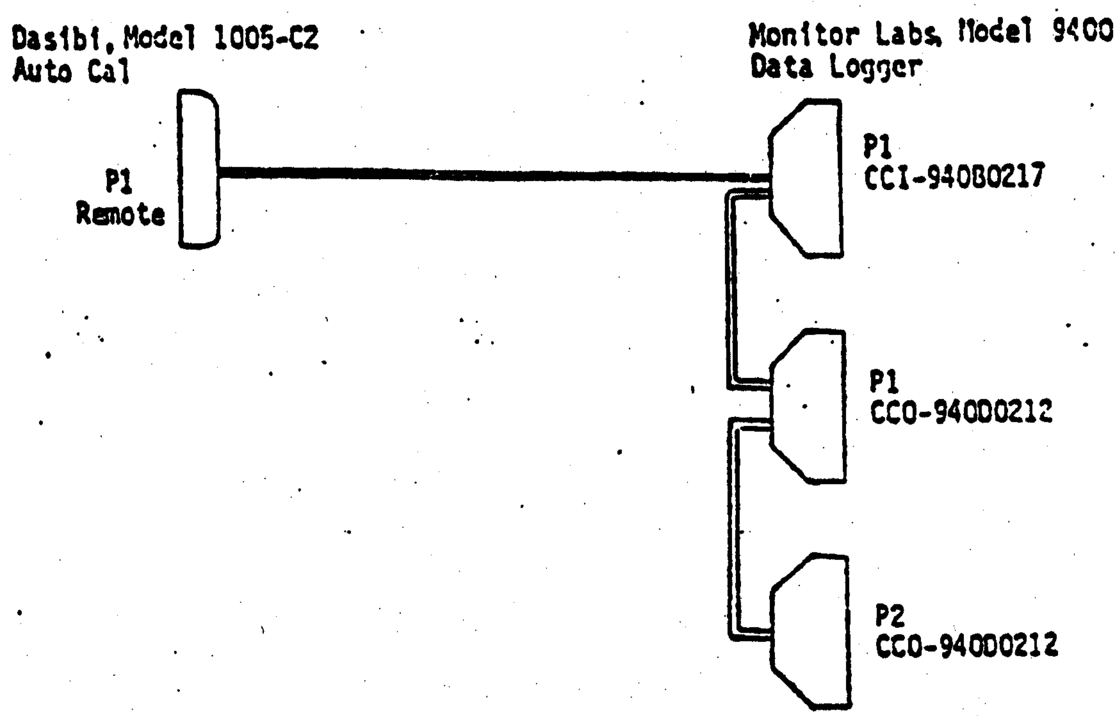


Figure G.1.1.3
Dasibi/Monitor Labs Interconnecting Cable

G.1.2 ROUTINE SERVICE CHECKS

G.1.2.1 GENERAL INFORMATION

Perform the following service checks at the intervals specified in the service schedule (Table G.1.2.1). Checks may be performed more frequently but should be performed at least at the prescribed intervals. The Monthly Quality Control Maintenance Checksheet (Figure G.1.2.1) should be completed weekly and forwarded monthly to your supervisor.

G.1.2.2 DAILY CHECKS

1. Verify that the "NON-OP" light is off, the calibrator is in "STOP," and the gas select lights are off. Check for adequate compressed gas cylinder pressure (>500 psig) and verify that there is no flow through the mass flow controllers.

2. Record the Timer program data in ppm on the back of the Checksheet. The step number that is to be recorded is listed on the back of the Checksheet.

G.1.2.3 WEEKLY CHECKS

1. Record the compressed gas cylinder pressure weekly.

2. Once every week, record the Auto program data in ppm on the front of the checksheet. The Auto program data will be used for analyzer precision determinations.

   The Monthly Quality Control Maintenance Checksheet will accommodate data from four auto programs per month.

G.1.2.4 FOUR MONTH CHECK

1. Contact your supervisor to arrange for a recalibration of the ozone generator. Use the procedure in Appendix G.3.

G.1.2.5 SEMI-ANNUAL CHECK

1. Contact your supervisor to arrange for a recalibration of the two mass flow controllers. Use the procedure in Appendix G.3.

Table G.1.2.1

Maintenance Schedule for the
Dasibi Model 1005 C_2 Gas Calibration System

Interval / Parameter	Daily*	Weekly	Four Months	Semi-Annual
"NON OP" LIGHT OFF	X			
"STOP" LIGHT ON	X			
"TIMER" PROGRAM DATA	X			
CYLINDER PRESSURE		X		
"AUTO" PROGRAM DATA				
OZONE GENERATOR			X	
MASS FLOW CONTROLLER RECALIBRATION				X

*or each day the operator services the calibrator.

CALIFORNIA AIR RESOURCES BOARD
MONTHLY QUALITY CONTROL MAINTENANCE CHECKSHEET
DASIBI MODEL 1005-C_2 CALIBRATION SYSTEM

LOCATION:______________________________ MONTH/YEAR:____________________
STATION NUMBER:________________________ TECHNICIAN: ___________________________
CALIBRATOR PROP NO:______PNEUM:________ELECT:________AGENCY: ________________________
OPERATOR INSTRUCTIONS:

1) DAILY CHECKS: NON-OP LIGHT OFF, CALIBRATION IN SYSTEM STOP, GAS SELECT LIGHTS OFF, NO FLOW THROUGH FLOW CONTROLLERS.
2) WEEKLY CHECKS: RECORD THE CYLINDER PRESSURE AND TIMER PROGRAM DATA ON THE BACK OF THIS SHEET, RECORD AUTO PROGRAM DATA BELOW (IN PPM).
3) MONTHLY CHECKS: PERFORM THROUGH-THE-PROBE CALIBRATION.
   DATE LAST PERFORMED:_________________
4) FOUR-MONTH CHECK: RECALIBRATE OZONE GENERATOR.
   DATE LAST CALIBRATED:_________________
5) SEMI-ANNUAL CHECKS: RECALIBRATE MASS FLOW CONTROLLERS.
   DATE LAST CALIBRATED:_________________
6) ANNUAL CHECKS: DURING MARCH OR APRIL, CLEAN SAMPLE INLET, PROBE AND MANIFOLD. DATE LAST CLEANED:____________________

DATE	CO	CH_4	THC	SO_2	NO_X	NO	NO_2	O_3

DATE	CO	CH_4	THC	SO_2	NO_X	NO	NO_2	O_3

DATE	CO	CH_4	THC	SO_2	NO_X	NO	NO_2	O_3

DATE	COMMENTS OR MAINTENANCE PERFORMED

MLD-26 (08-93) REVIEWED BY:__________________DATE:________________

Figure G.1.2.1
Monthly Quality Control Maintenance Checksheet (Front)

CONCENTRATION, PPM									CYLN. PRESSR.	COMMENTS
STEP NO.	1/3	1/3	1/3	1/3	2/3	2/3	1/3	1/4		
DAY	CO	CH_4	THC	SO_2	NO_X	NO	NO_2	O_3		
1	/	/	/	/	/	/	/	/		
2	/	/	/	/	/	/	/	/		
3	/	/	/	/	/	/	/	/		
4	/	/	/	/	/	/	/	/		
5	/	/	/	/	/	/	/	/		
6	/	/	/	/	/	/	/	/		
7	/	/	/	/	/	/	/	/		
8	/	/	/	/	/	/	/	/		
9	/	/	/	/	/	/	/	/		
10	/	/	/	/	/	/	/	/		
11	/	/	/	/	/	/	/	/		
12	/	/	/	/	/	/	/	/		
13	/	/	/	/	/	/	/	/		
14	/	/	/	/	/	/	/	/		
15	/	/	/	/	/	/	/	/		
16	/	/	/	/	/	/	/	/		
17	/	/	/	/	/	/	/	/		
18	/	/	/	/	/	/	/	/		
19	/	/	/	/	/	/	/	/		
20	/	/	/	/	/	/	/	/		
21	/	/	/	/	/	/	/	/		
22	/	/	/	/	/	/	/	/		
23	/	/	/	/	/	/	/	/		
CYLINDER NUMBER________________ SO_2___________ NO__________ CH_4____________ CO _____________										

Figure G.1.2.1a
Monthly Quality Control Maintenance Checksheet (Rear)

G.1.3 NON-ROUTINE SYSTEM MODIFICATIONS

G.1.3.1 INCREASING PROGRAM STEP TIME

The program step times may be increased from the nominal 15 minutes to a nominal 30 minutes by soldering a 10 microfarad tantalum capacitor in parallel with C5 on the logic board. Refer to the manufacturer's instruction manual for the location of C5.

G.1.3.2 INCREASING THE TIMEOUT OVERRIDE

The timeout override may be increased from the nominal 3 hours to a nominal 6 hours by C52 on the driver board. Any large (> 10 minutes/step) increase in the program step time will probably necessitate increasing the timeout override. Refer to the manufacturer's instruction manual for the location of C52 on the driver board.

G.1.4 TROUBLESHOOTING

G.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 have occurred are outlined below. Space is provided on the Monthly Q.C. Checksheet for recording malfunctions, causes, fixes, and actions taken to prevent reoccurrence.

Cautions listed in Section G.1.0.4 should be observed while performing troubleshooting or maintenance on the calibrator.

G.1.4.2 ELECTRONIC CHASSIS MALFUNCTIONS

Problem	Probable Cause	Fix
Calibrator will go into NO_2 mode only.	IC Malfunction	Replace driver board
”NON-OP” lamp always lit. No apparent malfunction.	IC Malfunction	Replace driver board
Proper mode lights on. No solenoid actuation.	IC Malfunction	Replace driver board
Calibrator will go into NO mode only.	IC Malfunction	Replace driver board
Calibrator will not stay in selected mode.	IC Malfunction	Replace driver board
NO solenoid action.	Transistor and IC Malfunction	Replace logic board
Unable to select “MANUAL” or “AUTO” mode.	IC Malfunction	Replace driver board
“REMOTE”, “TIMER”, and “STOP” lights all on.	IC Malfunction	Replace driver board

Problem	Probable Cause	Fix
Can't initiate "TIMER" mode.	IC Malfunction	Replace logic board
No zero air in "TIMER" mode.	Contact problem	Remove and replace U2O on program board

G.1.4.3 PNEUMATIC CHASSIS MALFUNCTIONS

Problem	Probable Cause	Fix
10% increase in ppm readings from Step 2 to Step 3 in "TIMER" mode.	Loose fitting on top of NO_2 solenoid.	Tighten fitting. Reset O_3 bypass regulator.
Zero O_3 output.	UV lamp out.	Replace UV lamp.
Low O_3 output.	UV lamp setting low.	Recalibrate O_3 generator (see Appendix G.3).
	UV lamp has low output.	Replace lamp.
	Bypass flow upset.	Recheck O_3 bypass flow. Set to 1 LPM using procedure in Section G.3.1.5 of Appendix G.3.
	UV transformer malfunctions.	Replace transformer.
No air flow.	Malfunction MFC board.	Replace MFC board.
No air flow indication on air flow MFC display.	Malfunction MFC board.	Replace MFC board.

Problem	Probable Cause	Fix
Vent solenoid actuating releasing built up system pressure	Zero air solenoid leaking.	Replace solenoid.
Excess O_3 in Step 3 of Timer program.	Ozone generator producing too much O_3.	Recalibrate O_3 generator (see Appendix G.3).
	Ozone bypass flow >1.5 SLPM.	Reset ozone bypass regulator and recalibrate O_3 generator (see Appendix G.3).

G.1.4.4 SYSTEM MALFUNCTIONS

Problem	Probable Cause	Fix
NO_x spiking in Step 2 of Timer program.	Condensation in compressed gas lines to calibrator.	Replace compressed gas line with 1/8" stainless steel tubing.

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ACCEPTANCE TEST PROCEDURE

TO BE DEVELOPED

MONITORING AND LABORATORY DIVISION

APRIL 1989

STATE OF CALIFORNIA

AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

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APPENDIX G.3

CALIBRATION PROCEDURE FOR DASIBI MODEL 1005 C_2 GAS CALIBRATION SYSTEM

MONITORING AND LABORATORY DIVISION

APRIL 1989

G.3.0 OVERVIEW

G.3.0.1 THEORY

An ozone transfer standard certified against a primary standard laboratory ultraviolet photometer is used in calibrating the Dasibi calibrator ozone generator. Air flow transfer standards (mass flow meters, or equivalent), certified against a primary standard flow rate calibrator, are used in the mass flow controller calibrations.

G.3.0.2 APPARATUS

1. Dasibi Model 1003 PC ozone analyzer/calibrator, or equivalent.

2. Calibrated 0-3 SLPM laminar flow device (Vol-o-Flo^{TM}, or equivalent).

3. 0.6-30 SLPM air flow transfer standard.

4. 0.4-200 SCCM, or 0.2-100 SCCM, air flow transfer standard.

5. One-quarter inch Teflon tubing for air flow connections.

6. Three Swagelock caps and three Swagelock plugs (1/4").

7. Digital voltmeter with test leads (preferably alligator clip leads) capable of reading 0-15 VDC with .001 VDC resolution.

8. Calibration Report Forms (Figures G.3.1.1 - G.3.1.4).

9. Spare UV lamps, lamp 0-rings and ozone bypass regulator.

G.3.1 "AS IS" CALIBRATION

PRIOR TO THE "AS IS" CALIBRATION, MAKE NO REPAIRS OR ADJUSTMENTS TO THE CALIBRATOR. An "as is" calibration involves all the tests documented in this section. On any partial "as is" calibration (ozone generator only, mass flow controllers only), always perform the leak check. On any ozone generator calibration, first perform the ozone bypass flow check.

G.3.1.1 0-30 SLPM MASS FLOW CONTROLLER

1. As applicable, connect the transfer standard to AC power. Allow the transfer standard to warm up for at least 30 minutes. If not already operating, turn the calibrator on and allow it to warm up for at least one hour.

2. Record the transfer standard and calibrator property numbers, the transfer standard's calibration slope and intercept, and any other pertinent information on the Calibration Datasheet, ADD-42 (Figure G.3.1.2).

3. Disconnect and cap the calibrator sample outlet line. Attach a line from the sample outlet port of the calibrator to the input of the transfer standard. The transfer standard outlet should be open to the atmosphere.

   NOTE: If the manifold is equipped with a sample pump and threeport solenoid valve, connect the Teflon line running from the sample manifold to the solenoid valve directly to the sample pump. This will insure that the residence time will remain within tolerances. Also, you must disconnect the Monitor Labs Model 9400 (or 9300) interface cable from the back of the calibrator. This will insure that the ambient data will not be improperly flagged.

4. If the transfer standard is a mass flow controller (MFC), adjust the potentiometer on the front panel to full open (999).

5. Select the calibrator "MANUAL ZERO" mode and set the calibrator air thumbwheel to 15.0, representing 15.0 SLPM. After the transfer standard reading stabilizes, record both the calibrator digital output and the transfer standard reading on the Calibration Datasheet.

6. Find the Previous True Air Flow Rate at this setpoint by referring to the Previous calibration report.

7. Using either the transfer standard calibration equation or the transfer standard calibration curve, convert the transfer standard reading to the True Air Flow Rate.

8. Using the Previous True Air Flow Rate (F2), and the current True Air Flow Rate (F1), calculate the percent deviation from the previous calibration as follows:

$$\text{Percent Deviation from Previous Calibration} = \frac{F1 - F2}{F2} \times 100$$

G.3.1.2 0-100 SCCM MASS FLOW CONTROLLER

1. As applicable, connect the transfer standard to AC power. Allow the transfer standard to warm up for at least 30 minutes. If not already operating, turn the calibrator on and allow it to warm up for at least 1 hour.

2. Record the transfer standard and calibrator property numbers, the transfer standard's calibration slope and intercept, and any other pertinent information on the Calibration Datasheet, ADD-42 (see Figure G.3.1.2).

3. Turn off the high concentration compressed gas cylinder. Disconnect and cap the gas line going to the calibrator NO port. Disconnect the zero air line and plug the calibrator zero air inlet port. Connect the zero air line to the calibrator NO port. Set the Aadco output pressure to 15 psig.

4. If not previously done, disconnect and cap the calibrator's sample outlet line. Attach a line from the sample outlet port of the calibrator to the input of the transfer standard. The transfer standard outlet should be open to the atmosphere.

5. If the transfer standard is a mass flow controller (MFC), switch the controller's front panel function switch to full open allowing the MFC to act as a mass flow meter.

6. Select the "MANUAL NO" mode. Set the calibrator gas thumbwheel to 99.0. Record both the calibrator digital output and the transfer standard reading on the Calibration Datasheet. When using a mass flow controller, allow at least 10-15 minutes for this first point to stabilize.

7. Repeat Step 6 for thumbwheel settings of 75.0, 50.0, 25.0, and 12.0.

8. Perform the calculations described in Section G.3.1.1, Steps 7 through 11.

9. Reconnect the calibrator, Aadco and compressed gas lines to their normal operating configuration.

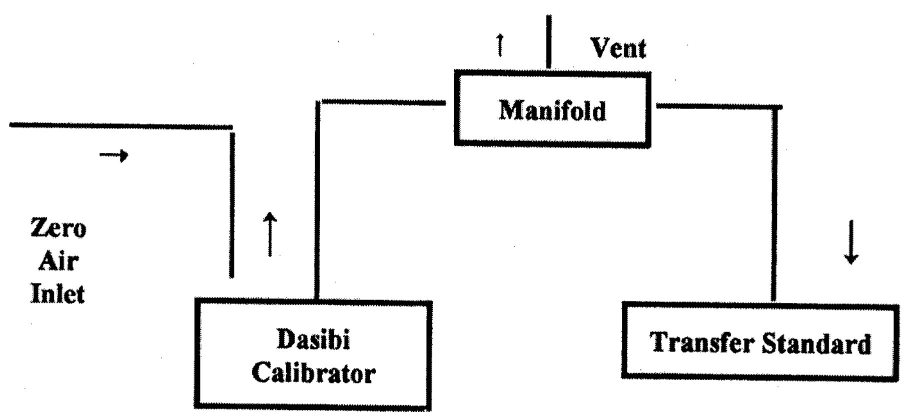
G.3.1.3 OZONE GENERATOR (WITH O_3 OPTICAL FEEDBACK)

1. Connect the ozone transfer standard to AC power and turn it on. Allow the ozone transfer standard to warm up for at least one hour. If not already operating, turn the calibrator on and allow it to warm up for at least one hour.

2. Record the ozone transfer standard and calibrator identification numbers, settings, and any other pertinent information on the Ozone Generator Calibration Datasheet, MLD-31a (see Figure G.3.1.4).

3. Using a calibrated laminar flow device (Vol-o-Flo™ or equivalent), adjust the sample air flow rate on the ozone transfer standard to 2.5 SLPM. Record the flow meter setting and the true air flow on the Calibration Datasheet. Leak check the ozone transfer standard by capping the sample inlet. If there are no leaks, the flow meter ball should go to zero. Otherwise, repair any leaks as required.

4. Disconnect and cap the sample outlet line from the Dasibi calibrator to the sample manifold. Interconnect the calibrator and transfer standard as shown in the schematic below. Depress "MANUAL ZERO" on the calibrator. Set the air thumbwheel to 15.0, corresponding to approximately 15.0 SLPM.



5. After the ozone transfer standard is warmed up (control frequencies stable), record 10 consecutive digital display values in the respective column labeled "Zero Air". Calculate the sum and average of the 10 numbers and record the values on the Calibration Datasheet in the respective blocks. The average value shall also serve as the transfer standard zero correction.

6. Depress "MANUAL O_3" on the calibrator. Set the ozone thumbwheel setting to 500. Allow the transfer standard response to stabilize. Record 10 consecutive transfer standard digital display readings in the appropriate blocks on the Calibration Datasheet. Calculate the sum and average of the 10 numbers and record the values on the Calibration Datasheet.

7. Measure and record the voltages at TP_1 and TP_2 . Caution: these voltages may be temperature and light sensitive. Therefore, they should be taken after stabilized conditions.

8. Repeat Step 6 and 7 for ozone thumbwheel settings of 250 and 090.

9. Calculate corrected average ozone values for the transfer standard at each setting using the formula:

   Corrected Average (A) =

   (Average Reading - Zero Correction) x True Ozone Correction Factor x Altitude Correction Factor

   (See Table A.3.0.1 of this Volume for the Altitude Correction Factor.)

10. Using the previous calibration data for the calibrator ozone generator, record the previous corrected average (B) corresponding to the appropriate thumbwheel settings. If there is no previous calibration data, proceed to Section G.3.1.5, "Calibrator Leak Check".

11. Calculate and record the percent deviation at each thumbwheel setting (except 000) from the previous calibration using the following equation:

$$\text{Percent Deviation} = \frac{(A-B)}{(B)} \times 100$$

G.3.1.4 OZONE GENERATOR (STANDARD VERSION)

1. Connect the ozone transfer standard to AC power and turn it on. Allow the ozone transfer standard to warm up for at least one hour. If not already operating, turn the calibrator on and allow it to warm up for at least one hour.

2. Record the ozone transfer standard and calibrator identification numbers, settings, and any other pertinent information on the Ozone Generator Calibration Datasheet, MLD-31 (see Figure G.3.1.3).

3. Using a calibrated laminar flow device (Vol-o-Flo™ or equivalent), adjust the sample air flow rate on the ozone transfer standard to 2.5 SLPM. Record the flow meter setting and the true air flow on the Calibration Datasheet. Leak check the ozone transfer standard by capping the sample inlet. If there are no leaks, the flow meter ball should go to zero. Otherwise, repair any leaks as required.

4. Disconnect and cap the sample outlet line from the Dasibi calibrator to the sample manifold. Interconnect the calibrator and transfer standard as shown in the schematic below. Depress "MANUAL ZERO" on the calibrator. Set the air thumbwheel to 15.0 corresponding to approximately 15.0 SLPM.

5. After the ozone transfer standard is warmed up (control frequencies stable), record 10 consecutive digital display values in the respective column labeled "Zero Air". Calculate the sum and average of the 10 numbers and record the values on the Calibration Datasheet in the respective blocks. The average value shall also serve as the transfer standard zero correction.

6. Depress "MANUAL O_3" on the calibrator. Set the ozone thumbwheel setting to 800. Allow the transfer standard response to stabilize. Record 10 consecutive transfer standard digital display readings in the appropriate blocks on the Calibration Datasheet. Calculate the sum and average of the ten numbers and record the values on the Calibration Datasheet.

7. Repeat Step 6 for ozone thumbwheel settings of 400 and 200.

8. Calculate corrected average ozone values for the transfer standard at each setting using the formula:

Corrected Average (A) =

(Average Reading - Zero Correction) x True Ozone Correction Factor x Altitude Correction Factor

(See Table A.3.0.1 of this Volume for the Altitude Correction Factor.)

9. Using the previous calibration data for the calibrator ozone generator, record the previous corrected average (B) corresponding to the appropriate thumbwheel settings. If there is no previous calibration data, proceed to Section G.3.1.5, "Calibrator Leak Check".

10. Calculate and record the percent deviation at each thumbwheel setting (except 000) from the previous calibration using the following equation:

$$\text{Percent Deviation} = \frac{(A-B)}{(B)} \times 100$$

G.3.1.5 CALIBRATOR LEAK CHECK

The following procedure uses the gas side MFC's digital voltmeter display (0-100 SCCM) to indicate any possible leaks in the gas calibration system.

1. Preparation for leak check:

   a. Turn off the valve on the "Super Blend" compressed gas cylinder and disconnect the tubing from that cylinder at the "NO" inlet port on the calibrator.

   b. Turn off the Aadco zero air supply. Disconnect the tubing from the Aadco to the calibrator and connect it to the NO inlet port. Cap the zero air inlet port. Be sure the "CO" and "HC" gas inlet ports are capped also. Turn on the Aadco zero air supply and set the output pressure to 10 psig $\pm$ 0.5 psig.

   c. Set the air thumbwheels to 15.0 and the gas thumbwheels to 99.0.

   d. Select the "MANUAL" mode and "NO" gas.

   e. Allow the "GAS" flowmeter digital display to stabilize (at approximately 99.0 cc/min).

   f. Depress the "STOP" button.

   g. Disconnect the sample outlet tubing (gas output to manifold) and cap the sample outlet port.

2. Leak check:

   a. Select the "MANUAL" mode and "NO" gas.

   b. Record the time.

   NOTE: The "GAS" flowmeter digital display will settle to the value of step 1e, above, and remain there for approximately two minutes. The display will then cascade down towards 20 cc/min or less.

c. Allow the calibrator to pressurize for at least 10 minutes. The gas flowmeter digital display should stabilize during this time.

d. Record the time. The display should read $\leq$ 5.0 cc/min in 10 minutes. The degree of leakage can be read directly, i.e., a reading of 10.0 on the gas flowmeter digital display would indicate approximately a 10 cc/min leak at 10 psig. Investigate and correct any leakage greater than 5.0 cc/min in 10 minutes. Note that most leaks occur in the ozone generator. Therefore, when searching for the leak, first close the control valve at the ozone rotometer and repeat the leak check. Leaks in the ozone generator may occur from a faulty O-ring around the UV lamp, a faulty UV lamp connector, or the fittings at the ozone oven.

e. Once the leak is found and corrected, return the calibrator, Aadco and compressed gas lines to their normal operating configuration.

G.3.1.6 OZONE BYPASS FLOW CHECK

1. Adjust the knob on the front panel ozone rotometer so it is wide open. With the calibrator in "MANUAL O_3", the air thumbwheel set to 15.0, and the ozone thumbwheel set to 000, set the bypass regulator so that 2 SLPM reads on the laminar flow device or mass flow meter. The bypass regulator is set by pulling up on the red ring to unlock it. After the regulator is turned to give the above flow, push down the red ring to secure the regulator.

2. Adjust the knob on the front panel ozone rotometer to obtain a rotometer reading of 1.0 $\pm$ 0.5 LPM for the standard calibrator or 0.5 $\pm$ 0.025 LPM for the calibrator with optical feedback. Record the ozone bypass flow rate (SLPM) and the ozone rotometer reading on the Ozone Generator Calibration Datasheet.

NOTE: The importance of the bypass flow cannot be overemphasized. Flows in excess of the above tolerance limits may result in insufficient NO/O_3 reaction times, resulting in unreliable NO_2 calibration data. Also, resetting the bypass flow necessitates an ozone generator recalibration.

G.3.1.7 RESULTS EVALUATION

A "final" calibration is required if any of the tolerances listed in Table G.3.1.1 are exceeded. If no tolerances are exceeded, then perform the following tasks:

1. Complete the calibration curves for the gas mass flow controller and the ozone generator (see Figure G.3.1.4).

2. Complete the Calibration Report cover sheet (Figure G.3.1.1) for the mass flow controller and the ozone generator. Since the monthly statistical analysis is dependent upon the calibration, forward the completed calibration report to the Air Monitoring Section area manager in Sacramento, within seven days of the end of the month in which the calibrations were performed. The area manager will review the report and forward a copy to the data input person. This will insure that the monthly analysis will be performed in a timely fashion.

Table G.3.1.1

"As Is" Calibration Tolerances

ITEM	PARAMETER	TOLERANCE
0-30 SLPM MFC	True Air Flow Rate	15.0±0.6 SLPM at a Thumbwheel setting of 15.0.
	Calibrator Digital Output	Within ±0.3 SLPM of True Air Flow Rate at thumbwheel setting 15.0
0-100 SCCM MFC	True Air Flow Rate	Within ±2 SCCM of 99.0 SCCM, 50.0 SCCM, 25.0 SCCM and 12.0 SCCM at thumbwheel settings of 99.0, 50.0, 25.0, and 12.0, respectively, and linear.
	Calibrator Digital Output	Within 1 SCCM of the True Air Flow Rate at each point.
Ozone Generator	Ozone Output	Within 0.55±.10 ppm at a thumbwheel setting of 800, and within 0.09±.01 ppm at a thumbwheel setting of 200.
Ozone Generator with O_3 Optical Feedback	For Optical Feedback Only	Within 0.55±.10ppm at a thumbwheel setting of 500, and within 0.09±.01 ppm at a thumbwheel setting of 090.
Calibrator Leak Check		≤5.0 cc/minute in 10 minutes as read on the gas flow meter digital display.
Ozone Bypass Flow		1.0±0.5 SLPM
Ozone Bypass Flow with Optical Feedback		0.5±0.025 SLPM

CALIFORNIA AIR RESOURCES BOARD
DASIBI MODEL 1005 C_2 GAS CALIBRATION SYSTEM
CALIBRATION REPORT

To:
From:

Log Number:
Date of Calibration:

IDENTIFICATION

Station Name:	Calibrator Property No.:
Station Code:	Electronics Chassis:
	Pneumatics Chassis:

CALIBRATION STANDARDS

Standard	I.D. Number	Certification Date	Certified Value or Factor

CALIBRATION RESULTS

	Air MFC	Gas MFC	Ozone Generator*
% Deviation from Previous Calibration			

*% deviation based on thumbwheel setting of 500.

CALIBRATION SUMMARY

Thumbwheel SETTING	Air Flow SCCM	Gas Flow SCCM		Expected Concentrations - PPM Superblend Cyl. #		
				POLLUT. PPM	TIMER PROG.	AUTO PROG
15.0				CO		
99.0				CH_4		
50.0				NO		
25.0				SO_2		
500/090				O_3 & NO_2		

Comments:____

Figure G.3.1.1
Dasibi Gas Calibration System - Calibration Report

CALIFORNIA AIR RESOURCES BOARD

BASIBI MODEL 1005 C2 GAS CALIBRATION SYSTEM
MASS FLOW CONTROLLER CALIBRATION DATA SHEET

DATE 5-23-84
LOG NUMBER ______

AS IS CALIBRATION ✓
FINAL CALIBRATION ______

Location SAN LUIS OBISPO
Calibrator Property Number: Electronics 2495

Station Number 40-835
Pneumatics 2415A

Serial No. 31

Calibrator Property of ARB

0-30 SLPM MASS FLOW CONTROLLER

Transfer Standard Make & Model MATHESON #8240 MFC Prop. No. 3178

Date Certified 3-27-84 Cert. Expires 6-27-84

True Air Flow Rate = .957 (Slope) Trans. Std. Reading ⊕ .301 (Intercept) (slpm)

Calibration information from previous data sheet, dated 3-29-84

Previous True Air Flow Rate: 14.5 slpm

0-100 SCCM MASS FLOW CONTROLLER

Transfer Standard Make & Model MATHESON #8240 MFC Prop. No. 3178

Date Certified 4-10-84 Cert. Expires 7-10-84

True Air Flow Rate = .998 (Slope) Trans. Std. Reading ⊕ 1.217 (Intercept) (sccm)

Calibration information from previous data sheet, dated 4-12-84

Previous True Air Flow Rate = 1.014 (Slope) Thumb. Set Pt. ⊖ 2.342 (Intercept) (sccm)

		15.0				Thumbwheel Set Point	99.0	75.0	50.0	25.0	12.0	0.0
		15.0				Basibi Calibrator Digital Output	98.6	74.6	49.7	24.7	11.7	
		14.5				Previous True Air Flow Rate	98.0	73.7	48.4	23.0	9.8	
		15.3				Transfer Standard Reading	93	70	45	20	7	
		14.9				True Air Flow Rate	94.0	71.1	46.1	21.2	8.2	

Previous True Air Flow Rate, F_2 = 14.5

Current True Air Flow Rate, F_1 = 14.9

% Deviation from Previous Calibration = $\frac{F_1-F_2}{F_2} \times 100 =$ 2.8%

Summation of Previous True Air Flow Rate, S_2 = 252.9

Summation of True Air Flow Rate, S_1 = 240.6

% Deviation from Previous Calibration = $\frac{S_1-S_2}{S_2} \times 100 =$ -4.9%

Linear Regression Equation:

True Air Flow Rate = ______ (Slope) Thumb. Set Point + ______ (Intercept) (sccm)

Comments: ______

AHD-42 (8/10/84)

Calibrated By J. McBride Checked By L.T. Smith

Figure G.3.1.2
Mass Flow Controller Calibration Datasheet

CALIFORNIA AIR RESOURCES BOARD
DASIBI MODEL C_2 GAS CALIBRATION SYSTEM
OZONE GENERATOR CALIBRATION DATASHEET (standard version)

DATE___________ AS IS CALIBRATION_________
LOCATION_______ STATION NUMBER________ FINAL CALIBRATION_________

TRANSFER STANDARD	DASIBI CALIBRATOR
Make and Model No.____________Property No.______	Property No.__________________Serial No._________
Date Certified__________Certification Expires_________	Air Flow Thumbwheel Setting_______________________
Sample Frequency (Display)_______(Initial)______(Final)	Digital Output____________________________________
Control Frequency (Display)_______(Initial)______(Final)	Ozone By-pass Flow: P___________________________
Air Flow: P______Flow_____slpm@_______Flow Setting	By-pass Flow__________slpm@_________Flow Setting
Span Setting (Dial)_________(Display)________(Offset)	Flow Measurement Device: Type_____________________
True Ozone Corr. Factor (TOCF)_____Alt. Corr. Factor*___	Property No.______________Date Calibrated:__________

			ZERO AIR	800	400	200	
	THUMBWHEEL SETTING						
		VOLTS DC					
	TRANSFER	1					
		2					
	STANDARD	3					
		4					
	OZONE	5					
		6					
	READING	7					
		8					
	PPM	9					
		10					
	Summation						
	Average						
	Zero Correlation						
	Corrected Average *, A						
	Previous Corrected Average, B						
	% Deviation from Previous Calibration **						

*Alt. Corr. Factor=.999 x exp (.0000371xAlt.,ft.) If Alt. >1000 ft.; otherwise=1.000 (Note: Alt. Corr. Factor $\geq$1).
**Corrected Average (Transfer Standard) = (Average Reading - Zero Correction) x TOCF x Alt. Corr. Factor.
***Percent Deviation from Previous Calibration = $\frac{A-B}{B}$ x 100, calculated for each thumbwheel setting.

Previous Calibration Date:_________________Barometric Pressure:___________Temperature:_________
COMMENTS:____
MLD-31 (5/89) Calibrated By_____________Checked By________________

Figure G.3.1.3
Ozone Generator Calibration Datasheet (Standard Version)

CALIFORNIA AIR RESOURCES BOARD
DASIBI MODEL C_2 GAS CALIBRATION SYSTEM
OZONE GENERATOR CALIBRATION DATASHEET (w/O_3 optical feedback)

DATE____________ AS IS CALIBRATION_________________
LOCATION________ STATION NUMBER________ FINAL CALIBRATION________________

TRANSFER STANDARD	DASIBI CALIBRATOR
Make and Model No.________Property No.__________ Date Certified_________Certification Expires__________ Sample Frequency (Display)_____(Initial)_____(Final) Control Frequency (Display)_____(Initial)_____(Final) Air Flow: P_____Flow_______slpm@_____Flow Setting Span Setting (Dial)_______(Display)______(Offset)______ True Ozone Corr. Factor (TOCF)_____Alt. Corr. Factor*___	Property No.______________Serial No.______________ Air Flow Thumbwheel Setting_______________________ Digital Output___________________________________ By-pass Flow_________slpm@__________Flow Setting

	THUMBWHEEL SETTING		ZERO AIR	500	250	090	
		VOLTS DC TP 1					
		TP 2					
	TRANSFER	1					
		2					
	STANDARD	3					
		4					
	OZONE	5					
		6					
	READING	7					
		8					
	PPM	9					
		10					
	Summation						
	Average						
	Zero Correlation						
	Corrected Average *, A						
	Previous Corrected Average, B						
	% Deviation from Previous Calibration **						

*Alt. Corr. Factor=.999 x exp (.0000371xAlt.,ft.) If Alt. >1000 ft.; otherwise=1.000 (Note: Alt. Corr. Factor $\geq$1).
**Corrected Average (Transfer Standard) = (Average Reading - Zero Correction) x TOCF x Alt. Corr. Factor.
***Percent Deviation from Previous Calibration = $\frac{A-B}{B}$ x 100, calculated for each thumbwheel setting.

Previous Calibration Date:_________________Barometric Pressure:___________Temperature:________________
COMMENTS:____
MLD-31 (5/89) Calibrated By_____________Checked By________________

Figure G.3.1.4
Ozone Generator Calibration Datasheet (With O_3 Optical Feedback)

CALIFORNIA AIR RESOURCES BOARD

CALIBRATION GRAPH

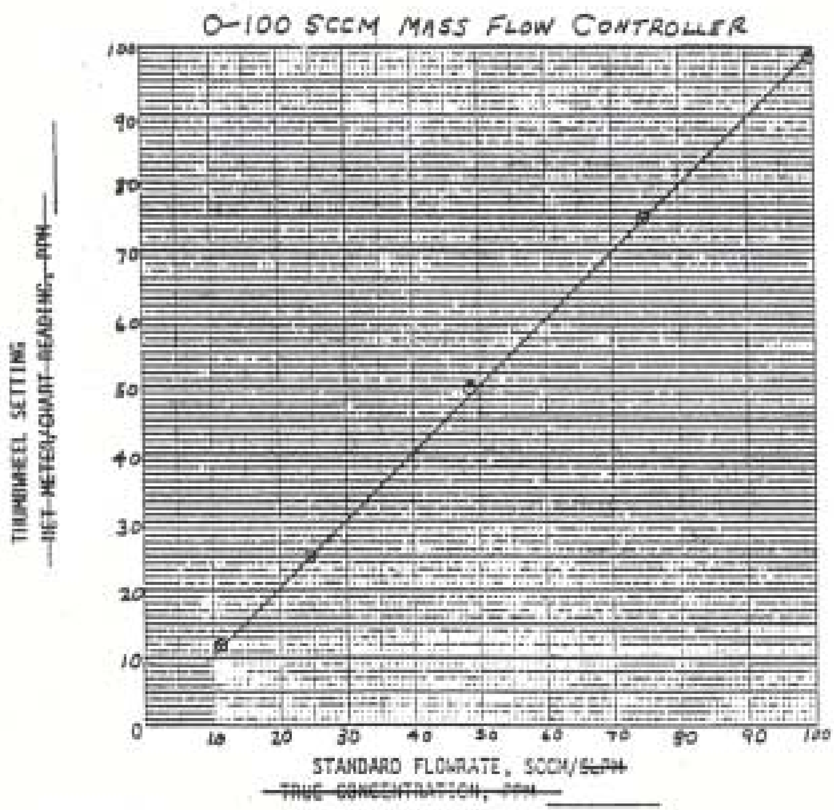
Log No.: ____________

Station Name: San Luis Obispo   Date of Calibration: 2-27-80

Station Site No.: 40-835   "As Is" Calibration: ____________

Instrument Property No.: 2495   Final Calibration: ✓

Instrument Make and Model No.: Dasibi 1005 C2



COMMENTS: ____________

TSD No. 24 (4-80)   Graph prepared by J.T. McBride

Figure G.3.1.5
Ozone Generator Calibration Datasheet

G.3.2 "FINAL" CALIBRATION

This section outlines an adjustment procedure to insure that: (a) the calibrator air (or gas) thumbwheel setting agrees with the True Air Flow Rate, and (b) the calibrator digital display agrees with the True Air Flow Rate. Agreement shall be within the tolerances specified in Table G.3.1.1.

NOTE: In carrying out the adjustment procedure, you may use the linear regression equation or calibration curve for the transfer standard to calculate the transfer standard reading corresponding to the desired True Air Flow Rate.

Before making any adjustments, turn off the calibrator and unplug. Then remove the PC boards, clean the contacts with a soft eraser if required, and replace the boards. The PC boards are: the program board, the logic board, the driver board, and the digital voltmeter boards. There is an additional PC board for newly retrofitted calibrators: the optical feedback printed circuit board. See the ozonator adjustment procedure relating to this board in Section G.3.2.3. Plug in the calibrator and turn on the power.

NOTE: On calibrators with serial numbers greater than 0022, do not attempt to unplug the digital voltmeter board, as it is secured to the motherboard.

G.3.2.1 0-30 SLPM MASS FLOW CONTROLLER

1. If the calibrator air thumbwheel setting agrees with the True Air Flow Rate within the specified tolerances, skip Steps 2 and 5 of the following procedure. If it does not agree, perform Steps 1 through 5 of Section G.3.1.1, and then proceed with the following procedure.

2. Set the calibrator mode to "MANUAL ZERO" and the calibrator air thumbwheel to 15.0, representing 15.0 SLPM. Adjust the air span pot R23 on the program board (see Figure G.3.2.1) until the desired reading is reached on the transfer standard corresponding to the True Air Flow Rate of 15.0 SLPM. Clockwise rotation increases flow.

   NOTE: Steps 3-4 and 7 are to be performed only if the calibrator digital display does not agree with the True Flow Rate within tolerances.

3. On calibrators with serial numbers greater than 0022, there is only one digital voltmeter board for both mass flow controllers. The board is located directly behind the front panel display. An air digital display span pot is located on the left-hand side of the board. There is no zero pot. With the calibrator air thumbwheel on 15.0, adjust the span pot until the calibrator digital display agrees with the transfer standard reading corresponding to the True Air F1ow Rate of 15.0 SLPM.

4. On calibrators with serial number 0022 and lower, there is a separate digital voltmeter board for each mass flow controller. Facing the front of the calibrator, the air digital voltmeter board is located behind the gas digital voltmeter board. There are two pots on the air DVM board--a span pot on the left and a zero pot on the right. With the calibrator set on "MANUAL ZERO" and the calibrator air thumbwheel set on 15.0, adjust the span pot until the calibrator digital display agrees with the transfer standard reading corresponding to the True Air Flow Rate of 15.0 SLPM.

5. After performing Steps 2 through 4, if you are unable to obtain the proper flow or proper digital display value, an internal adjustment of the calibrator mass flow controller may be required. Contact the Air Monitoring Section area manager for further instructions.

6. After the calibrator digital display has been properly adjusted, or if no adjustment was required, perform Steps 5 and 7 of Section G.3.1.1 and all of Section G.3.1.6.

   NOTE: If the calibrator is to be used at setpoints other than 15.0, repeat Step 2 for other calibration points covering the range of use. Record your selected set point(s) and readings in the spaces provided on the Calibration Datasheet.

G.3.2.2 0-100 SCCM MASS FLOW CONTROLLER

1. If the calibrator gas thumbwheel setting agrees with the True Air Flow Rate within the specified tolerances, skip Steps 2 and 5 of the following procedure. If it does not agree, perform Steps 1 through 5 of Section G.3.1.2, and then proceed with the following procedure.

   NOTE: If using a Matheson mass flow controller as transfer standard, connect a DVM to the leads of the Matheson digital display unit. This will more accurately monitor when the transfer standard reading stabilizes.

2. Set the calibrator mode to "MANUAL NO" and the calibrator gas thumbwheel to 99.0, representing 99.0 SCCM. Adjust the gas span pot, R28, on the program board (see Figure G.3.2.1) until the desired reading is reached on the transfer standard corresponding to the True Air Flow Rate of 99.0 SCCM. Clockwise rotation increases flow.

   NOTE: Steps 3-4 and 6-7 are to be performed only if the calibrator digital display does not agree with the True Flow Rate within tolerances.

3. On calibrators with serial numbers greater than 0022, there is only one digital voltmeter board for both mass flow controllers. The board is located directly behind the front panel display. There is no zero pot. The gas span pot is located on the right-hand side of the board. With the calibrator gas thumbwheel on 99.0, adjust the gas span pot until the calibrator digital display agrees with the transfer standard reading corresponding to the True Air Flow Rate of 99.0 SCCM.

4. On calibrators with serial number 0022 or lower, there is a separate digital voltmeter board for each mass flow controller. As you face the front of the calibrator, the gas digital voltmeter board is located in front of the air digital voltmeter board. There are two pots on the gas DVM board--a span pot on the left and a zero pot on the right. With the calibrator set on "MANUAL NO" and the calibrator gas thumbwheel set on 99.0., adjust the gas span pot until the calibrator digital display agrees with the transfer standard reading corresponding to the True Air Flow Rate of 99.O SCCM.

5. Set the calibrator gas thumbwheel to 12.O, representing 12.0 SCCM. Adjust the gas zero pot, R30, on the program board (see Figure G.3.2.1) until the desired reading is reached on the transfer standard corresponding to the True Air F1ow Rate of 12.0 SCCM. Clockwise rotation increases flow.

6. On calibrators with serial number 0022 or lower, locate the zero digital display pot on the right side of the gas DVM board as described in Step 4, above. With the calibrator gas thumbwheel set at 12.0, adjust the zero pot until the calibrator digital display agrees with the transfer standard reading corresponding to the True Air Flow Rate of 12.0 SCCM.

7. Repeat Steps 2 through 6 until no change occurs. If you are unable to obtain the proper flows or proper digital display values, an internal adjustment of the calibrator mass flow controller may be required. Contact the Air Monitoring Support Section for further instructions.

8. After the calibrator digital display has been properly adjusted, or if no adjustment was required, perform Steps 6, 7 and 9 of Section G.3.1.2, Steps 9 and 11 of Section G.3.1.1 and all of Section G.3.1.6.

G.3.2.3 OZONE GENERATOR (WITH O_3 OPTICAL FEEDBACK)

1. If the ozonator needs to be readjusted (see Table G.3.1.1), set the ozonator thumbwheel to 500 and allow the transfer standard's response to stabilize. If the reading, corrected for true ozone, is less than 0.40 ppm, turn V counterclockwise (CCW) (see Figure G.3.2.1 for the location of the V and zero potentiometer); if it is greater than 0.60 ppm, turn V clockwise (CW). When the response is 0.50 $\pm$ 0.05, with a DVM, measure the voltage

between ground and the ozone test point on the program board (lower left portion of board). Record this reading on the ozone generator calibration datasheet, MLD-31a.

2. Set the ozonator thumbwheel to 090 and allow the output to stabilize. If the true ozone output is not within the range of 0.09 $\pm$ 0.01 ppm, adjust the zero potentiometer clockwise to increase (counterclockwise to decrease) the response. When the true ozone output is 0.09 $\pm$ 0.005, record the voltage at the ozone test point to ground.

3. Set the ozonator thumbwheel to 500 and adjust the V potentiometer until the voltage is the same as that recorded in Step 1.

4. Set the ozonator thumbwheel to 090. Adjust the zero potentiometer until the voltage is the same as that recorded in Step 2.

5. Repeat Steps 3 and 4 until the voltages at both thumbwheel setpoints are the same as that initially recorded.

6. After the ozonator is properly set, perform the instructions listed in Sections G.3.1.3, Steps 2 through 8, and Section G.3.1.6.

7. If the ozonator is unstable or if the ozone concentration requirements cannot be met, check the condition of the UV lamp by observing the voltages at the test points of the optical feedback printed circuit board (OF PCB) as tabulated below: (see Figure G.3.2.2 for location of test points).

TP2	TP1	TP3	LAMP
0.6 - 1.0 VDC	0.9 - 1.0 VDC	0.9 - 1.0	OK
13 - 15 VDC	0 VDC	0.9 - 1.0 V	OUT
1.5 - 2 VDC	0.1 - .5 VDC	0.9 - 1.0 V	WEAK

If replacement of the UV lamp becomes necessary, the following procedure should be used.

a. Close the control valve on the ozonator rotometer.

b. Leak test the pneumatic system (see paragraph G.3.1.4) and record the value shown on the gas mass flowmeter display.

c. Fully open the control valve on the ozonator rotometer. The gas display will indicate 99 cc/min for several minutes, then should decrease to the value recorded in Step b, above. A leak in the ozonator will be evident by the increase of the value of the gas mass flowmeter display.

d. Should a leak occur, it will most likely be in the UV lamp holder. Applying soap bubble solution ("Snoop" or equivalent) around the base of the UV lamp holder will usually indicate the leak. If the leak is in the UV lamp holder, slowly tighten the holder until the gas mass flowmeter indicates the value recorded in Step b above.

e. Allow the UV lamp at least 10 hours to stabilize before recalibrating the ozonator.

f. With the voltmeter at the ozone test point and the thumbwheel set to 500, adjust R-20 for 1.000 VDC.

g. Select the "MANUAL" and "O_3" gas modes. Insure the ozone bypass flow is 0.50 $\pm$ 0.025 LPM.

h. If the ozone concentration needs to be adjusted (see Table G.3.1.1), connect a voltmeter at TP2 of the OF PCB located in the pneumatics chassis. Adjust P-1 until 0.50 $\pm$ 0.05 ppm is achieved. Record the values at TP2, TP1, and TP3.

i. The ozonator should then be recalibrated in the normal manner starting with Section G.3.2.3, Step 2.

G.3.2.4 OZONE GENERATOR (STANDARD VERSION)

1. If the ozonator needs to be readjusted (see Table G.3.1.1), set the ozonator thumbwheel to 800 and allow the transfer standard's response to stabilize. If the reading, corrected for true ozone, is less than 0.45 ppm, turn V counterclockwise (CCW) (see Figure G.3.2.1 for the location of the V and zero potentiometer); if it is greater than 0.65 ppm, turn V clockwise (CW). When the response is 0.55 $\pm$ 0.05, with a DVM, measure the voltage between ground and the ozone test point on the program board (lower left portion of board). Record this reading on the ozone generator calibration datasheet, MLD-31.

2. Set the ozonator thumbwheel to 200 and allow the output to stabilize. If the true ozone output is not within the range of 0.09 $\pm$ 0.01 ppm, adjust the zero potentiometer clockwise to increase, counterclockwise to decrease the response. When the true ozone output is 0.09 $\pm$ 0.005, record the voltage at the ozone test point to ground.

3. Set the ozonator thumbwheel to 800 and adjust the V potentiometer until the voltage is the same as that recorded in Step 1.

4. Set the ozonator thumbwheel to 200. Adjust the zero potentiometer until the voltage is the same as that recorded in Step 2.

5. Repeat Steps 3 and 4 until the voltages at both thumbwheel setpoints are the same as that initially recorded.

6. After the ozonator is properly set, perform the instructions listed in Sections G.3.1.3, Steps 2 through 8, and Section G.3.1.6.

7. If the ozonator is unstable or if the ozone concentration requirements cannot be met, replace the ultraviolet lamp. After replacement, perform a calibrator leak check using the procedure in Section G.3.1.4. The ozonator output may then be checked for stability. However, a full calibration should be delayed for at least three days to allow the lamp to condition. Before the full calibration, center the potentiometer wipers using the procedure in the manufacturer's instruction manual.

   NOTE: If a millivolt resolution voltmeter is not available, the procedure may be performed with the ozone transfer standard alone.

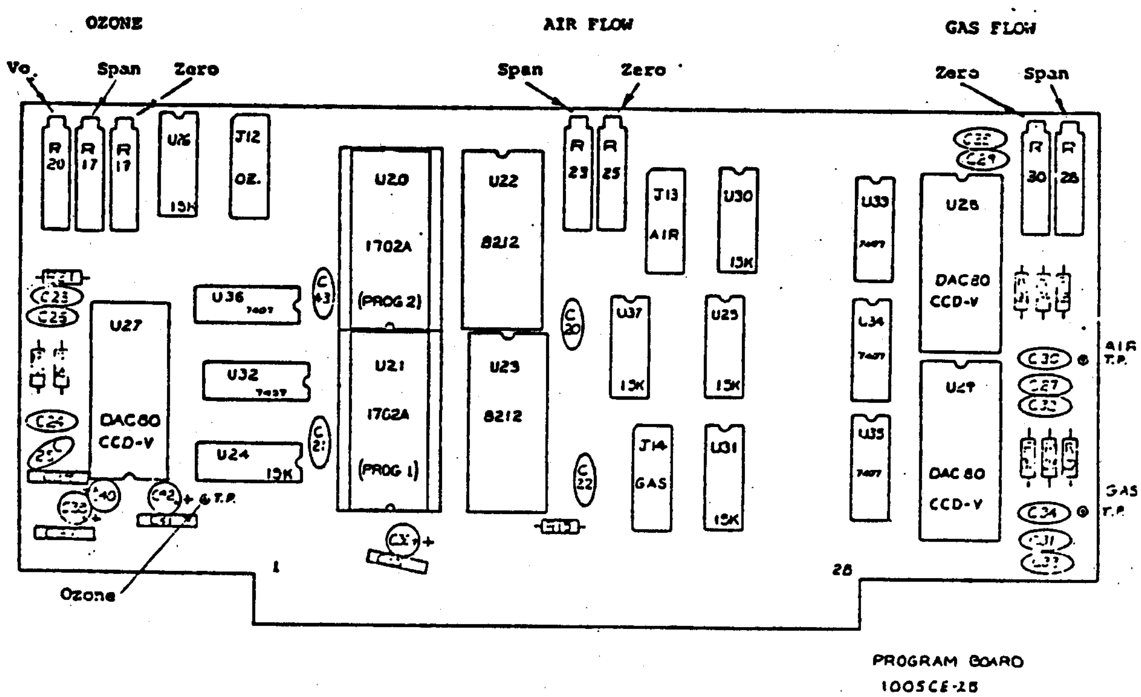


Figure G.3.2.1
Location of Adjustment Potentiometers

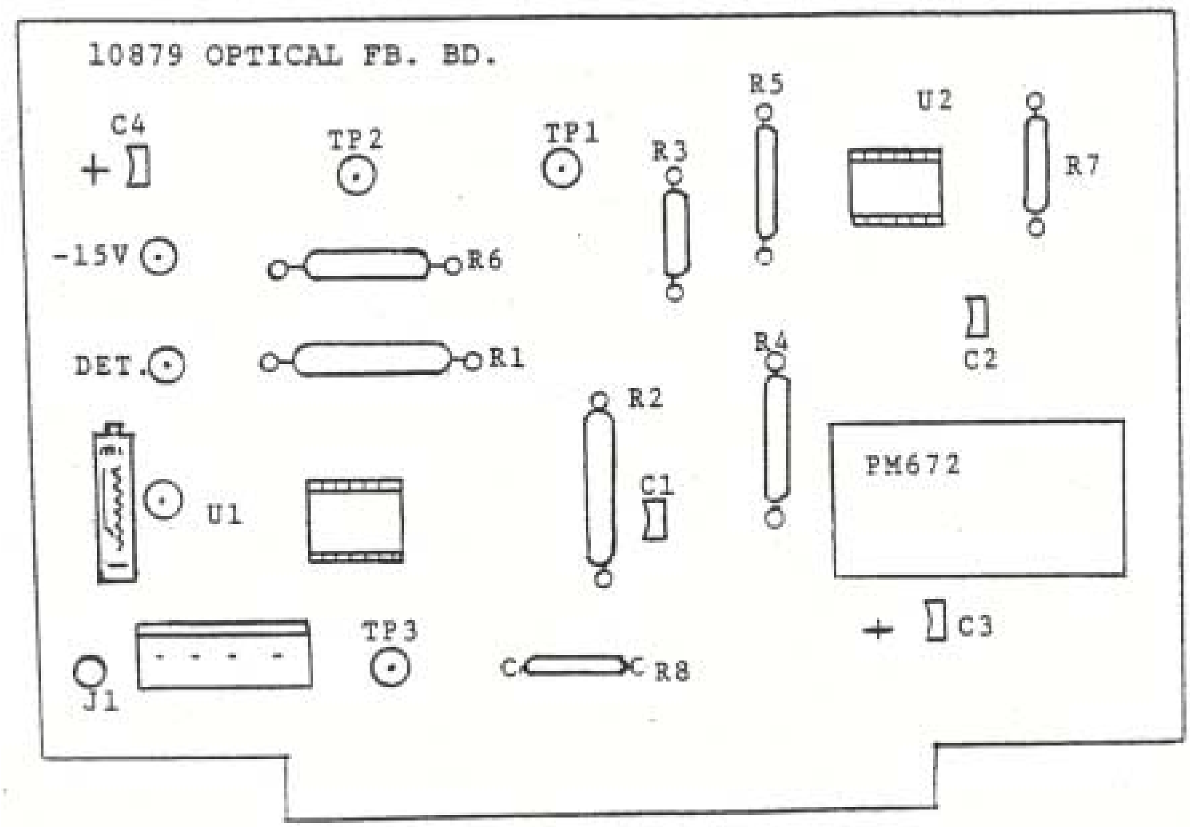


Figure G.3.2.2
Optical Feedback Printed Circuit Board

STATE OF CALIFORNIA

AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME II

STANDARD OPERATING PROCEDURES
FOR
AIR QUALITY MONITORING

APPENDIX G.4

DATA EVALUATION PROCEDURES FOR THE DASIBI MODEL 1005 C_2 GAS CALIBRATION SYSTEM

MONITORING AND LABORATORY DIVISION

APRIL 1989

G.4.0 GUIDELINES FOR REVIEWING DATA

G.4.0.1 STRIP CHARTS

This section provides guidelines for reviewing the calibrator traces on the strip charts.

1. Check the daily zeroes for indication of contaminated zero air. High NO (> .01 ppm) may indicate that inadequate purge flow is being maintained through the pure air generator. Compare positive day-to-day zero shifts against a known good zero air source to rule out possible pure air generator column malfunctions.

2. If the NO and NO_x daily traces overshoot and then drop down to a stable value, it may indicate that the teflon superblend lines are contaminated. The prob1em can be eliminated by replacing the line with 1/8" stainless steel tubing.

3. Excessive increases or decreases (> 3% FS) between SO_2 , CO, or HC concentrations recorded from Step 2 and Step 3 of the Timer program may indicate a calibrator electronic contact problem and should be investigated.

4. Ozone present (> .01 ppm) in Step 3 of the Timer program or steps 3, 5, 7, or 9 of the Auto program indicates that either the ozone bypass flow is too high (> 1.5 SLPM) or that the ozone generator needs to be recalibrated. See the section on ozone generator calibration (Appendix G.3) for further details.

G.4.0.2 MONTHLY DATA ANALYSIS

The Planning and Quality Assurance Section will perform a statistical analysis of the data recorded on the Monthly Checksheet. Figures G.4.0.1, G.4.0.2, and G.4.0.3 show example printouts. Table G.4.0.1 explains each category on the statistics printout. The following information should be helpful in reviewing the analysis.

1. Carbon monoxide analyzers have proven to be the most stable. Therefore, carbon monoxide data are plotted on both graphs showing percent difference versus day of the month. Thus, other data are evaluated with respect to CO. If all data shift up or down on a given day, you can reasonably assume that a system malfunction occurred. System malfunction examples include a pure air generator failure, loss of station temperature control, or calibrator mass flow controller malfunction. If only one trace shifts, you can reasonably assume that the individual analyzer shifted.

2. The graphs of percent difference versus day of the month may be used to evaluate analyzer response trends. Control limits are set at ±15%. If an analyzer response falls outside this limit, air quality data will be withheld from data processing. Therefore, analyzer corrective action should be taken prior to exceeding the control limits, if possible.

3. One use of the statistics printout is to evaluate the performance of the calibrator mass flow controllers and the ozone generator. CO Timer program data are generally within ±5%. Although an inaccurate superblend assay or insufficient air flow would give similar results, if the average percent difference is greater than ±5%, a mass flow controller calibration is probably needed. In addition, if abnormally high positive or negative percent differences at the low point in the Auto program for CO, HC, SO_2, or NO_2 are obtained, the mass flow controllers may need to be recalibrated. Abnormally high positive or negative percent differences for NO probably indicate the ozone generator needs recalibration.

4. The ozone concentration generated in Steps 3 and 4 of the Timer program should be constant. As a result, the ratio of the NO_2 generated in Step 3 and the ozone generated in Step 4 of the second page of the graphics analysis. If NO_2 and O_3 percent difference data are not plotted on the first page of the graphics analysis, you should have the Monthly Quality Control Maintenance Checksheet availab1e in order to properly evaluate the rates.

   Listed below are several ways the ratio may be evaluated.

NO_2 /O_3Ratio	O_3 Reading	NO_2 Reading	Probable Cause
constant	decreasing	decreasing	calibrator UV lamp output decreasing
increasing	decreasing	constant	O_3 analyzer
increasing	constant	increasing	NO/NO_x analyzer needs recalibration
decreasing	constant	decreasing	bad NO_2 converter or NO/NO_x analyzer needs recalibration
decreasing	increasing	constant	malfunctioning ozone generator

G.4.0.3 BASIC EQUATIONS

1. Nomenclature

a. F_g = gas flow, liters per minute

b. F_a = air flow, liters per minute

c. F_t = total air flow, = Fa + Fg, liters per minute

d. C_{cyl} = compressed gas cylinder concentration, ppm

e. C_o = resultant concentration or desired concentration, ppm

2. Calculating the desired concentration, C_o given

F_g, F_a and C_{cyl}: $C_o = \frac{F_g\,(C_{cyl})}{F_a+F_g}$

3. Calculating the gas flow, F_g, given F_a, C_{cyl} and C_o

$$F_g = \frac{(C_o)\,(F_a)}{C_{cyl} - C_o}$$

4. Calculating the air flow, F_a, given F_g, C_{cyl} and C_o

$$F_a = F_g \frac{(C_{cyl} - C_o)}{C_o}$$

5. Calculating the cylinder concentration, C_{cyl}, given F_a, F_g, and C_o

$$C_{cyl} = \frac{(F_a + F_g)\,(C_o)}{F_g}$$

Table G.4.0.1

Definitions of Statistical Analysis Categories

PART 1 - TIMER PROGRAM DATA EVALUATION

Pollutant - The test gas that is generated to assess the analyzer response.

No. of Valid Days - The number of days in the month for which valid daily analyzer responses were recorded.

Percent Difference - The difference between the true concentration and the net recorded concentration, divided by the true concentration, multiplied by 100. The true concentrations for CO, CH_4 , THC, SO_2, and NO are calculated using the superblend concentrations and mass flow controller calibrations. The true concentrations for ozone are taken from the ozone generator calibration. The true concentrations for the daily NO_2 equal the true concentration of ozone.

a. Average Percent Difference - The average percent difference is the sum of the daily percent differences divided by the number of valid days.

b. 95% Probability Limits - The upper and lower probability limits equal the average percent difference, plus or minus 1.96 times the standard deviation of the individual percent differences.

c. Highest Moving Range - The moving range is calculated by determining the percent difference for one day and subtracting the percent difference from the previous day. The highest moving range is the largest consecutive day difference for the month. The day indicated on the Printout represents the start of the excursion. Under "CAUSE", space is provided to indicate the reason for the excursion.

Percent Difference/Day - Presents the slope and intercept for the analysis of all the percent differences (y) vs the day of the month (x).

Total Change for the Month - The total change for the month is calculated by multiplying the slope by the number of days in the month.

Average NO_2/NO Converter Efficiency - The average converter efficiency is the sum of the daily converter efficiencies divided by the number of valid days.

Lowest NO_2/NO Converter Efficiency - The lowest converter efficiency calculated for the month.

Table G.4.0.1 (cont.)

Definitions of Statistical Analysis Categories

PART 2 - AUTO PROGRAM DATA EVALUATION

Pollutant - The test gas that is generated to assess the analyzer response

Ratio of the Means - The ratio is calculated by summing the true concentrations and the recorded concentrations, respectively, taking the difference, dividing by the sum of the true concentration and multiplying by 100. The zero points are not included in this calculation.

Percent Difference at Each Point - For CO, CH_4, THC, SO_2 and NO_2, Steps 3, 5, 7, and 9 of the Auto program are used to determine recorded concentration. For NO, Steps 2, 4, 6, and 8 are used. The following information is listed for each point:

a. True - The true concentrations for CO, CH_4, THC, SO_2, and NO are calculated using the superblend concentrations and the mass flow controller calibrations. The true concentrations for NO_2 equal ozone concentrations at the appropriate calibration setting.

b. Percent Difference - The difference between the true concentration and the net recorded concentration, divided by the true concentration, multiplied by 100.

Best Fit Linear Regression - Using x as the true concentration and y as the recorded concentration, a least squares linear regression is performed. All points, including zero, are used in the regression calculations.

NO_2/NO Converter Efficiency - The following information is presented for each point:

NO_2 Concentration - The NO_2 concentration represents the recorded NO_2 concentration at Steps 3, 5, 7, and 9 of the Auto program. This information is presented to give the reviewer a basis for evaluating the NO_2/NO converter efficiency.

Converter Efficiency (C.E.) - The converter efficiency at Steps 3, 5, 7, and 9 is expressed as a percentage, mathematically:

$$C.E. = \left[1 - \frac{NO_x(n-1) - NO_x(n)}{NO(n-1) - NO(n)} \right] \times 100$$

Where n = 3, 5, 7 or 9
n-1 = 2, 4, 6 or 8

DASIBI GAS CALIBRATION SYSTEM-MONTHLY STATISTICAL ANALYSIS

STATION NAME SAN LUIS OBISPO   STATION CODE 4000835   MONTH/YEAR 04/80

TIMER PROGRAM DATA EVALUATION (X=TRUE CONCENTRATION, PPM; Y=NET CHART READING, PPM)

POLLUTANT	NO. OF VALID DAYS	AVERAGE %	PERCENT DIFFERENCE (Y-X)/X * 100: 95% PROBABILITY LIMITS UPPER	LOWER	HIGHEST MOVING RANGE DAY	%	CAUSE	PERCENT DIFFERENCE/DAY SLOPE %/DAY	INTERCEPT %	TOTAL CHANGE FOR THE MONTH
CO	29	- 0.3	0.6	- 1.2	16	0.8		-0.031	0.16	- 0.94
CH4	NO DATA									
THC	NO DATA									
SO2	NO DATA									
NO	29	- 2.8	0.3	- 5.9	29	- 1.4		-0.136	- 0.70	- 4.07
NO2	29	6.1	11.5	0.6	23	- 4.4		-0.157	8.46	- 4.71
O3	29	1.8	5.4	- 1.9	27	3.7		-0.147	3.99	- 4.40

THE AVERAGE NO2/NO CONVERTER EFFICIENCY= 99.608%   THE LOWEST NO2/NO CONVERTER EFFICIENCY= 99.100% ON DAY 15

AUTO PROGRAM DATA EVALUATION (X=TRUE CONCENTRATION, PPM; Y=NET CHART READING, PPM)

FIRST AUTO PROGRAM TEST DATE: 9   SECOND AUTO PROGRAM TEST DATE 23   THIRD AUTO PROGRAM TEST DATE: 0

POLLUTANT	RATIO OF THE MEANS (SUMX-SUMY)/SUMX %	PERCENT DIFFERENCE AT EACH POINT: TRUE PPM / % DIFF	TRUE PPM / % DIFF	TRUE PPM / % DIFF	TRUE PPM / % DIFF	BEST FIT LINEAR REGRESSION SLOPE	INTERCEPT PPM	NO2/NO CONVERTER EFFICIENCY NO2 CONC PPM	C.E. %
CO	- 1.9	39.40 / -00.0	20.37 / -02.3	10.62 / -04.9	5.55 / -08.1	1.004	-0.254	0.563	99.1
CH4	NO DATA							0.293	99.3
THC	NO DATA							0.149	99.3
SO2	NO DATA							0.060	98.6
NO	- 3.1	0.714 / -01.6	0.369 / -03.0	0.192 / -04.9	0.101 / -10.5	0.989	-0.005		
NO2	7.1	0.519 / 08.5	0.274 / 07.7	0.144 / 03.5	0.067 / 01.5	1.090	-0.004		
CO	- 1.5	39.40 / -00.0	20.37 / -02.3	10.62 / -03.0	5.55 / -06.3	1.002	-0.164	0.548	99.8
CH4	NO DATA							0.290	99.0
THC	NO DATA							0.147	99.3
SO2	NO DATA							0.068	100.0
NO	- 4.1	0.714 / -02.7	0.369 / -04.1	0.192 / -05.9	0.101 / -10.5	0.978	-0.004		
NO2	4.7	0.519 / 05.6	0.274 / 05.8	0.144 / 02.1	0.067 / 01.5	1.060	-0.002		

ANALYSIS AND RECOMMENDATIONS ______________________________

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ANALYSIS REVIEWED BY ______________ (PI&QA) DATE ________ ______________ (AQS) DATE ________

Figure G.4.0.1
Dasibi Gas Calibration System-Monthly Statistical Analysis

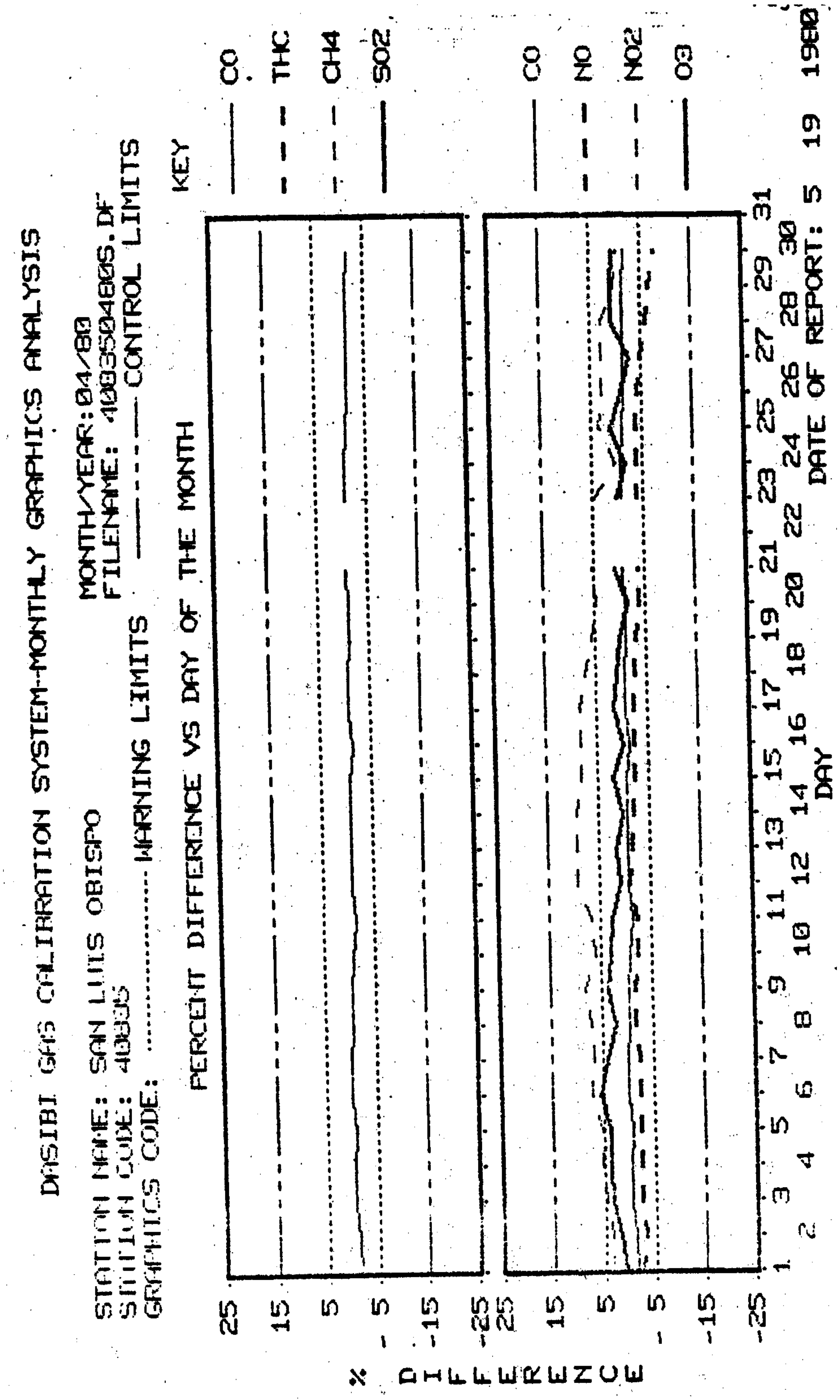

Figure G.4.0.2
Dasibi Gas Calibration System-Monthly Graphics Analysis (Page 1)

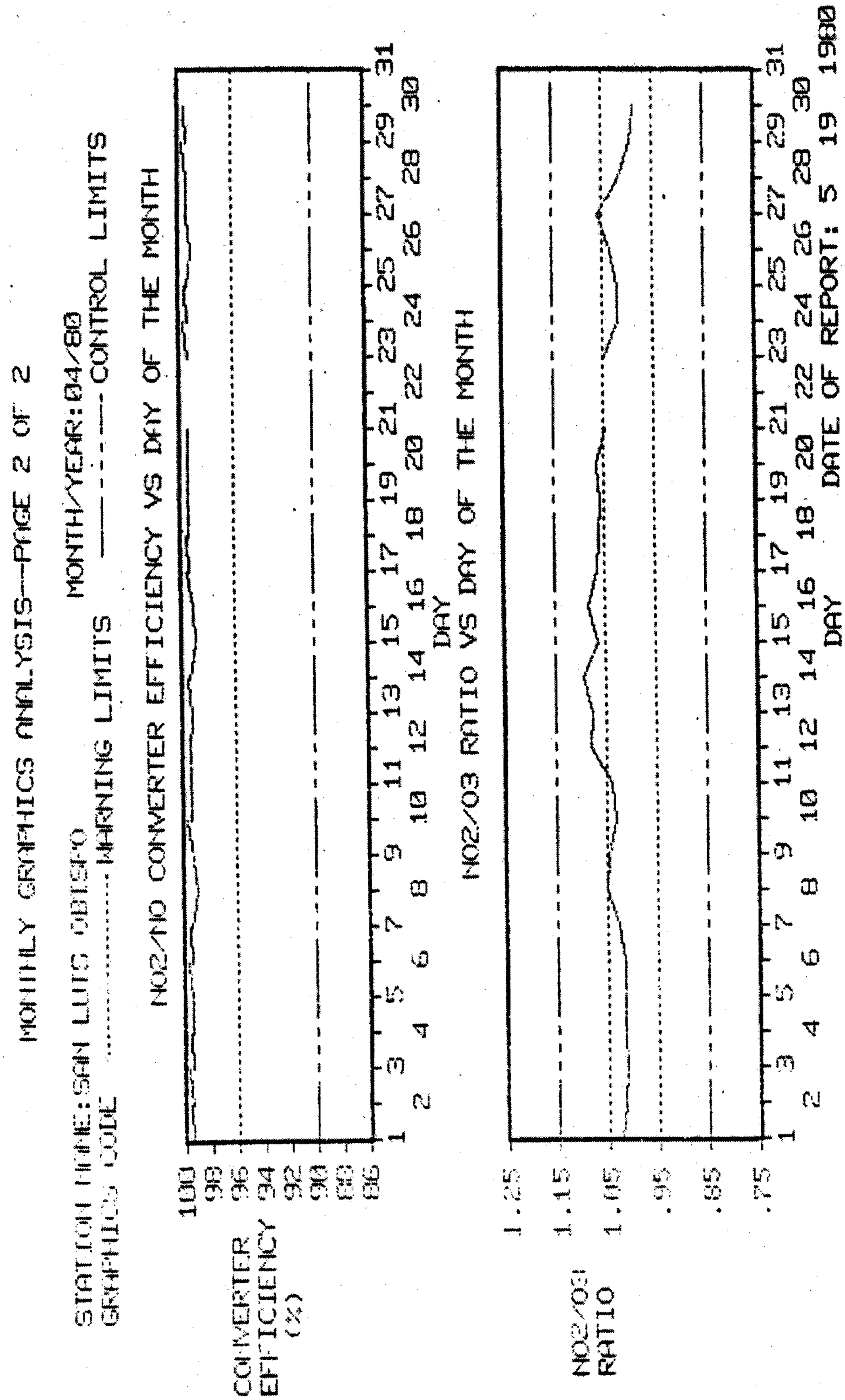

Figure G.4.0.3
Dasibi Gas Calibration System-Monthly Graphics Analysis (Page 2)