

Highway Safety Programs; Model Specifications for Devices to Measure Breath Alcohol

AGENCY: National Highway Traffic Safety Administration, DOT.

ACTION: Notice.

SUMMARY: This notice amends the Model Specifications for evidential breath testing devices published in 1984 and updates the list of conforming products. Recent trends indicate that the states are lowering the alcohol levels that indicate drunk driving (e.g., "zero tolerance" laws for underage offenders). Moreover, these specifications address comments received in response to a Department of Transportation Notice of Proposed Rulemaking published in the Federal Register on December 15, 1992 (57 FR 59382). The Model Specifications and the Conforming Products List set forth below reflect new lower evaluation thresholds for devices to measure breath alcohol, to better reflect the range of critical measurements during actual use.

DATES: This notice becomes effective October 18, 1993.

FOR FURTHER INFORMATION CONTACT: Ms. Robin Mayer, Office of Alcohol and State Programs, NTS-21, National Highway Traffic Safety Administrator, 400 Seventh Street, SW., Washington, DC 20590. Telephone (202) 366-9825.

SUPPLEMENTARY INFORMATION: On December 14, 1984 (49 FR 48854), the National Highway Traffic Safety Administration (NHTSA) issued a notice converting the mandatory standards for breath alcohol test devices (38 FR 30459) to Model Specifications for such devices. The Notice indicated that the Agency would continue to test evidential breath testers (EBTs) and would release its findings to provide States which choose not to conduct their own testing with adequate information upon which to base their purchasing decisions.

Since publication of the Model Specifications in 1984 (49 FR 48855), States have been moving toward a lowering of alcohol levels which indicate drunk driving and enacting new laws targeting youthful offenders (i.e., "zero tolerance" laws).

On December 15, 1992, the U.S. Department of Transportation (DOT) published Notices of Proposed Rulemaking (NPRMs) proposing rules to implement the "Omnibus Transportation Employee Testing Act of 1991," which requires alcohol testing programs in aviation, motor carrier, rail, and mass transit industries in the interest of public safety. The Research and Special Programs Administration (RSPA) has proposed similar regulations for the pipeline industry. In general, the proposed rules would prohibit covered employees from performing safety-sensitive functions when test results indicate a breath alcohol concentration (BAC) of 0.04 or greater. Slightly different consequences would apply with respect to an employee having a BAC of 0.02 or greater but less than 0.04. If the NPRMs are adopted as final rules, transportation workers in safety-sensitive positions will be tested at lower alcohol (commercial motor vehicle drivers are already subject to DWI standards at ≥ 0.04).

DOT received comments in response to the rulemaking actions recommending that if NHTSA's Model Specifications are to be used for the transportation workplace alcohol testing programs, then the Model Specifications should be consistent with the requirements of the rules.

In light of the trend toward lowering alcohol levels and to address the comments received in response to DOT's NPRMs, NHTSA has decided to revise its Model Specifications by lowering the BACs at which instruments are evaluated.

Under the earlier specifications, EBTs were evaluated for precision and accuracy at 0.000, 0.050, 0.101, and 0.151 BAC, and tests for operation of the devices at various conditions of operation were performed at 0.101 BAC. The Specifications below establish evaluations for precision and accuracy at 0.000, 0.020, 0.040, 0.080, and 0.160 BAC, and evaluations at various conditions of operation at 0.080. Tests for acetone interference will also be conducted at 0.020 BAC. NHTSA is also expanding its definition of alcohol to better reflect State laws and the capabilities of testing devices.

These revisions will assist the States and local communities by providing a centralized qualification test program for breath-testing devices designed to

collect evidence in law enforcement programs. The Model Specifications are not intended to replace the current qualification programs required in certain States for this equipment or to directly regulate the manufacture of EBTs. However, some States may wish to make use of this program in addition to setting their own requirements. While the agency is not imposing these Model Specifications on State and local governments, NHTSA encourages each State to consider adopting them.

Procedures

Testing of EBTs submitted by manufacturers to these Model Specifications will continue to be conducted by the DOT Volpe National Transportation Systems Center (VNTSC). Procedures for submitting instruments for evaluation have not changed. Tests will continue to be conducted semi-annually or as necessary. Manufacturers wishing to submit EBTs for testing must apply to NHTSA for a test date (Office of Alcohol and State Programs (OASP), NTS-21, NHTSA, 400 Seventh Street SW., Washington, DC 20590). Normally, at least 30 days will be required from the date of notification until the test can be scheduled. One week prior to the scheduled initiation of the test program, the manufacturer will deliver the device to be tested to VNTSC, DTS 75, Kendall Square, Cambridge MA 02142. The manufacturer shall be responsible for ensuring that its device is operating properly and is in proper calibration. If the manufacturer wishes to submit a duplicate, backup instrument, it may do so. The Operator's Manual and the Maintenance Manual will be delivered with the EBT, to VNTSC, with specifications and drawings which fully describe the device. Proprietary information will be respected. (See 49 CFR part 512, regarding the procedure by which NHTSA will consider claims of confidentiality.)

The manufacturer will have the right to check the EBT between arrival in Cambridge and the start of the test and to ensure that the EBT is in proper calibration, but will have no access to it during the tests. Any malfunction of the EBT which results in failure to complete any of the tests satisfactorily will result in a finding that it does not conform to the Model Specifications. If the EBT fails to conform, it may be resubmitted for testing.

On the basis of these results, NHTSA will continue to periodically publish a Conforming Products List (CPL), identifying the EBTs that meet the performance criteria set forth in these Model Specifications.

In anticipation of the publication of this notice and DOT's final rules to implement the Omnibus Transportation Employee Testing Act of 1991, NHTSA invited manufacturers currently known to produce EBTs to submit their instruments for evaluation utilizing these amended specifications. Instruments provided by the manufacturers have been evaluated under these Model Specifications, and this notice includes, as Appendix A, a revised CPL. This CPL identifies those instruments found to conform with the Model Specifications, as amended by this notice. It also identifies those instruments that meet the Model Specifications detailed in 49 FR 48854 (December 14, 1984).

Retesting of instruments will continue to be conducted when necessary. NHTSA intends to modify and improve these Model Specifications as new data and improved test procedures become available. (The test procedures may be altered in specific instances, if necessary, to meet unique design features of an EBT.) If these Model Specifications are modified, notification will be provided in the Federal Register. If NHTSA determines that retesting to the modified specification is necessary, a manufacturer whose equipment is listed on the CPL will be notified to resubmit the equipment for testing to the modified specification only. Also, if at any time a manufacturer wishes to change the design of an EBT currently on the CPL, the manufacturer shall submit the proposed changes to OASP for review. Based on this review, a determination will be made regarding whether retesting is required. Guidance to manufacturers on considerations governing this decision is given in Appendix B.

OASP will continue to be the point of contact for information about acceptance testing and field performance of equipment already on the list. When it is available, NHTSA requests that the State and local agencies provide both acceptance and field performance data to OASP. Information from users will be used to: (1) Help NHTSA determine whether EBTs continue to perform according to the NHTSA Model Specifications and (2) ensure that field use does not indicate excessive breakdown or maintenance problems.

If information gathered indicates that an instrument on the CPL is not performing in accordance with the Model Specifications, NHTSA will direct VNTSC to conduct a special investigation. This study may include visits to users and additional tests of the instrument obtained from the open

market. If the investigation indicates that the instruments actually sold on the market are not meeting the Model Specifications, then the manufacturers will be notified that the instrument may be dropped from the list. In this event the manufacturer shall have 30 days from the date of notification to reply. Based on the VNTSC investigation and any data provided by the manufacturer, NHTSA will decide whether the instrument should remain on the list. Upon resubmission, the manufacturer must submit a statement describing what has been done to overcome the problems which led to the dropping of the instrument in question from the list.

This notice addresses comments received by DOT in response to its NPRMs on The Omnibus Transportation Employee Testing Act of 1991 published in the Federal Register on December 15, 1992. The changes to the Model Specifications for evidential breath testers contained in this notice become effective on the date noted above. If any person believes NHTSA should reconsider the changes made in this notice, that person may submit a petition for reconsideration. The petition shall be submitted to the Administrator, National Highway Traffic Safety Administration, 400 7th Street, SW., Washington, DC 20590. It is requested, but not required, that 10 copies be submitted. The petition must be received by the date noted above and contain a brief statement of the basis for the petition. The statement may not exceed 15 pages in length, but necessary attachments may be appended to the submission without regard to the 15 page limit. The filing of a petition will not stay the effective date of this notice.

In accordance with the foregoing, the Model Specifications for performance testing of EBTs are set forth below.

Authority: 23 U.S.C. 402, 403, 408, 410; delegations of authority at 49 CFR 1.50 and 501.

Michael B. Brownlee,
Associate Administrator for TSP.

Model Specifications for Evidential Breath Testers

1. Purpose and Scope

These specifications establish performance criteria and methods for testing of evidential breath testers (EBTs). EBTs measure the alcohol content of deep lung breath samples with sufficient accuracy for evidential purposes. These specifications are intended primarily for use in the conformance testing of EBTs.

2. Classification

2.1 Mobility

2.1.1 Mobile Evidential Breath Testers
EBTs that are designed to be transported to non-fixed operational sites in the field.

2.1.2 Nonmobile Evidential Breath Testers
EBTs that are designed to be operated at a fixed location.

2.2 Power Source

2.2.1 Battery Powered Evidential Breath Testers
EBTs that are powered by batteries.

2.2.2 AC Powered Evidential Breath Testers

EBTs that are powered from the AC power lines.

3. Definitions

3.1 Alcohol—The intoxicating agent in beverage alcohol, ethyl alcohol or other low molecular weight alcohols including methyl or isopropyl alcohol.

3.2 BAC, BrAC—Blood alcohol concentration: grams of alcohol per 100 milliliters blood or grams of alcohol per 210 liters of breath in accordance with the Uniform Vehicle Code, Section 11-903(a)(5).¹ BrAC is often used to indicate that the measurement is a breath measurement. In these Model Specifications, concentration units of test samples are referred to as BAC units and are grams of alcohol per 210 liters of air.

3.3 Conformance Tests

Tests performed to check the compliance of a product with these specifications.

3.4 Standard Deviation

An indication of measurement precision of the EBT in a test, expressed as follows:

Standard deviation = $[\text{Sum } (X_i - X_m)^2 / (N-1)]^{1/2}$
where X_i = a single measurement result
 X_m = the average of the measurements
 N = the number of measurements made in the test.

3.5 Systematic Error

An indication of the accuracy of the EBT in a test.

Systematic error = $[(X_m - \text{test BAC}) / \text{test BAC}] \times 100$

3.6 Calibrating Unit (CU)

A device that produces an alcohol-in-air test sample of known concentration that meets the Model Specifications for Calibrating Units (49 FR 48865).

3.7 BASS

Breath Alcohol Sample Simulator. A device which provides an alcohol-in-air

test sample with known and adjustable alcohol concentration profile, flow rate, and air composition at 34° centigrade. (See NBS Special Publication 480-41, July 1981² for a description of a BASS unit suitable for use in Test 4.)

4. Test Methods and Requirements

Each of the tests below requires 10 measurements to three decimal places made at 0.080 BAC or other specified BAC using the EBT being evaluated. Procedures specified by the manufacturer will be followed. Unless otherwise specified, the tests will be performed in the absence of drafts and at prevailing normal laboratory temperature, humidity, and barometric pressure. Ethyl alcohol will be used to prepare the test samples in this Model Specifications. A CU of the type which uses aqueous alcohol solutions thermostated at 34° C and a ratio of headspace concentration to liquid concentration of 0.000393 (see 49 FR 48865) will be used to provide the BAC samples. The CU shall be capable of delivering 10 complete vapor samples with alcohol depletion of not more than 1%. Human breath will be used to drive the CU. (For Test 4, the BASS device will be used.) Performance requirements are indicated in square brackets. [SE=systematic error, SD=standard deviation].

4.1 Test 1 Precision and Accuracy.

Test at each specified BAC.

Test 1.1: 0.020 BAC [SE \pm 0.005 BAC; SD \leq 0.0042]

Test 1.2: 0.040 BAC [SE \pm 0.005 BAC; SD \leq 0.0042]

Test 1.3: 0.080 BAC [SE \pm 0.005 BAC; SD \leq 0.0042]

Test 1.4: 0.160 BAC [SE \pm 0.008 BAC; SD \leq 0.0042]

The following test is information for potential users only.

There is no performance requirement.

Test 1.5: 0.300 BAC.

4.2 Test 2. Acetone Interference.

Test at 0.020 BAC with the specified amount of acetone added to the CU solution.³ Replace the solution if acetone depletion is indicated during the test. [SE \pm 0.005 BAC; SD \leq 0.0042]

Test 2.1: 70 microliters acetone per 500 ml solution.

Test 2.2: 115 microliters acetone per 500 ml solution.

4.3 Test 3. Blank Reading.

¹ Available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

² The amounts of acetone have been specified on the basis of an experimentally determined water to air partition factor of 365 to 1 at 34° C to yield a sample of alcohol in air at concentrations of 0.3 mg/l and 0.5 mg/l.

³ Available from National Committee on Uniform Traffic Laws and Ordinances, 405 Church Street, Evanston, IL 60201.

Test at 0.000 BAC. The tester shall use his or her own breath for this test and he or she may not consume alcohol for a period of 48 hours prior to this test or smoke for a period of 20 minutes prior to this test. The tester shall verify that the volume of each breath sample delivered is at least two liters. [SE \leq \pm 0.005 BAC with no single result greater than 0.005 BAC].

4.4 Test 4. Breath Sampling (Alternate test in Appendix C may be used).

Prepare the BASS solutions so that the BAC of each of the three segments of the simulated breath sample increases from 0.048, to 0.072, to 0.080. Use compressed breathing air to drive the samples. If the EBT is sensitive to carbon dioxide at concentrations found in human breath (5%), the driver gas will contain this gas at that concentration. Use a spirometer to measure sample volumes and, if necessary, place the EBT in a glove box to make that measurement. Perform three tests at each of the following volume-time combinations [SE \leq \pm 0.005 BAC; SD \leq 0.0042]

	Volume of each segment (liters)	Time of each segment (seconds)
Test 4.1	0.67	3.3
Test 4.2	0.67	2
Test 4.3	2	4

4.5 Test 5. Input Power.

If the EBT is powered by nominal voltages of 120 volts AC or 12 volts DC, condition the device for one half hour at the appropriate input voltage specified below, then test at that voltage. Monitor the input power with a voltmeter accurate to \pm 2% of full scale in the range used and readjust the voltage, if necessary. [SE \leq \pm 0.005 BAC; SD \leq 0.0042]

Test 5.1: 108 VAC

Test 5.2: 123 VAC

Test 5.3: 11 VDC

Test 5.4: 15 VDC.

4.6 Test 6. Ambient Temperature.

Use a temperature chamber controllable to \pm 1°C. Soak the EBT at the specified temperature for 1 hour before each test, then test at that temperature [SE \leq \pm 0.005 BAC; SD \leq 0.0042].

Test 6.1: 20°C

Test 6.2: 30°C

The following portion of Test 6 is applicable to hand held EBTs and is for information to potential users only.

Soak hand-held EBT at specified temperature for one hour before each test, then test at that temperature. Operate the CU outside of the

temperature chamber, if necessary, to ensure that it remains at normal operating temperature. There is no performance requirement.

Test 6.3: 10°C

Test 6.4: 35°C

4.7 Test 7. Vibration Stability.

Use a programmable shake table with sufficient power to drive the weight of the EBT to be tested. Through each of its three major axes, subject the EBT to simple harmonic motion of the specified amplitude and frequency. Sweep through each frequency range in 2.5 minutes, then reverse sweep to the starting frequency in 2.5 minutes. After vibration, test the EBT. [SE \leq \pm 0.005 BAC; SD \leq 0.0042]

Frequency range (Hertz)	Amplitude (inches, peak to peak)
10 to 30	.030
30 to 60	.015

4.8 Test 8.

Electrical Safety Inspection. Examine the EBT for protection of the operator and person being tested from electrical shock. Examine for proper use of input power fuses, and verify that there are no exposed male connectors or conducting surfaces at high potential. Determine that overheating does not occur during operation and that fire hazards do not exist.

APPENDIX A—CONFORMING PRODUCTS LIST OF EVIDENTIAL BREATH MEASUREMENT DEVICES

Manufacturer and model	Mobile	Nonmobile
Alcohol Counter-measures System, Inc., Port Huron, MI: Alert J3AD	X	X
BAC Systems, Inc., Ontario, Canada: Breath Analysis Computer		X
CAMEC Ltd., North Shields, Tyne and Ware, England: IR Breath Analyzer	X	X
CMI, Inc., Owensboro, KY: Intoxilyzer Model: 200	X	X
1400	X	X
4011	X	X
4011A	X	X
4011AS	X	X
4011AS-A	X	X
4011AS-AQ	X	X
4011 AW	X	X
4011A27-10100	X	X
4011A27-10100 with filter	X	X

APPENDIX A—CONFORMING PRODUCTS LIST OF EVIDENTIAL BREATH MEASUREMENT DEVICES—Continued

Manufacturer and model	Mobile	Nonmobile
5000	X	X
5000 (w/Cal. Vapor Re-Circ.)	X	X
5000 (w/3/8" ID Hose option)	X	X
5000CD	X	X
5000 (CAL DOJ)	X	X
5000VA	X	X
PAC 1200	X	X
S-D2	X	X
Decator Electronics, Decator, IL: Alco-Tector model 500		X
Intoximeters, Inc., St. Louis, MO: Photo Electric Intoximeter		X
GC Intoximeter MK II	X	X
GC Intoximeter MK IV	X	X
Auto Intoximeter	X	X
Intoximeter Model: 3000	X	X
3000 (rev B1)	X	X
3000 (rev B2)	X	X
3000 (rev B2A)	X	X
3000 (rev B2A) w/ FM option	X	X
3000 (Fuel Cell)	X	X
3000 D	X	X
3000 DFC	X	X
Alcomonitor		X
Alco-Sensor III	X	X
Alco-Sensor IV	X	X
RBT III	X	X
BRT III-A	X	X
RBT IV	X	X
Komyo Kitagawa, Kogyo, K.K.: Alcozyler DPA-2	X	X
Breath Alcohol Meter PAM 101B	X	X
Life-Loc, Inc., Wheat Ridge, CO: PBA 3000-P	X	X
Lion Laboratories, Ltd., Cardiff, Wales, UK: Alcolmeter Model: AE-D1	X	X
SD-2	X	X
EBA	X	X
Auto-Alcolmeter		X
Luckey Laboratories, San Bernardino, CA: Alco-Analyzer Model: 1000		X
2000		X
National Draeger, Inc., Pittsburgh, PA: Alcotest Model: 7010	X	X
7110	X	X
7410	X	X
Breathalyzer Model 900	X	X

APPENDIX A—CONFORMING PRODUCTS LIST OF EVIDENTIAL BREATH MEASUREMENT DEVICES—Continued

Manufacturer and model	Mobile	Nonmobile
900A*	X	X
900BG*	X	X
National Patent Analytical Systems, Inc., Mansfield, OH:		
BAC DataMaster ²	X	X
BAC DataMaster-Transportable	X	X
Omicron Systems, Palo Alto, CA:		
Intoxilyzer Model:		
4011*	X	X
4011AW*	X	X
Plus 4 Engineering, Minturn, CO:		
5000 Plus4*	X	X
Siemens-Altis, Cherry Hill, NJ:		
Alcomat*	X	X
Alcomat F*	X	X
Smith and Wesson Electronics, Springfield, MA:		
Breathalyzer Model:		
900*	X	X
900A*	X	X
1000*	X	X
2000*	X	X
2000 (non-Humidity Sensor)*	X	X
Stephenson Corp.: Breathalyzer 900*	X	X
U.S. Alcohol Testing, Inc./Protection Devices, Inc., Rancho Cucamonga, CA:		
Alco-Analyzer 1000		X
Alco-Analyzer 2000		X
Alco-Analyzer 2100	X	X
Verax Systems, Inc., Fairport, NY:		
BAC Verifier*	X	X
BAC Verifier Datamaster*	X	X
BAC Verifier Datamaster II*	X	X

* Instruments marked with an asterisk (*) meet the Model Specifications detailed in 49 FR 48854 (December 14, 1984) (i.e., instruments tested at 0.000, 0.050, 0.101, and 0.151 BAC.) Instruments not marked with an asterisk meet the Model Specifications detailed in this notice (i.e., instruments tested at 0.000, 0.020, 0.040, 0.080, and 0.160 BAC.)

APPENDIX A—CONFORMING PRODUCTS LIST OF EVIDENTIAL BREATH MEASUREMENT DEVICES—Continued

Manufacturer and model	Mobile	Nonmobile
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¹ During this reporting period, Intoximeters, Inc. provided VNTSC a modified Alcomonitor, the "Alcomonitor CC", for evaluation. In addition to a redesigned cabinet, a function has been added to permit the user to alter program sequencing and printing options via a desk-top computer. Because these modifications do not affect precision or accuracy, and since it is essentially the same as the approved device, the "Alcomonitor CC" does not require a separate listing on the CPL.

² During this reporting period, National Patent Analytical Systems, Inc., provided VNTSC with a BAC DataMaster having an internal keyboard. The addition of a keyboard, whether internal or external, does not affect precision and accuracy and does not require a separate listing on the CPL. Therefore the model designation "BAC DataMaster", for the purposes of the CPL, includes all such instruments, whether or not they have a keyboard.

Appendix B—Guidelines for Re-testing of Modified EBT

Manufacturers contemplating revisions to an EBT which is currently listed on the Conforming Products List (CPL) are advised that the revision may affect the status of the device on the CPL. It may or may not be necessary to retest the revised EBT. The manufacturer should inform NHTSA of the contemplated change so that a judgment can be made. The following lists the type of information NHTSA uses in determining the necessity to retest an instrument, and is provided as guidance to manufacturers:

- Manufacturer and Model Name.
- Nature and reason for change.
- Scope of change (e.g., will existing devices be retrofitted? Will the change apply to some users but not others?).
- Will the change affect performance of the device as regards the Model Specifications? (Precision and accuracy, acetone interference, blank reading, linearity, sampling efficiency, low or high temperature operation, low or high input power operation, mobile operation, electrical safety).
- Will the change alter performance with regard to the possibility of chemical or electrical interference or unusually high relative humidity?
- How will the changes be documented for the benefit of the user? (e.g., will the changes be documented in service bulletins and/or service manuals? If not, why not?).

If necessary for clarity, drawings of the current and changed device may

also be helpful in NHTSA's deliberations.

If, upon review of information provided by a manufacturer, it is determined that re-testing is not warranted, a statement to that effect will be included in the next scheduled CPL update.

Appendix C—Alternate Breath Sampling Test

Select eight human subjects who are in good health. Their oral temperatures prior to the start of testing shall be between 97.0°F and 99.5°F.

Divide the subjects into two groups of four. The target BAC range for group 1 shall be from 0.04 to 0.10. The target BAC range for group 2 shall be from 0.10 to 0.20. In order to obtain a distribution of EACs, each subject shall be given a different amount of alcohol to drink. As a rough guide to dose vs. peak resultant BAC, and based on ingestion of a 100 proof beverage, a body weight of 160 lbs., and a 2 hour drinking period, 3 oz. of beverage should produce a BAC of 0.04; 6 oz. should produce a BAC of 0.10; and 8 oz. should produce a BAC of 0.15.

Blood samples taken shall be either from a vein in the arm or from capillaries in the fingertip. Non-alcoholic swabs shall be used to prepare the skin surface. If fingertip blood is to be taken, a 90-minute waiting period will be observed before beginning breath sample testing and if venous blood is to be taken, a 120-minute period will be observed. No subject may smoke during the 20-minute period before testing begins.

Use the EBT to measure the subject's breath, then take a blood sample, then measure the subject's breath again. Allow no more than five minutes between the taking of the first and second breath sample.

The blood samples shall be analyzed within 72 hours of being taken and at least two alcohol determinations shall be made on each sample. A reference sample of known BAC in the range 0.05 to 0.15 shall be prepared by the analyzing laboratory. Five determinations of the reference sample shall be made concurrently with the analysis of the human subject blood samples. The SD of the reference sample analysis shall not exceed 0.005 BAC and the SE shall not exceed $\pm 5\%$ of the known BAC.

Calculate the average blood result and the average breath result for each subject. Label each average blood result X, (i=1 to 8 for each of the subjects, in ascending order of BAC). For each such result X, label the companion average breath result Y.

Calculate X_H , the average of the three highest blood results, and X_L , the three lowest. For the three highest blood results, and for the three lowest blood results, calculate the companion averages of the breath results, Y_H and Y_L .

Calculate X_M , the average of the eight blood results, and Y_M , the average of the eight breath results.

On graph paper, plot the points corresponding to (X_M, Y_M) , (X_H, Y_H) , (X_L, Y_L) , and the eight points (X_i, Y_i) .

Draw a straight line, the blood-breath correlation line, through the point (X_M, Y_M) and parallel to the line joining the points (X_L, Y_L) and (X_H, Y_H) .

At $X=0.100$ on the blood-breath correlation line, mark points on the perpendicular at $Y=-0.020$ and another at $Y=+0.020$. Draw a line through each of these points, the negative bias and

positive bias lines, parallel to the blood-breath correlation line. Requirements:

1. The value on the Y axis which corresponds to the point $X=0.100$ shall lie at or between 0.080 and 0.100.

2. At least seven of the eight averaged breath results shall lie within the area between the positive and negative bias lines.

[FR Doc. 93-22792 Filed 9-15-93; 11:52 am]

BILLING CODE 4810-00-M