STATE OF CALIFORNIA

AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME II

STANDARD OPERATING PROCEDURES
FOR
AIR QUALITY MONITORING

APPENDIX AL

METEOROLOGICAL PARAMETERS
FOR
MET ONE 090D BAROMETRIC PRESSURE SENSOR

MONITORING AND LABORATORY DIVISION

NOVEMBER 1999

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AIR RESOURCES BOARD

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VOLUME II

STANDARD OPERATING PROCEDURES
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AIR QUALITY MONITORING

APPENDIX AL.1

STATION OPERATOR'S PROCEDURES
FOR
MET ONE 090D BAROMETRIC PRESSURE SENSOR

MONITORING AND LABORATORY DIVISION

NOVEMBER 1999

AL.1.0 OVERVIEW

AL.1.0.1 INTRODUCTION

Barometric Pressure (BP) is a meteorological parameter that measures the atmospheric pressure induced by the present weather conditions and is also a function of altitude. The BP is measured as absolute pressure at the elevation of the sensor. The National Weather Service (NWS) reports the BP normalized to sea level. An example is: at sea level the average BP for 0' would be approximately 760 mmHg (29.92"Hg) and reported in absolute and normalized as 760 mmHg (29.92"Hg). However, at 1500' of elevation the average BP is 660 mmHg (26"Hg) and would be reported as such in absolute, but reported as 760 mmHg (29.92"Hg) as normalized by the NWS.

With the exception of Photochemical Assessment Monitoring Stations (PAMS), BP is not a required parameter for ambient air monitoring. However, the Air Quality Surveillance Branch (AQSB) has elected to place BP sensors at their stations with PM2.5 samplers. This data may be used as a quality control tool for comparison with sampler BP sensors. Along with ambient temperature, BP is a factor used in the conversion of standard to actual (volumetric) flow rates or visa versa. BP data can also be used as a factor in determining air quality forecasts in support of ARB’s agricultural burn programs.

AL.1.0.2 THEORY OF OPERATION

The Met One 090D Barometric Pressure Sensor uses an active solid-state device to sense atmospheric BP changes. Its self-contained electronics provide a regulated voltage to the solid state sensor and amplification for the signal output to the translator card. At sea level, normal BP is 29.92" of mercury (Hg) and with each 1000' increase in elevation the BP decreases approximately 1"Hg. The table below (Table AL.1.0.1) shows the range selection guide for Met One 090D sensors for various elevations in which AQSB BP sensors would normally operate.

Table AL.1.0.1
MODEL 090D BAROMETRIC PRESSURE SENSOR RANGE SELECTION GUIDE

ELEVATION in FEET	RANGE in "Hg (mmHg)
0 to 1,500	26/32 (660/813)
1,501 to 3,500	24/30 (610/762)
3,501 to 5,500	22/28 (559/711)
5,501 to 8,000	20/26 (508/660)
8,001 to 10,000	18/24 (457/610)

AL.1.0.3 DISCUSSION

AQSB reports BP in millimeters of mercury (mmHg). All references to BP in these procedures will be expressed in units of mmHg. Over short periods of less than 1 hour, there is generally little, if any change in barometric BP. When the BP is higher than the normal BP it generally means that a high pressure zone is setting over the area and as long as the BP stays above normal, good weather shall prevail. If the BP drops below normal and continues to drop at a rapid pace of $\geq$1 mmHg per hour, less than ideal weather is approaching. With AQSB saving BP in one hour averages it is difficult to use the BP data as a weather predictor, but personnel at the site can visually check it and see if the weather is changing.

There are many ways to determine the accuracy of the BP sensor. The four most commonly used methods are listed in order of accuracy. The first, if you have access to a pressure standard, is to use the pressure standard. The second is to use the PM2.5's internal BP sensor. However, this sensor is less stable than the Met One sensor and not always right near the station BP sensor. The third is to call the NWS or your local airport. With this method you must take into account that the data given you may be at least one hour old and any elevation differences must be taken into consideration. Also remember that the NWS readings are normalized, reference the INTRODUCTION section (Section AL.1.0.1), and other organizations may not calibrate their sensors to the close tolerances that AQSB does. The fourth method should only be used when the above three methods are not available. Visually check the weather. If it is changing for the worse, the sensor E.U's. should be dropping and if the conditions are improving, the sensor E.U's. should be rising.

AL.1.0.4 ABBREVIATION INDEX

1. "Hg = inches of mercury
2. AQSB = Air Quality Surveillance Branch of ARB
3. ARB = Air Resources Board
4. AtoD = analog to digital converter
5. BP = barometric pressure
6. DMM = digital multi-meter (AC, DC, Ohms, Current, Frequency, etc.)
7. E.U's. = engineering units
8. met. = meteorological parameters
9. mmHg = millimeters of mercury
10. MQCMCS = Monthly Quality Control Maintenance Checksheet
11. NWS = National Weather Service
12. PAMS = Photochemical Assessment Monitoring Stations
13. PM2.5 = particulate matter of 2.5 microns or less in size
14. pot = potentiometer
15. PSD = Prevention of Significant Deterioration
16. Qpro = Quattro Pro version 8 spreadsheet
17. T/P = Temperature/Pressure standard

AL.1.0.5 EQUIPMENT

1. 4.5 digit, digital multi-meter
2. Meteorological Instrumentation Monthly Quality Control Maintenance Checksheet

AL.1.1 ROUTINE SERVICE CHECKS

AL.1.1.1 DAILY CHECKS

On a daily basis, the station operator should review the BP data collected for the previous day. The operator should compare the BP readings with the previous day's weather (i.e., if the weather was blustery or raining, the BP should have read a few mmHg below the normal value for this site). If the comparisons appear to be bad, the operator should continue with the MONTHLY CHECKS (Section AL.1.1.2).

AL.1.1.2 MONTHLY CHECKS

1. Check that the BP port is clear

   At least once a month, the station operator should check that the port at the bottom of the BP sensor has not been blocked by an insect or debris. If this port is blocked, the BP data will be virtually unchanged for many hours and should be cleaned out as soon as possible.

2. Perform translator card checks

   The translator card checks consist of checking the zero and span outputs from the BP translator card to the data logger. The zero and span engineering units (E.U's.) displayed by the data logger should be within 0.5 mmHg of the scale for your sites elevation. Reference "Model 090D Barometric Pressure Sensor Range Selection Guide" table. For sites that are below 1,500', the zero E.U's. should be 660.0 ±0.5 mmHg, and the span E.U's. should be 813.0 ± 0.5 mmHg. If the zero or span E.U's. are off more than the ±0.5 mmHg, you must adjust the appropriate potentiometer (pot) so that the output is correct. After adjusting for the proper E.U's. display, if the voltage readings are off by more than ±0.003V's of 0.0000V's for the zero and ±0.003V's of 1.0000V's for the span, you will have to troubleshoot to see if the data loggers' analog to digital converter (AtoD) has drifted or the translator board is working incorrectly.

   If you use a DMM, the preferred method, instead of the data loggers voltage display, in 90% of the cases you will insert the red (+) lead into TP3 and the black (gnd) lead into TP1. The 10% of the cases you may need to insert the red (+) lead into TP4 is if the card is an old style and the 0-1v. output comes out via the appropriate terminal strip pins 7 and 8 instead of 5 and 6. Another possibility is if the card is a 2740-4BP (AQSB's new standard), both outputs are 0-1v. Just remember that V1, TP3, and pins 5 & 6 of the appropriate terminal strip are all linked and V2, TP4, and pins 7 & 8 are all linked.

a. Hold the Zero switch S1 up and record the E.U's. and voltage out on the Meteorological Instrumentation "Monthly Quality Control Maintenance Checksheet" (MQCMCS) (Figure AL 1.1.2). If the E.U's. do not fall within the tolerances determined from the information in the paragraphs above, adjust Z1 pot. If the full range of adjustment is not enough to get the E.U's. within tolerance replace the translator board.

b. Release S1 and hold the Span switch S2 up. Record the E.U's. and voltage out on the MQCMCS. If the E.U's. do not fall within the tolerances determined from the information in the paragraphs above, adjust V1 pot. If the full range of adjustment is not enough to get the E.U's. within tolerance replace the translator board.

3. Compare the station BP sensor with another BP sensors output. There may be other ways of checking that the stations BP sensor is operating close to specifications, but generally one of the four following methods works for most operators. These will be listed from most accurate to least accurate. Remember to reference the <u>DISCUSSION</u> section (Section AL.1.0.3) for things to be aware of when using an unknown BP sensor as a comparison. If after the comparison you feel the station BP sensor is not operating within specifications, ask that a calibration of the sensor be performed.

   a. Place the T/P standard close to the inlet of the station sensor. Heat from the sun may influence the standards reading, so try to keep it out of any sunlight. If the difference is greater than $\pm$5 mmHg and the T/P standard is not due calibration, request that a calibration be performed on the station sensor.

b. Use the PM2.5 samplers BP sensor as a comparison. However, remember that this sensor is less stable than the Met One 090D, and if a difference of greater than ± 6 mmHg is noted, request that the PM2.5 BP sensor be recalibrated.

c. Call the local airport, or any local source that has BP data, and compare what its output is in relation to the stations BP output. If the readings are greater than ±10 mmHg, try to do the monthly check with method 1 or 2 above. If the differences are still off, request that a calibration be performed on the station sensor.

d. This is a last resort check. If the weather is getting worse, the BP E.U's. should be dropping, and if the weather is getting better, the BP E.U's. should be increasing. Document what you find for historical information only.

CALIFORNIA AIR RESOURCES BOARD
MONTHLY QUALITY CONTROL MAINTENANCE CHECKSHEET
METEOROLOGICAL INSTRUMENTATION

Location: ____ Month/Year: _________________________
Station Number: ____________ Agency: __________________ Operator: ____________________________

	RESULTANT WIND SPEED				RESULTANT WIND DIRECTION			
	Translator Check		Visual Check		Translator Check		Visual Check	
	Zero	Span	Estimate	Data logger	Zero	Half or Span	Estimate	Data logger
Date	V's/Knots	V's/Knots	Knots	E.U.	V's/Degree	V's/Degree	Degree	E.U.

Ideal E.U's. = 0.52 86.84 0.00 270.0 or 360.0 depends on card generation

	OUTSIDE TEMPERATURE				INSIDE TEMPERATURE			
	Translator Check		Reference Check		Translator Check		Reference Check	
	Zero	Span	Reference	Data logger	Zero	Span	Reference	Data logger
Date	V's/Celsius	V's/Celsius	Celsius	E.U.	V's/Celsius	V's/Celsius	Celsius	E.U.

Ideal E.U's. = -50.00 +50.00 0.00 50.00 (MET ONE ONLY)

	PERCENT RELATIVE HUMIDITY				SOLAR RADIATION			
	Translator Check		Reference Check		Translator Check		Visual Check	
	Zero	Span	Reference	Data logger	Zero	Span	Visibility of	Data logger
Date	V's/%RH	V's/%RH	%RH	E.U.	V's/E.U.	V's/E.U.	sky & time	E.U.

Ideal E.U's. = 0.00 100.0 0.00 2.00 or 2000 depends on if RAD or SRAD

	BAROMETRIC PRESSURE							
	Translator Check		Reference Check					
	Zero-----	Span	Reference	Data logger				
Date	V's/mmHg	V's/mmHg	mmHg	E.U.				

Ideal E.U's. = dependant on elevation. Use logger slope & intercept
See other side/second page for specific notes and instructions on filling out Checksheet.
MLD-111 1 of 2 (11/99)

Figure AL.1.1.2
Monthly Quality Control Maintenance Checksheet

OPERATOR INSTRUCTIONS:

1. Daily: Review data logger data for each meteorological parameter at all your sites.

2. Monthly: Record translator zero and span or half scale voltages and engineering units (E.U.). Voltage tolerances are ±3mV's. However, it is more important to have the E.U's. reading correctly. The data logger A to D convertor may be drifting. Reference tolerances are listed below each parameters block on the first page. MET ONE ONLY.

   Perform a visual or reference check of each met. parameter as described below. If any problems, correct them.

   RWS: Visually inspect sensor cups or propellor for damage. Take a rough guess at what speed the cups or propellor are turning and record it along with the data loggers E.U's. Averaged over 15 to 30 seconds, the E.U's. should be within ±5 knots of the estimate, after some practice.

   RWD: Visually inspect the vane for damage and using the last calibrations crossbar orientation, confirm that the crossbar has not moved. Then estimate the direction the pointer on the vane is pointing. Record this estimate and the E.U's. They should be within ±25E.

   OTEMP: Assure the radiation fan is working. Non-operation means delete data. Place a reference thermometer close to the aspirated shield, but out of any sunlight. After 3 to 5 minutes of stabilization time, record the reference and E.U's. They should be within ±3EC.

   ITEMP: Assure that the sensor is not being heated or cooled by any device other than the ambient air and is located near the back and center of the instrument racks no higher than six feet above floor. Place a reference thermometer close to the sensor. After 3 to 5 minutes of stabilization time, record the reference and E.U's. They should be within ±1EC.

   %RH: Assure the radiation fan is working. If you have a reference meter, place it close to the radiation shield. After a 3 to 5 minute stabilization time, record the reference and E.U's. They should be within ±5%RH. If you do not have a reference, call the local airport or T.V. station. The two readings should be within ±10%RH.

   SRAD: Can also be RAD. SRAD = Met One 096 sensor (0 to 2000 W/M^2) and RAD = Met One 095 sensor (0.00 to 2.00 or 2.87 Langleys/minute). Assure that the sensor is still level, there is no blockage between the sun and the sensor, and it appears clean. Record the time and general visibility, i.e., few clouds, lots of clouds, hazy, foggy, etc., along with the E.U's. No tolerances. This data just acts as a history for future reference in troubleshooting.

   BP: Visually confirm that the inlet port is not blocked. If you have a reference BP sensor, such as in the PM2.5 calibration kit, place it near the station sensor. After a 3 to 5 minute stabilization time, record the reference and E.U's. They should be within ±5 mmHg. If you do not have a reference sensor, the best you can do is record the general weather conditions and the E.U's. Lower readings should correlate with weather that is getting worse, i.e., windy, colder, raining, etc.

3. Semi-Annual: Operator clean all met. components. Perform a calibration of all parameters (Last Cal. Date:_________)

DATE	COMMENTS or MAINTENANCE PERFORMED

MLD-111 2 of 2 (11/99) Reviewed by: ______________________________ Date: ____________________

Figure AL.1.1.2 (cont.)
Monthly Quality Control Maintenance Checksheet

STATE OF CALIFORNIA

AIR RESOURCES BOARD

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VOLUME II

STANDARD OPERATING PROCEDURES
FOR
AIR QUALITY MONITORING

APPENDIX AL.2

ACCEPTANCE TEST PROCEDURES FOR MET ONE 090D BAROMETRIC PRESSURE SENSOR

MONITORING AND LABORATORY DIVISION

NOVEMBER 1999

AL.2.0 ACCEPTANCE TEST PROCEDURES

AL.2.0.1 GENERAL INFORMATION

Before beginning acceptance testing of the barometric pressure (BP) systems, read the operating manual thoroughly. Initiate an "Acceptance Test Log" (Figure AL.2.0.1) and an "Acceptance Test "Mini" Report" (Figure AL.2.0.2). Record the dates of the individual tests, problems, contacts with the manufacturer, and any other pertinent information on the "Acceptance Test Log".

AL.2.0.2 PHYSICAL INSPECTION

Unpack the BP system and check for physical damage if this has not been done already. Verify that the system is complete and includes all options and parts required by the purchase order.

AL.2.0.3 OPERATIONAL CHECKS

Operational checks should assure that the BP sensors and the translators meet or exceed performance specifications stated by the vendor. In addition, the check out should verify that the BP sensor meets an accuracy of ±4 mmHg. This is a compromise between the Prevention of Significant Deterioration Standards (PSD) of ±7.5 mmHg and the PAMS ±0.75 mmHg. Perform the following operational checks using a DMM, oscilloscope, and/or data logger and record the results on the "Acceptance Test "Mini" Report". These tests should be run in the range normally used in field operations.

1. Translator Test - Connect a recorder or voltmeter to the output of the translator. Verify that the translator zero equals 0.000V's. ±3 mV's. and the span equals 1.000V's ±3 mV's.

2. Linearity - Set the BP sensor up to induce vacuum and pressure and verify that the translator voltage outputs are linear across the full scale at a minimum of five points. Do this by applying a "least squares" regression to the acceptance test data, where "Y" is the actual and "X" is the indicated value, the correlation coefficient shall be not less than 0.997. Enter the results in the "Acceptance Test "mini" Report".

3. Range Test - Verify that the BP system operates at the full BP range scale stated in the vendor's specifications.

4. Accuracy - Verify that the BP system accuracy meets or exceeds the vendor's specifications.

ACCEPTANCE TEST LOG

Make ____________________________ Model ___________________S.N. ____________

Date	Initials	Action

Figure AL.2.0.1
Acceptance Test Log

ACCEPTANCE TEST "MINI" REPORT

Make ________________________ Model _________________ Date _________________

S.N. _______________ Property Number _______________ Performed by _______________

	Pass	Fail	Comments
PHYSICAL INSPECTION			
Shipping damage			
Electrical wiring			
Completeness			
OPERATIONAL TEST			
Translator			
Linearity			
Range			
Accuracy			

LINEARITY CHECK

%FS	True Voltage	Indicated Voltage	Diff. True-Ind.	Comments
		Avg. Difference TrueInd.		

Average Diff. True - Ind. must be less than 1% of Full Scale.

Figure AL.2.0.2
Acceptance Test "Mini" Report

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STANDARD OPERATING PROCEDURES
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APPENDIX AL.3

CALIBRATION PROCEDURES
FOR
MET ONE 090D BAROMETRIC PRESSURE SENSORS

MONITORING AND LABORATORY DIVISION

NOVEMBER 1999

AL.3.0 OVERVIEW

AL.3.0.1 INTRODUCTION

Barometric Pressure sensors should be calibrated at least every six months. Calibrations are performed to verify that the BP sensors are properly converting atmospheric pressure changes to the correct ambient pressure and are meeting the PSD standards.

The following calibration procedure gives the most accurate and easily performed calibration of various procedures tried. Once the initial setup is completed, one person can easily perform this calibration of the BP sensor in the field. One reason this procedure was chosen was because a lot of Temperature/Pressure (T/P) standards are susceptible to drift with heating of the standard. With almost all the BP sensors located out in the open, the sun becomes a critical factor in getting good accuracy. This procedure is similar to what one would perform in the shop and allows a slope and intercept to be generated which can then be used to correct data, if necessary.

It should be noted that this procedure works very well on Met One 090D models and can possibly be used on many other manufacturers BP sensors. However, when used on the Met One 090C model one must be very quick at taking the readings, for the C model leaks some and cannot be made leak free.

The calibration spreadsheet is available in both Quattro Pro 8 and Excel 97 versions (Figure AL.3.1.1 and Figure AL.3.1.3, respectively). A complete cell-to- cell printout of the Quattro Pro 8 version is also provided for those that wish to see the details of how the spreadsheet works or if you need to know how to setup a paper version (Figure AL.3.1.2). In both the QPRO and Excel versions, black input is data that in most cases does not change, blue is the data the calibrator inputs when performing the calibration, red is calculated by the spreadsheet or after you press the regression button, and yellow is used to highlight the most important results of the spreadsheet. You should never enter anything in cells which have red formatting. To obtain an electronic version of the calibration spreadsheet, please contact Steve Rider at (916) 327-4719.

AL.3.0.2 EQUIPMENT

1. AQSB Temperature/Pressure Standard or equivalent setup to connect $^1/_4$" O.D. x $^3/_{16}$" I.D. Teflon tubing and a vacuum/pressure gun to. The T/P standard must have an accuracy of $\pm$1 mmHg over the full range or correctable with a slope and intercept.

2. Plastic automotive Vacuum/Pressure gun.

3. $^{9}/_{16}$" open/box end wrench

4. 2 ea. small cable ties

5. Leak free $^{1}/_{4}$" O.D. x $^{3}/_{16}$" I.D. Teflon tubing running between the BP sensor and the Temperature/Pressure Standard with a $^{1}/_{4}$" swagelok fitting at the T/P standard end.

6. $^{3}/_{8}$" O.D. x $^{1}/_{4}$" I.D. Tygon tubing $\leq$ 3" long inserted over the inlet barb to BP sensor.

7. 1 ea. Quattro Pro 8 version of the “ARB Calibration Report - Barometric Pressure” spreadsheet, an equivalent spreadsheet from another brand of software, or a paper worksheet.

AL.3.1 CALIBRATION PROCEDURE

AL.3.1.1 PREPARATION

The following steps should be performed during initial installation or when the assembly no longer holds a vacuum or pressure. Some minor leakage is okay, but it should not be large enough that the calibrator isn't confident that the readings he gets from the T/P standard and data logger are the same at the point of taking the reading.

1. Open the cover to the BP sensor and confirm all fittings are tight and leak free. Place the ≤3" long $^{3}/_{8}$" O.D. x $^{1}/_{4}$" I.D. Tygon tubing over the inlet barb of the BP sensor. Insert tubing completely over the whole length of the barbs.

2. Attach the leak free $^{1}/_{4}$" O.D. x $^{3}/_{16}$" I.D. Teflon tubing between the BP sensor and inside the station where you can easily see the Temperature/Pressure Standard and the data logger display at the same time. Place a $^{1}/_{4}$" swagelok fitting at the T/P standard end or whatever fitting that assures a leak free connection to the hookup for the T/P standard, vacuum/pressure gun, and the tubing. Leave some extra length at both ends to store each end out of the way after the calibration. Also attach a label saying BP on both ends of the tubing so no one removes it, or if they damage the tubing, they can notify the appropriate calibrator.

   A suggested leak free hookup for the T/P standard is a $^{1}/_{4}$" swagelok "T" fitting attached to the T/P standards pressure input. Place a ≤ 3" long piece of $^{1}/_{4}$" O.D. stainless steel tubing through a $^{1}/_{4}$" swagelok fitting, and secure it to one end of the $^{1}/_{4}$" swagelok "T" fitting. The other end of the $^{1}/_{4}$" swagelok "T" fitting is where the calibrator attaches the $^{1}/_{4}$" O.D. x $^{3}/_{16}$" I.D. Teflon tubing from the BP sensor.

AL3.1.2 PROCEDURE

1. Place the T/P standard where the calibrator can see the T/P standard reading and the data logger reading simultaneously. Turn on the T/P standard.

2. After a minimum of a one-hour warmup, connect the $^{1}/_{4}$" O.D. x $^{3}/_{16}$" I.D. Teflon tubing to the leak free hookup on the T/P standard. Slip the hose from the vacuum/pressure gun over the hookup assembly. Disable the data logger's BP channel.

3. Take the end of the $^{1}/_{4}$" O.D. x $^{3}/_{16}$" I.D. Teflon tubing at the BP sensor and insert it into the $^{3}/_{8}$" O.D. x $^{1}/_{4}$" I.D. Tygon tubing attached to the inlet barb. Insert it all the way until it touches the barb and secure the joined tubing with 2 each cable ties.

4. When the data logger and T/P readings are stable, record the two ambient readings on the calibration form.

NOTE: WHEN PULLING A VACUUM OR INPUTTING PRESSURE WITH AN AUTOMOTIVE VACUUM/PRESSURE GUN, IT IS IMPORTANT TO TAKE SHORT STROKES OF THE GUN. IN MOST CASES ONE STROKE IS ENOUGH TO PEG THE BP SENSOR. THUS, TAKE TINY MULTIPLE STROKES UNTIL YOU GET THE READING YOU WANT.

5. Next, pull a vacuum midway between the ambient reading and the lowest point the BP sensor can record, i.e., if the BP sensor is a 0 to 1500' sensor, its lowest reading will be 660 mmHg. If your ambient reading was 760 mmHg, pull a vacuum to 710 mmHg. If you are not sure what the maximum and minimum the BP sensor can report, check the data logger’s BP channel configurations. Once you are confident the readings are stable enough, record the two pressure readings.

6. Pull more vacuum to near the lowest reading possible for the BP sensor, i.e., using the same example from step 4, pull a vacuum till you read slightly above 660 mmHg. Record these two pressure readings.

7. Relieve the vacuum and move the vacuum/pressure gun hose from the vacuum inlet to the pressure outlet of the gun. Apply a pressure that is midway between the ambient reading and the maximum reading that the BP sensor can report. See step 4 for reference. Record these two pressure readings.

8. Apply more pressure until the readings are just below the maximum that the BP sensor can report. Record these two pressure readings.

9. If you are using the Qpro spreadsheet, press the “B.P. Regression” button. This will assure all calculations have been performed.

10. If any of the five points, “Difference Data Logger - Corrected” are greater than $\pm$5.0 mmHg, the BP sensor fails. Previous data should be corrected with the newly generated slope and intercept back to a point where it can be determined that the BP sensor no longer met the accuracy specifications. The sensor should be replaced and a new calibration performed on the replacement BP sensor. The defective BP sensor should be sent in for repair. No field repairs should be made except fitting and tubing changes.

11. When it is determined that the BP sensor passes, remove the 2 each cable ties and slip the $^{1}/_{4}$" O.D. x $^{3}/_{16}$" I.D. Teflon tubing out of the $^{3}/_{8}$" O.D. x $^{1}/_{4}$" I.D. Tygon tubing. Store each end of the $^{1}/_{4}$" O.D. x $^{3}/_{16}$" I.D. Teflon tubing out of the way and assure that nothing can get into the ends and plug the tubing. Reenable the data loggers BP channel.

ARB CALIBRATION REPORT - BAROMETRIC PRESSURE

Calibration Summary:

ID Information:

Station Name:	Yuba City - Almond	Manufacturer:	Met One
Site #:	51-898	Model #:	090D-26/32-1
Station Address:	733 Almond Street	Serial #:	X1368
Agency:	ARB	Translator #:	120-8
		Serial #:	R7199

Calibration Info.:

AS-FOUND:	X
AS-LEFT:	
Calibration Date:	09/01/99
Report Date:	09/06/99
Prev. Cal. Date:	03/31/99

Calibration Results:

	Component:	Pressure
	Instrument Range (mm of Mercury/Torrs):	660 - 813
	Slope:	0.991
Barometric Pressure Best Fit Line	Intercept:	7.755
	Correlation:	1.00000
	AS-FOUND Average Difference:	-1.3
	Meets PSD Requirements:	YES

Meteorology:

Temperature (° C):	23.4
Elevation (Ft.):	60
Avg. Amb Pressure:	759.0

Sensor Height:

Feet Above Ground:	23.0
Feet Above Roof:	4.0

Calibration Standards:

Standard:	I.D. #:	Cert. Date:	Slope:	Intercept:
CARB Pressure Sensor Box	2-4175	02/01/99	1.0024	-2.5050
CARB Temperature Sensor Box	2-4175	02/01/99	0.9985	-0.1040

Calibration Data:

Translator:

Zero Scale:		Full Scale:	
DMM Voltage:	Pressure	DMM Voltage:	Pressure
-0.0009	660.2	0.9989	813.2

Pressure Accuracy: (Difference Datalogger - Corrected Pressure < 5.0 mm Hg)

Temperature Standard Reading		Pressure Standard Reading		Datalogger	Difference Datalogger	To Meet PSD
Uncorrected	Corrected	Uncorrected	Corrected (y)	Reading (x)	- Corrected	Data
23.5	23.4	757.4	756.7	755.4	-1.3	1
23.6	23.5	708.3	707.5	706.0	-1.5	1
23.6	23.5	663.2	662.3	660.2	-2.1	1
23.4	23.3	790.0	789.4	788.4	-1.0	1
23.5	23.4	812.8	812.2	811.6	-0.6	1
23.5	23.4	746.3	745.6	744.3	-1.3	5

Regression Output: **Graph Values:**

Constant		7.7548627	
Std Err of Y Est		0.1213593	
R Squared		0.9999970	
No. of Observations		5	756.6
Degrees of Freedom		3	707.6
Correlation	0.9999985		662.2
X Coefficient(s)	0.9913362		789.3
Std Err of Coef.	0.0009864		812.3

B.P. Regression

Comments:	Ran 3/16" I.D. tubing up to sensor. Standard inside.		
Calibrated by:	Steve Rider	Checked by:	

Figure AL.3.1.1
ARB Calibration Report - Quattro Pro

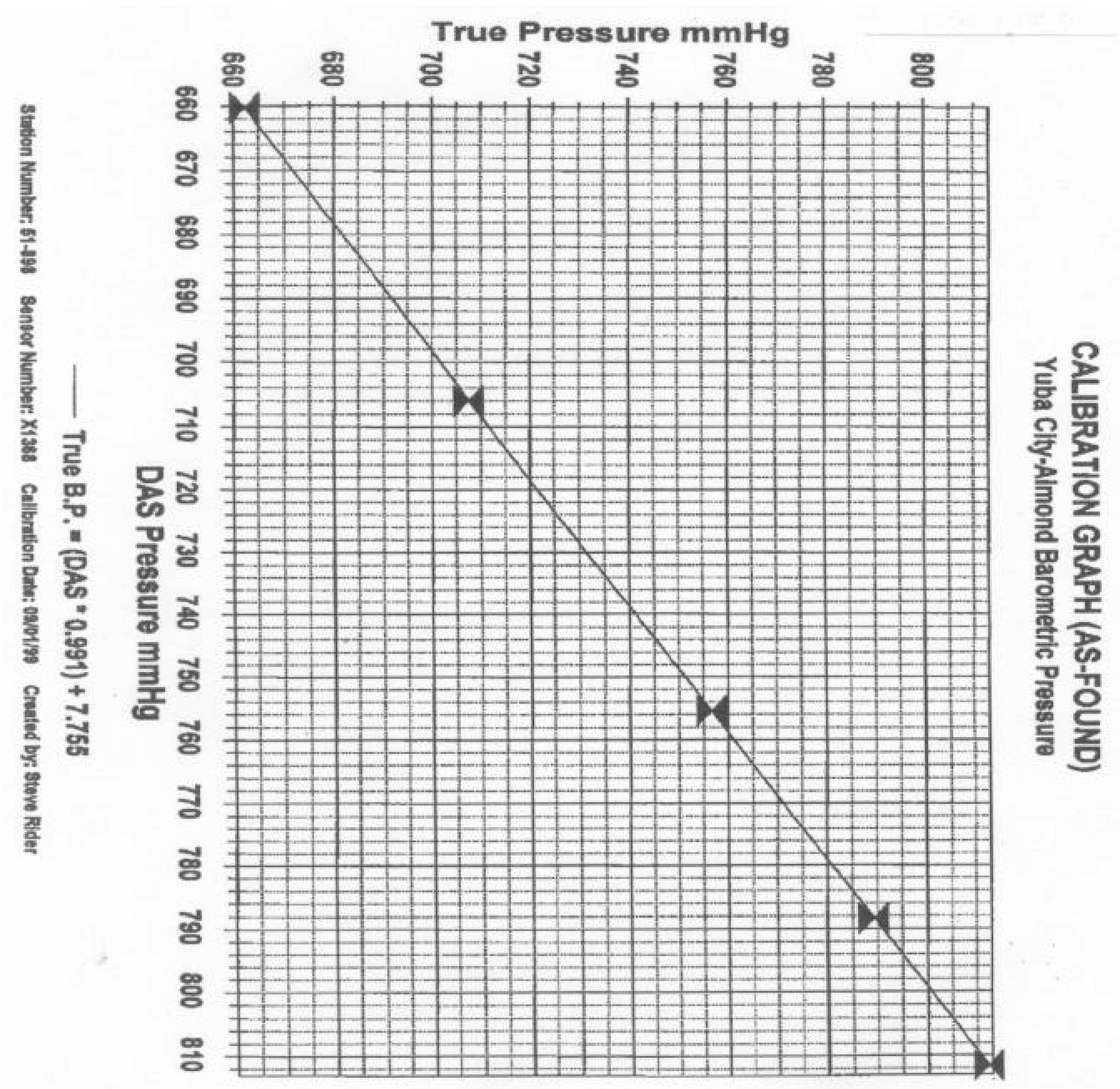

Figure AL.3.1.1 (cont.)
ARB Calibration Report - Quattro Pro

ARB Calibration Report - Barometric Pressure

BaroPress:A1:	^Calibration Summary:
BaroPress:A2:	'ID Information:
BaroPress:F2:	'Calibration Info.:
BaroPress:A3:	"Station Name:
BaroPress:B3:	^Yuba City - Almond
BaroPress:D3:	"Manufacturer:
BaroPress:E3:	^Met One
BaroPress:F3:	"AS-FOUND:
BaroPress:G3:	^X
BaroPress:A4:	"Site #:
BaroPress:B4:	^51-898
BaroPress:D4:	"Model #:
BaroPress:E4:	^090D-26/32-1
BaroPress:F4:	"AS-LEFT:
BaroPress:A5:	"Station Address:
BaroPress:B5:	^733 Almond Street
BaroPress:D5:	"Serial #:
BaroPress:E5:	^X1368
BaroPress:F5:	"Calibration Date:
BaroPress:G5:	36404
BaroPress:A6:	"Agency:
BaroPress:B6:	^ARB
BaroPress:D6:	"Translator #:
BaroPress:E6:	^120-8
BaroPress:F6:	"Report Date:
BaroPress:G6:	36409
BaroPress:D7:	"Serial #:
BaroPress:E7:	^R7199
BaroPress:F7:	"Prev. Cal. Date:
BaroPress:G7:	36250
BaroPress:A9:	'Calibration Results:
BaroPress:F9:	'Meteorology:
BaroPress:A10:	'Component:
BaroPress:D10:	^Pressure
BaroPress:F10:	"Temperature (° C):
BaroPress:G10:	@SUM(B39)
BaroPress:A11:	'Instrument Range (mm of Mercury/Torrs):
BaroPress:D11:	^660 - 813
BaroPress:F11:	"Elevation (Ft.):
BaroPress:G11:	60
BaroPress:C12:	'Slope:
BaroPress:D12:	@SUM(C48)
BaroPress:F12:	"Avg. Amb Pressure:
BaroPress:G12:	@SUM((G11*-0.027855739)+760.8488267)
BaroPress:A13:	^Barometric Pressure Best Fit Line
BaroPress:C13:	'Intercept:
BaroPress:D13:	@SUM(D42)
BaroPress:C14:	'Correlation:
BaroPress:D14:	@SUM(C47)

Figure AL.3.1.2
ARB Calibration Report Printout - Quattro Pro

ARB Calibration Report - Barometric Pressure

BaroPress:F14:	'Sensor Height:
BaroPress:A15:	'AS-FOUND Average Difference:
BaroPress:D15:	@SUM(F39)
BaroPress:F15:	"Feet Above Ground:
BaroPress:G15:	23
BaroPress:A16:	'Meets PSD Requirements:
BaroPress:D16:	@IF(G39<5,"NO","YES")
BaroPress:F16:	"Feet Above Roof:
BaroPress:G16:	4
BaroPress:A18:	'Calibration Standards:
BaroPress:A19:	^Standard:
BaroPress:D19:	^I.D. #:
BaroPress:E19:	^Cert. Date:
BaroPress:F19:	^Slope:
BaroPress:G19:	^Intercept:
BaroPress:A20:	^CARB Pressure Sensor Box
BaroPress:D20:	^2-4175
BaroPress:E20:	36192
BaroPress:F20:	1.0024
BaroPress:G20:	-2.505
BaroPress:A21:	^CARB Temperature Sensor Box
BaroPress:D21:	^2-4175
BaroPress:E21:	36192
BaroPress:F21:	0.9985
BaroPress:G21:	-0.104
BaroPress:A23:	'[illegible]
BaroPress:A24:	^Calibration Data:
BaroPress:B25:	'Translator:
BaroPress:B26:	^Zero Scale:
BaroPress:D26:	^Full Scale:
BaroPress:B27:	^DMM Voltage:
BaroPress:C27:	^Pressure
BaroPress:D27:	^DMM Voltage:
BaroPress:E27:	^Pressure
BaroPress:B28:	-0.0009
BaroPress:C28:	660.2
BaroPress:D28:	0.9989
BaroPress:E28:	813.2
BaroPress:A30:	'Pressure Accuracy: (Difference Datalogger - Corrected Pressure < 5.0 mm g)
BaroPress:A31:	^Temperature Standard
BaroPress:C31:	^Pressure Standard
BaroPress:F31:	^Difference
BaroPress:G31:	^To Meet
BaroPress:A32:	^Reading
BaroPress:C32:	^Reading
BaroPress:E32:	^Datalogger
BaroPress:F32:	^Datalogger

Figure AL.3.1.2 (cont.)
ARB Calibration Report Printout - Quattro Pro

ARB Calibration Report - Barometric Pressure

BaroPress:G32:	^PSD
BaroPress:A33:	^Uncorrected
BaroPress:B33:	^Corrected
BaroPress:C33:	^Uncorrected
BaroPress:D33:	^Corrected (y)
BaroPress:E33:	^Reading (x)
BaroPress:F33:	^- Corrected
BaroPress:G33:	^Data
BaroPress:A34:	23.6
BaroPress:B34:	@IF(A34="","",@SUM((A34*$F$21)+$G$21))
BaroPress:C34:	757.4
BaroPress:D34:	@IF(C34="","",@SUM((C34*$F$20)+$G$20))
BaroPress:E34:	755.4
BaroPress:F34:	@IF(E34="","",@SUM(E34-D34))
BaroPress:G34:	@ARRAY(@IF(@ABS(F34..F38)>5,0,1))
BaroPress:A35:	23.6
BaroPress:B35:	@IF(A35="","",@SUM((A35*$F$21)+$G$21))
BaroPress:C35:	708.3
BaroPress:D35:	@IF(C35="","",@SUM((C35*$F$20)+$G$20))
BaroPress:E35:	706
BaroPress:F35:	@IF(E35="","",@SUM(E35-D35))
BaroPress:G35:	1
BaroPress:A36:	23.6
BaroPress:B36:	@IF(A36="","",@SUM((A36*$F$21)+$G$21))
BaroPress:C36:	663.2
BaroPress:D36:	@IF(C36="","",@SUM((C36*$F$20)+$G$20))
BaroPress:E36:	660.2
BaroPress:F36:	@IF(E36="","",@SUM(E36-D36))
BaroPress:G36:	1
BaroPress:A37:	23.4
BaroPress:B37:	@IF(A37="","",@SUM((A37*$F$21)+$G$21))
BaroPress:C37:	790
BaroPress:D37:	@IF(C37="","",@SUM((C37*$F$20)+$G$20))
BaroPress:E37:	788.4
BaroPress:F37:	@IF(E37="","",@SUM(E37-D37))
BaroPress:G37:	1
BaroPress:A38:	23.5
BaroPress:B38:	@IF(A38="","",@SUM((A38*$F$21)+$G$21))
BaroPress:C38:	812.8
BaroPress:D38:	@IF(C38="","",@SUM((C38*$F$20)+$G$20))
BaroPress:E38:	811.6
BaroPress:F38:	@IF(E38="","",@SUM(E38-D38))
BaroPress:G38:	1
BaroPress:A39:	@PUREAVG(A34..A38)
BaroPress:B39:	@PUREAVG(B34..B38)
BaroPress:C39:	@PUREAVG(C34..C38)
BaroPress:D39:	@PUREAVG(D34..D38)
BaroPress:E39:	@PUREAVG(E34..E38)
BaroPress:F39:	@PUREAVG(F34..F38)

Figure AL.3.1.2 (cont.)
ARB Calibration Report Printout - Quattro Pro

ARB Calibration Report - Barometric Pressure

BaroPress:G39:	@SUM(G34..G38)
BaroPress:A41:	'Regression Output:
BaroPress:E41:	^Graph Values:
BaroPress:A42:	'Constant
BaroPress:D42:	7.76486268153288
BaroPress:E42:	^B.P. Regression Line
BaroPress:A43:	'Std Err of Y Est
BaroPress:D43:	0.121359258211627
BaroPress:A44:	'R Squared
BaroPress:D44:	0.999997029812757
BaroPress:A45:	'No. of Observations
BaroPress:D45:	5
BaroPress:E45:	@SUM(E34*C$48)+D$42
BaroPress:A46:	'Degrees of Freedom
BaroPress:D46:	3
BaroPress:E46:	@SUM(E35*C$48)+D$42
BaroPress:A47:	'Correlation
BaroPress:C47:	@CORREL(E34..E38,D34..D38)
BaroPress:E47:	@SUM(E36*C$48)+D$42
BaroPress:A48:	'X Coefficient(s)
BaroPress:C48:	0.991336190507399
BaroPress:E48:	@SUM(E37*C$48)+D$42
BaroPress:A49:	'Std Err of Coef.
BaroPress:C49:	0.000986399612564014
BaroPress:E49:	@SUM(E38*C$48)+D$42
BaroPress:A52:	"Comments:
BaroPress:B53:	'Ran 3/16" I.D. tubing up to sensor. Standard Inside.
BaroPress:A54:	"Calibrated by:
BaroPress:B54:	^Steve Rider
BaroPress:F54:	"Checked by:
BaroPress:A55:	]::

Figure AL.3.1.2 (cont.)
ARB Calibration Report Printout - Quattro Pro

ARB CALIBRATION REPORT - BAROMETRIC PRESSURE

Calibration Summary:

ID Information:

Station Name:	Yuba City - Almond	Manufacturer:	Met One
Site #:	51-898	Model #:	090D-26/32-1
Station Address:	733 Almond Street	Serial #:	X1368
Agency:	ARB	Translator #:	120-8
		Serial #:	R7199

Calibration Info.:

AS-FOUND:	
AS-LEFT:	X
Calibration Date:	09/01/99
Report Date:	09/06/99
Previous Cal. Date:	09/01/99

Calibration Results:

	Component:	Pressure
	Instrument Range (mm of Mercury/Torrs):	660 - 813
	Slope:	0.978
Barometric Pressure Best Fit Line	Intercept:	15.603
	Correlation:	0.999935
	AS-LEFT Average Difference:	0.6
	Meets PSD Requirements:	YES

Meteorology:

Temperature (°C):	22.7
Elevation (Ft.):	60
Avg. Amb Pressure:	759.0

Sensor Height:

Feet Above Ground:	23.0
Feet Above Roof:	4.0

Calibration Standards:

Standard:	I.D. #:	Cert. Date:	Slope:	Intercept:
AQSB Pressure Sensor Box	2-4175	02/01/99	1.0024	-2.5050
AQSB Temperature Sensor Box	2-4175	02/01/99	0.9985	-0.1040

Calibration Data:

Translator:

Zero Scale:		Full Scale:	
DMM Voltage:	Pressure:	DMM Voltage:	Pressure:
-0.0012	660.0	0.9980	813.0

Pressure Accuracy: (Difference Datalogger - Corrected Pressure < 5.0 mmHg)

Temperature Standard Reading		Pressure Standard Reading		Datalogger	Difference Datalogger	To Meet PSD
Uncorrected	Corrected	Uncorrected	Corrected (y)	Reading (x)	- Corrected	Data
22.5	22.4	756.0	755.3	756.4	1.1	1
22.9	22.8	707.0	706.2	707.0	0.8	1
23.2	23.1	664.0	663.1	661.2	-1.9	1
22.7	22.6	789.0	788.4	789.4	1.0	1
23.0	22.9	811.0	810.4	812.6	2.2	1
22.9	22.7	745.4	744.7	745.3	0.6	5

Barometric Pressure Regression Button

Regression Results:

X Coefficient (Slope):	0.9782126
Y Constant (Intercept):	15.6025316
Number of Observations:	5
Correlation:	0.9999350

Graph Values:

Regression Line For B.P.
755.5
707.2
662.4
787.8
810.5

Comments:			
Calibrated by:	Steve Rider	Checked by:	

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.99993498
R Square	0.999869964
Adjusted R Square	0.999826618
Standard Error	0.792415823
Observations	5

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	14484.60183	14484.60183	23067.48694	6.29365E-07
Residual	3	1.88376851	0.627922837		
Total	4	14486.4856			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	15.60253157	4.813445964	3.24144733	0.047798424	0.283983876	30.92107926
X Variable 1	0.978212618	0.006440701	151.8798437	6.29365E-07	0.957715415	0.998709821

Figure AL.3.1.3
ARB Calibration Report - Excel