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RESULTS OF THE FIRST SEMI-ANNUAL QUALIFICATION TESTING OF DEVICES TO MEASURE BREATH ALCOHOL

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INTERIM REPORT

Prepared for

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NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
Research Institute
Office of Driver Performance Research
Washington DC 20590

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16. Abstract

Eight Evidential Breath Testers were performance tested according to the Standard for Devices to Measure Breath Alcohol Federal Register, Vol 38, No. 212, November 5, 1973. In addition, a prototype breath tester not commercially available was tested. Test results are presented.

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PREFACE

The results of the first Semi-Annual Qualification Testing of devices to measure breath alcohol are reported. These tests were carried out by the DOT Transportation Systems Center in accordance with the Standard for Devices to Measure Breath Alcohol, Federal Register, Vol. 38, No. 212, November 5, 1973. Eight instruments submitted by six manufacturers and one instrument developed for the Government were tested. The tests were carried out during February and March 1974.

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All tests were carried out in accordance with the Standard for Devices to Measure Breath Alcohol, Federal Register, Vol. 38, No. 212, November 5, 1973 (hereafter called the Standard). The ambient conditions maintained for the tests were: 22-24° C, 50-60% relative humidity, 29-30.5 inches mercury, and operating voltage 117 $\pm$3 volts AC. These conditions were maintained except as otherwise required by the specific tests.

The specific tests carried out are listed below.

1.1 TEST NO. 1 - PRECISION TESTS USING KNOWN ETHANOL VAPOR CONCENTRATION

This test was carried out in accordance with Section 5.1 of the Standard.

1.2 TEST NO. 2 - ACCURACY TEST USING KNOWN ETHANOL VAPOR CONCENTRATION

This test was carried out in accordance with Section 5.2 of the Standard. The test data obtained in Test No. 1 are used for this test.

1.3 TEST NO. 3 - BLANK TEST USING ALCOHOL-FREE TEST SUBJECTS

This test was carried out in accordance with Section 5.3 of the Standard.

1.4 TEST NO. 4 - BREATH SAMPLING TEST (SECTION 5.4 OF THE STANDARD)

The National Highway Traffic Safety Administration has determined that this test requires modification. Results of this test are not reported.

1.5 TEST NO. 5 - POWER LINE VOLTAGE TEST

This test was carried out in accordance with Section 5.5 of the Standard.

1.6 TEST NO. 6 - AMBIENT TEMPERATURE TEST

This test was carried out in accordance with Section 5.6 of the Standard.

1.7 TEST NO. 7 - VIBRATION TEST FOR MOBILE EBT

This test was carried out in accordance with Section 5.7 of the Standard. A Unholtz-Dickie Model TK-100-20 shake table was used for this test.

1.8 ELECTRICAL SAFETY INSPECTION

Each instrument tested was inspected for electrical safety in accordance with Section 4.8 of the Standard.

2. TEST RESULTS - DEVICES TESTED

The following devices were submitted for testing:

Table No.	Instrument	Manufacturer	Model No.
1.	Alco-Limiter	Energetic Sciences, Inc.	1100
2.	Alco-Tector	Decatur Electronics, Inc.	500
3.	Breathalyzer	Smith and Wesson Electronics	900A
4.	Breathalyzer	Smith and Wesson Electronics	1000
5.	Gas Chromato-graph Analyzer	Luckey Laboratories, Inc.	1000
6.	Gas Chromato-graph Intoximeter	Intoximeters, Inc.	Mark II
7.	Intoxilyzer	Omicron System Corp.	4011
8.	Photo-Electric Intoximeter	Intometers, Inc.	400
9.	An instrument developed for the Government and built by American Science and Engineering, Inc.		

See Tables 1 through 9 for test results.

TABLE 1. TEST DATA ENERGETICS SCIENCE ALCO-LIMITER 1100 S/N 0042

Test	Test Data													Meets Requirements
(1&2) Precision/Accuracy	1	2	3	4	5	6	7	8	9	10	M	S.D.	S.E.	
at 0.05 BAC	.053	.053	.053	.051	.052	.052	.051	.053	.054	.053	.052	.0010	+4	
at 0.10 BAC	.100	.101	.101	.094	.101	.099	.098	.097	.097	.095	.098	.0025	-2	Yes
at 0.15 BAC	.155	.151	.153	.155	.153	.153	.155	.155	.152	.152	.153	.0015	+2	
(3) Alcohol Free Subjects	.006	.005	.000	.001	.001	.001	.000	.001	.008	.003	.0026			Yes
(5) Power Line Voltage														
at 108 VAC														N/A*
at 123 VAC														
(6) Ambient Temperature														
at 20°C	.096	.100	.099	.098	.097	.098	.099	.098	.099	.099	.098	.0012	-2	Yes
at 30°C	.099	.099	.098	.097	.099	.097	.104	.103	.101	.099	.100	.0024	0	
(7) Post Vibration	.098	.099	.102	.099	.098	.100	.099	.099	.100	.104	.100	.0019	0	Yes
Electrical Safety														Yes

M = Mean
S.D. = Standard Deviation
S.E. = Systematic Error (%)

*Instrument is battery powered.

TABLE 2. TEST DATA DECATUR ELECTRONICS ALCC-TECTOR 500 S/N 263

Test	Test Data													Meets Requirements
(1&2)Precision/Accuracy	1	2	3	4	5	6	7	8	9	10	M	S.D.	S.E.	
at 0.05 BAC	.050	.056	.050	.051	.046	.050	.050	.051	.052	.050	.051	.0025	+2	
at 0.10 BAC	.102	.104	.104	.101	.108	.105	.099	.101	.105	.107	.104	.0028	+4	Yes
at 0.15 BAC	.150	.156	.148	.156	.151	.152	.148	.151	.151	.156	.152	.0031	+2	
(3) Alcohol Free Subjects	.001	.000	.000	.000	.001	.000	.001	.001	.000	.000	.000			Yes
(5) Power Line Voltage														
at 108 VAC	.097	.096	.095	.095	.100	.096	.098	.095	.097	.094	.096	.0018	-4	Yes
at 123 VAC	.099	.100	.098	.102	.099	.098	.099	.097	.107	.103	.100	.0030	0	
(6) Ambient Temperature														
at 20°C	.094	.097	.101	.098	.095	.098	.097	.096	.100	.100	.098	.0023	-2	Yes
at 30°C	.098	.101	.103	.098	.101	.100	.102	.105	.102	.106	.102	.0026	+2	
(7) Post Vibration														NA*
Electrical Safety														YES

M = Mean

S.D. = Standard Deviation

S.E. = Systematic Error (%)

*Mobile test not requested by manufacturer.

TABLE 3. TEST DATA SMITH AND WESSON BREATHALYZER 900A S/N 0831562

Test	Test Data													Meets Requirements
(1&2) Precision/Accuracy	1	2	3	4	5	6	7	8	9	10	M	S.D.	S.E.	
at 0.05 BAC	.049	.052	.051	.050	.050	.055	.054	.054	.049	.049	.051	.0023	+2	
at 0.10 BAC	.103	.100	.100	.103	.105	.100	.103	.101	.106	.099	.102	.0024	+2	Yes
at 0.15 BAC	.141	.149	.148	.151	.151	.160	.150	.144	.150	.149	.149	.0049	-.7	
(3) Alcohol Free Subjects	.000	.006	.011	.011	.000	.000	.000	.002	.006	.003	.004			Yes
(5) Power Line Voltage														
at 108 VAC	.098	.101	.097	.100	.094	.100	.100	.099	.098	.103	.099	.0025	-1	Yes
at 123 VAC	.100	.095	.100	.103	.099	.100	.101	.103	.104	.104	.101	.0028	+1	
(6) Ambient Temperature														
at 20°C	.098	.101	.100	.101	.099	.100	.100	.099	.099	.099	.099	.0010	-1	Yes
at 30°C	.104	.102	.108	.101	.102	.100	.104	.100	.103	.103	.103	.0024	+3	
(7) Post Vibration	.101	.100	.100	.101	.099	.101	.100	.100	.095	.100	.100	.0018	0	Yes
Electrical Safety														Yes

M = Mean
S.D. = Standard Deviation
S.E. = Systematic Error (%)

TABLE 4. TEST DATA SMITH AND WESSON BREATHALYZER 1000 S/N 0140490

Tests	Test Data													Meets Requirements
(1&2)Precision/Accuracy	1	2	3	4	5	6	7	8	9	10	M	S.D.	S.E.	
at 0.05 BAC	.046	.050	.053	.051	.051	.051	.050	.050	.049	.048	.050	.0019	0	
at 0.10 BAC	.097	.097	.095	.100	.095	.098	.095	.101	.101	.099	.098	.0024	-2	Yes
at 0.15 BAC	.142	.145	.149	.146	.149	.147	.144	.146	.148	.145	.146	.0022	-3	
(3) Alcohol Free Subjects	.000	.000	.014	.000	.001	.001	.000	.000	.002	.002	.002			Yes
(5) Power Line Voltage														
at 108 VAC	.096	.098	.103	.095	.099	.098	.098	.097	.101	.098	.098	.0020	-2	Yes
at 123 VAC	.098	.098	.100	.104	.102	.101	.102	.098	.100	.102	.100	.0024	0	
(6) Ambient Temperature														
at 20°C	.100	.096	.097	.097	.094	.098	.101	.102	.096	.099	.098	.0025	-2	Yes
at 30°C	.097	.099	.105	.102	.101	.100	.102	.101	.102	.104	.101	.0023	+1	
(7) Post Vibration	.095	.099	.096	.097	.104	.101	.096	.097	.093	.093	.097	.0034	-3	Yes
Electrical Safety														Yes

M = Mean
S.D. = Standard Deviation
S.E. = Systematic Error (%)

TABLE 5. TEST DATA LUCKEY LABORATORIES GAS CHROMATOGRAPH ANALYZER 1000 NSN

Test	Test Data													Meets Requirements
(1&2)Precision/Accuracy	1	2	3	4	5	6	7	8	9	10	M	S.D.	S.E.	
at 0.05 BAC	.056	.050	.048	.052	.050	.049	.050	.053	.049	.053	.051	.0025	+2	
at 0.10 BAC	.098	.100	.105	.101	.105	.103	.098	.095	.101	.098	.100	.0033	0	Yes
at 0.15 BAC	.152	.149	.152	.155	.155	.153	.155	.156	.156	.157	.154	.0025	+2.7	
(3) Alcohol Free Subjects	.001	.001	.000	.001	.001	.000	.001	.000	.002	.001	.001			Yes
(5) Power Line Voltage														
at 108 VAC	.102	.104	.106	.107	.103	.099	.102	.101	.099	.101	.102	.0027	+2	No
at 123 VAC	.129	.127	.126	.172	.121	.124	.116	.116	.150	.116	.130	.0179	+30	
(6) Ambient Temperature														
at 20°C	.107	.099	.100	.095	.090	.089	.089	.091	.092	.097	.095	.0059	-5	No
at 30°C	.099	.102	.099	.102	.103	.099	.096	.099	.142	.127	.107	.0152	+7	
(7) Post Vibration														NA*
Electrical Safety														Yes

M = Mean
S.D. = Standard Deviation
S.E. = Systematic Error (%)

*Mobile test not requested by manufacturer.

TABLE 6. TEST DATA INTOXIMETERS GAS CHROMATOGRAPH MARK II S/N1

Test	Test Data													Meets Requirements
(1&2)Precision/Accuracy	1	2	3	4	5	6	7	8	9	10	M	S.D.	S.E.	
at 0.05 BAC	.049	.048	.050	.050	.049	.049	.050	.050	.050	.050	.050	.0007	0	Yes
at 0.10 BAC	.102	.101	.105	.099	.101	.102	.103	.104	.102	.101	.102	.0017	+2	
at 0.15 BAC	.146	.150	.149	.152	.149	.152	.153	.150	.153	.150	.150	.0022	0	
(3) Alcohol Free Subjects	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000			Yes
(5) Power Line Voltage														
at 108 BAC	.095	.097	.096	.096	.096	.096	.095	.097	.096	.095	.096	.0007	-4	Yes
at 123 VAC	.101	.097	.099	.102	.100	.098	.099	.100	.099	.099	.099	.0014	-1	
(6) Ambient Temperature														
at 20°C	.098	.098	.100	.100	.098	.099	.098	.099	.098	.098	.099	.0008	-1	Yes
at 30°C	.099	.097	.099	.099	.099	.098	.097	.096	.096	.096	.096	.0007	-4	
(7) Post Vibration	.099	.095	.094	.093	.096	.098	.094	.096	.094	.098	.096	.0021	-4	Yes
Electrical Safety														Yes

M = Mean
S.D. = Standard Deviation
S.E. = Systematic Error (%)

TABLE 7. TEST DATA OMICRON SYSTEMS INTOXILYZER 4011 S/N219

Test	Test Data													Meets Requirements
(1&2)Precision/Accuracy	1	2	3	4	5	6	7	8	9	10	M	S.D.	S.E.	
at 0.05 BAC	.046	.047	.049	.048	.048	.049	.049	.050	.051	.052	.049	.0018	-2	
at 0.10 BAC	.100	.099	.098	.096	.096	.095	.092	.094	.094	.095	.096	.0025	-4	Yes
at 0.15 BAC	.143	.147	.147	.149	.143	.144	.143	.144	.148	.147	.145	.0023	-3	
(3) Alcohol Free Subjects	.000	.004	.001	.000	.000	.001	.000	.001	.000	.002	.0008			Yes
(5) Power Line Voltage														
at 108 VAC	.105	.102	.103	.101	.101	.099	.099	.098	.097	.097	.100	.0027	0	Yes
at 123 VAC	.100	.099	.099	.098	.098	.098	.098	.098	.098	.098	.098	.0007	-2	
(6) Ambient Temperature														
at 20°C	.099	.096	.098	.098	.097	.096	.096	.097	.095	.097	.097	.0012	-3	Yes
at 30°C	.106	.105	.105	.105	.105	.104	.103	.104	.104	.105	.105	.0008	+5	
(7) Post Vibration	.096	.097	.098	.098	.097	.099	.097	.096	.098	.096	.097	.0010	-3	Yes
Electrical Safety														Yes

M = Mean
S.D. = Standard Deviation
S.E. = Systematic Error (%)

TABLE 8. TEST DATA INTOXIMETERS PHOTO-ELECTRIC INTOXIMETER 400 S/N1

Test	Test Data													Meets Requirements
(1&2)Precision/Accuracy	1	2	3	4	5	6	7	8	9	10	M	S.D.	S.E.	
at 0.05 BAC	.046	.047	.056	.059	.055	.055	.052	.050	.052	.052	.052	.004	+4	
at 0.10 BAC	.100	.095	.096	.096	.093	.094	.101	.098	.100	.098	.097	.0027	-3	Yes
at 0.15 BAC	.144	.136	.145	.146	.145	.142	.147	.145	.143	.143	.144	.0030	-4	
(3) Alcohol Free Subjects	.006	.010	.006	.012	.002	.007	.008	.010	.004	.008	.0073			Yes
(5) Power Line Voltage														
at 108 VAC	.099	.100	.101	.095	.097	.098	.100	.097	.099	.096	.098	.0019	-2	Yes
at 123 VAC	.098	.100	.101	.096	.101	.099	.099	.096	.098	.096	.098	.0020	-2	
(6) Ambient Temperature														
at 20°C	.096	.095	.095	.097	.099	.095	.098	.096	.096	.100	.097	.0018	-3	Yes
at 30°C	.096	.096	.098	.097	.096	.094	.095	.097	.097	.095	.096	.0012	-4	
(7) Post Vibration	.131	.132	.130	.128	.115	.136	.132	.134	.140	.140	.132	.007	+32	No
Electrical Safety														Yes

M = Mean
S.D. = Standard Deviation
S.E. = Systematic Error (%)

TABLE 9. TEST DATA AMERICAN SCIENCE AND ENGINEERING ALCOHOL SCREENING DEVICE 400 S/N 458

Test	Test Data													Meets Requirements
(1&2)Precision/Accuracy	1	2	3	4	5	6	7	8	9	10	M	S.D.	S.E.	
at 0.05 BAC	.050	.049	.051	.053	.053	.053	.051	.054	.050	.049	.051	.002	+2	
at 0.10 BAC	.096	.102	.099	.097	.097	.097	.096	.095	.096	.096	.097	.002	-3	Yes
at 0.15 BAC	.142	.144	.144	.143	.142	.145	.144	.144	.147	.145	.144	.0015	-4	
(3) Alcohol Free Subjects	.001	.001	.001	.002	.001	.001	.005	.003	.002	.002	.0019			Yes
(5) Power Line Voltage														
at 108 VAC														N/A*
at 123 VAC														
(6) Ambient Temperature														
at 20°C	.095	.096	.097	.099	.098	.097	.094	.100	.098	.095	.097	.002	-3	Yes
at 30°C	.102	.103	.096	.103	.102	.095	.101	.102	.103	.103	.101	.003	+1	
(7) Post Vibration	.102	.103	.104	.104	.104	.106	.106	.107	.104	.105	.104	.0015	+4	Yes
Electrical Safety														Yes

M = Mean
S.D. = Standard Deviation
S.E. = Systematic Error (%)

*Instrument is battery powered.

3. SUMMARY

The following instruments met all of the requirements of the Standard for mobile and non-mobile evidential breath testers:

Energetics Science, Inc.: Alco-Limiter 1100

Intoximeters, Inc.: Gas Chrometrograph Mark II

Omicron Systems Corp.: Intoxilyzer 4011

Smith and Wesson Electronics: Breathalyzer 900A and Breathalyzer 1000

American Science and Engineering Inc.: Alcohol Screening Device 400

The following instruments met all of the requirements of the Standard for non-mobile evidential breath testers:

Decatur Electronics, Inc.: Alco-Tector 500

Intoximeters, Inc.: Photo-Electric Intoximeter 400

Test results are summarized in Table 10.

TABLE 10. SUMMARY OF RESULTS

TEST	Standard Requirements[a]	Decatur Alco-Tector 500	Energetics Science Alco-Limiter	Intoximeter G.C. Mark II	Intoximeter Photo-Electric Intoximeter	Luckey Laboratories G.C. Analyzer 1000	Omicron Intoxilyzer 4011	Smith and Wesson Breathalyzer 900A	Smith and Wesson Breathalyzer 1000	American Science and Engineering ASD Series 400
(1 & 2) Precision/Accuracy Tests										
Standard Deviation at .05 BAC		.003	.001	.001	.004	.003	.002	.002	.002	.002
.10 BAC		.003	.002	.002	.003	.003	.003	.002	.002	.002
.15 BAC		.003	.002	.002	.003	.003	.002	.005	.002	.002
Average Standard Deviation	.004	.003	.002	.002	.003	.003	.002	.003	.002	.002
Systematic Error at .05BAC	+10%	+2	+4	0	+4	+2	-2	+2	0	+2
.10 BAC	+ 5%	+4	-2	+2	-3	0	-4	+2	-2	-3
.15 BAC	+ 5%	+2	+2	0	-4	+3	-3	-.7	-3	-4
(3) Alcohol Free Subjects Test (Average of 10 tests)	.010	.000	.003	.000	.007	.001	.001	.004	.002	.002
(5) Power Line Voltage Test			c							c
Standard Deviation at 108V	.004	.002	c	.001	.002	.003	.003	.002	.002	c
123V	.004	.003	c	.001	.002	.018*	.001	.003	.002	c
Systematic Error at 108V	+ 5%	-4	c	-4	-2	+2	0	-1	-2	c
123V	+ 5%	0	c	-1	-2	+30*	-2	+1	0	c
(6) Temperature Test										
Standard Deviation at 20°C	.004	.002	.001	.001	.002	.006*	.001	.001	.003	.002
30°C	.004	.003	.002	.001	.003	.015	.001	.002	.002	.003
Systematic Error at 20°C	+ 5%	-2	-2	-1	-3	-5	-3	-1	-2	-3
30°C	+ 5%	+2	0	-4	-3	+7*	+5	+3	+1	+1
(7) Vibration Test		b				b				
Standard Deviation	.004	b	.002	.002	.007*	b	.001	.002	.003	.002
Systematic Error	+ 5%	b	0	-4	+32*	b	-3	0	-3	+4
Electrical Safety Inspection		Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass

a Equal to or less than (in BAC % W/V, or percentage)

b Manufacturer did not request test

c Test not applicable. Instrument is battery powered

* Does not meet requirement of standard

APPENDIX

STANDARD FOR DEVICES TO MEASURE BREATH ALCOHOL

DEPARTMENT OF TRANSPORTATION

National Highway Traffic Safety Administration

HIGHWAY SAFETY PROGRAMS

Standard for Devices to Measure Breath Alcohol

The purpose of this notice is to publish the details of a program for development of a qualified products list for use by the National Highway Traffic Safety Administration, and by State and local governments using Federal funds for purchasing evidential breath-testing equipment.

The Highway Safety Act of 1966 provides that each State shall have a highway safety program designed to reduce motor vehicle accidents and deaths, injuries and property damage resulting therefrom. The Secretary of Transportation is charged with the responsibility for developing uniform standards for highway safety programs, pursuant to section 402(a) of the Act, and for carrying out a research and demonstration program, pursuant to section 403 of the Act. From the outset of the program, development of a broadly-based alcohol countermeasures program has been a high priority. Highway Safety Program Standard No. 8 covers Alcohol in Relation to Highway Safety, and establishes requirements for the alcohol-related aspects of the State programs. The standard includes requirements for legislative actions (such as development of implied consent laws, and laws establishing presumptive levels of intoxication), as well as for development of breath testing and other law enforcement capabilities. The NHTSA has also conducted a vigorous research and demonstration effort to advance the available technology in this field.

In these efforts it has been clear that development and use of accurate testing devices is essential. All jurisdictions covered by the Act now have implied consent statutes. All but four have statutes establishing a 0.10 percent blood alcohol level or lower as a presumptive level of intoxication. Some States have also recently adopted statutes establishing a certain blood alcohol level as illegal "per se", for a person in control of a motor vehicle.

In addition to a requirement in Standard No. 8 for development of controls relating to breath-testing activities, Volume 8 of the Highway Safety Program Manual provides additional guidelines for assisting States in implementing programs. Section IV, paragraph 3 of the Manual deals with chemical tests for alcohol impairment. The requirements with respect to breath tests are further specified in subsection 3(c), "Analysis of Breath". This section provides certain specifications for the accuracy of breath-testing equipment to be used in the law enforcement process. With the rapidly advancing breath-sensing technology there has been a proliferation of new devices being offered on the market for use by police in enforcement programs. As a result of these developments there is a need for an extension of the requirements currently provided in Volume 8 of the Manual. Officials from State and local governments have requested guidance in making purchases; court developments have highlighted the importance of accuracy; and the continuing use of Federal funds for purchasing breath-testing equipment makes it important to ensure effective expenditure of the funds.

To meet this need a variety of standards are being developed by the National Bureau of Standards (NBS) for the NHTSA. The first of these standards covers evidential breath-testing devices. The development of this standard included a review of the current state of the art in breath-testing devices to develop a performance standard against which devices could be tested and a qualified products list developed. The effort began initially in the Committee on Alcohol and Drugs of the National Safety Council (NSC) and has been carried through by the NHTSA in close collaboration with the National Bureau of Standards. Since many manufacturers may wish to sell products to the NHTSA and State and local governments using Federal funds it was decided that a comment and assistance on the standards would be sought from manufacturers as well as from scientific and other technological experts. In December 1972, manufacturers were sent copies of the draft standard for review. The NBS mailed a draft of the standard, with a request for comments or suggestions, to 22 manufacturers, 52 State governors' representatives and highway safety coordinators (with a request that they forward an additional enclosed copy of the draft to their State official responsible for selecting or purchasing breath-testing equipment), and 21 other experts in the field, most of whom were members of the Executive Board of the Committee on Alcohol and Drugs, National Safety Council. Replies have been received from 12 manufacturers, 30 State officials, and 6 other experts. Comments were also received from an ad hoc review subcommittee of the National Safety Council Committee on Alcohol and Drugs.

Generally the letters approved of the draft, although most letters contained suggestions for change. Subjects most frequently mentioned were the system of units, the definition of blood alcohol equivalent (BAQ) and the specificity test using alcohol-free subjects.

As a result of these suggestions, the units for blood alcohol concentration were changed from mg/ml to the more familiar percent weight by volume (percent W/V) based upon grams of alcohol per 100 milliliters of blood. The definition of BAQ was eliminated. The name of the specificity test was changed to "Blank Reading" test. The scope of the standard was also changed to include mobile evidential breath testers.

Three letters suggested that the precision and accuracy tolerances were too tight and three others (including the Committee on Alcohol and Drugs) suggested that these tolerances were too loose. After restudying the data, NBS decided not to change these tolerances, which are based on a chi-square test at the 95-percent confidence level using data from 90 tests at NBS with three different breath testers at the three concentration levels.

Notice of the availability of the draft for review was also published in the Commerce Business Daily in December 1972.

The result of this review and deliberation is the standard testing procedure set forth below. Items meeting the standard will be included on a qualified products list that will be used to determine acceptability for purchase by the Federal Government in its efforts and for

purchase by the State and local governments with funds available pursuant to section 402(a) of the Act.

Qualification testing to these standards, of products submitted by manufacturers, will be conducted by the DOT Transportation Systems Center (TSC), 55 Broadway, Cambridge, Massachusetts 02142. The National Bureau of Standards will act as consultants to the Transportation Systems Center in the conduct of these tests. Tests will be conducted semiannually. Manufacturers wishing to submit devices for evaluation must apply for a test date to the Department Systems Center not later than 4 weeks after publication of this notice. 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 testing program, the manufacturer will deliver two units of his equipment to TSC. In addition to the Operator's Manual and the Maintenance Manual normally supplied with the purchase of this equipment, the manufacturer shall deliver to TSC specifications and drawings which fully describe these units. Proprietary information will be respected.

The two units submitted must be a prototype model. One of the two units will be returned to the manufacturer at the end of the testing period. The United States will reserve the right to purchase the remaining device at its discretion. The manufacturer will have the right to check his units between the arrival in Cambridge and the start of the test, but will have no access to the units during the tests. Any malfunction of the device which results in failure to complete any of the tests satisfactorily will result in failure of the qualification program. If a device fails, it may be resubmitted for next testing series.

All testing is expected to be completed within 3 months of the date of publication of this notice. The test results will be transmitted to each manufacturer. On the basis of these results, the NHTSA will develop a qualified products list covering the evidential breath-testing equipment. It is expected that within 6 months of the publication of this notice an NHTSA Directive will be issued amending Volume 8 of the Highway Safety Program Manual to include the qualified products list as a funding criteria. Only devices appearing on this list will be purchased with Federal funds available under sections 402 (a) or 403 of the Act. However, units not on the list may be purchased by DOT or NBS for experimental or developmental testing.

Retesting of devices will be conducted under several circumstances. First, it is expected that annual periodic testing will be conducted using devices purchased on the open market. Second, the NHTSA intends to modify and improve these standards as new data and test procedures become available. It is intended, for example, to add to the standards another section defining means of checking for the capability of a device to collect deep lung air by the use of rebreathing techniques. It is also intended to increase the requirements for accuracy and precision if warranted by cost-effectiveness considerations. A requirement may be added for instruments to produce a permanent record of the test results. Comments and recommended revisions are invited from all interested parties. Suggestions should be addressed to the Associate Administrator, Traffic Safety Programs, National Highway Traffic Safety Administration, DOT, 400 7th Street, SW, Washington, D.C. 20590. Notification will be provided in the FEDERAL REGISTER of each such modification. The manufacturers whose equipment has already been tested to the standard will be notified to resubmit the equipment for testing to the new specification only.

Third, if at any time a manufacturer changes the design of a device currently on the NHTSA qualified products list, the manufacturer should submit the proposed changes to the DOT Transportation Systems Center for review. Based on this review, the NHTSA will decide whether the change will require retesting of the unit. Normally, such retesting will be accomplished at the next annual testing period. In special cases, however, the NHTSA may, at its option, permit an earlier retesting of the device.

Fourth, the DOT Transportation Systems Center will, on behalf of NHTSA, establish a Standards Compliance Information System (SCIS) for the purpose of eliciting information on the performance of devices listed on the NHTSA qualified products list. Reports will be solicited from State and local agencies on their acceptance testing. In addition, field performance data will be obtained from law enforcement agencies using the equipment. User reports will be elicited to assure that (1) devices continue to perform according to the NHTSA standard, and (2) experience in field use does not indicate an excessive breakdown rate or maintenance problems.

If information gathered through the SCIS indicates that an instrument on the qualified products list is not performing in accordance with the NHTSA standard, the Transportation Systems Center will initiate a special investigation. This study may include visits to users and additional tests of the device obtained from the open market. If this investigation indicates that the devices actually sold on the market are not meeting the NHTSA standard, then the manufacturer will be notified that the instrument may be dropped from the qualified products list. In this event the manufacturer shall have 30 days to reply.

Based on the DOT Transportation Systems Center investigation and the data presented in reply by the manufacturer, the NHTSA will make a determination as to whether the instrumentation should remain on the qualified products list. Devices dropped from the list may not be resubmitted for reconsideration for a period of 1 year. Upon resubmission, the manufacturer must submit a statement describing what has been done to overcome the problems which led to the dropping of the device in question from the list.

The primary objective of these standards is to ensure that Federal funds provided to the States under Section 402 of the Highway Safety Act are expended only for effective breath test equipment. A second objective of these standards is to assist the State and local communities by providing a centralized qualification test program for breath-testing devices designed to collect evidence in law enforcement programs. These standards are not intended to replace the current qualification programs required in certain States for this equipment or to directly regulate the manufacture of breath-testing equipment. However, some States may wish to make use of this program in addition to setting their own requirements. Finally, it is hoped that these standards can assist industrial organizations in producing breath test equipment by establishing a minimum national performance standard against which they can develop their designs.

Accordingly, the DOT performance standard for evidential breath testers to measure alcohol content shall be as set forth below.

(23 U.S.C. 402, 403.)

Issued on: October 30, 1973.

WILLARD Y. HOWELL,
Acting Associate Administrator, Traffic Safety Programs, National Highway Traffic Safety Administration.

EVIDENTIAL BREATH TESTERS FOR ALCOHOL CONTENT

1. *Purpose and Scope.* The purpose of this standard is to establish performance requirements and methods of test for evidential breath testers. Evidential breath testers (EBT) are instruments which measure the alcohol content of deep lung samples of breath with sufficient accuracy for evidential purposes. The standard as a whole is intended primarily for use in qualification testing of EBT.

2. *Classification.*

2.1 *Mobility.*

2.1.1 *Mobile evidential breath testers.* EBT which are designed to be transported to nonfixed operational sites in the field.

2.1.2 *Nonmobile evidential breath testers.* EBT which are designed for operation at a fixed location.

2.2 *Power source.*

2.2.1 *Battery powered evidential breath testers.* EBT which are powered by batteries.

2.2.2 *A.C. powered evidential breath testers.* EBT which are powered from the a.c. power lines.

3. *Definitions.*

3.1 *Alcohol.* Ethanol; ethyl alcohol.

3.2 *Blood alcohol concentration (BAC).* Blood alcohol concentration, expressed in percent weight by volume (percent w/v) based upon grams of alcohol per 100 milliliters of blood in accordance with the Uniform Vehicle Code [1]

[1] Copies of the Uniform Vehicle Code Supplement 1 1972 are available from the National Committee on Uniform Traffic Laws and Ordances, 955 North L'Enfant Plaza, SW., Washington, D.C. 20024.

§ 11-902.1(a) (Supplement 1, 1972). A BAC of 0.10 percent w/v is equivalent to 0.10 grams of alcohol per 100 milliliters of blood (0.10g/100ml or 1.0mg/ml).

Alcohol concentrations in either breath or in vapor mixtures are expressed in milligrams of alcohol per liter of vapor (mg/l). For convenience, an equivalent BAC will be given in percent w/v in parentheses. To convert a vapor concentration in units of mg/l to units of percent w/v, multiply by 0.21.

3.3 *Qualification tests.* Tests performed to check the compliance of a product with the requirements of a standard in advance of, and independent of, any specific procurement action.

3.4 *Standard deviation.* A common indication of precision among repeated measurements of a single quantity given by:

$$\text{Standard Deviation} = \sqrt{\frac{\text{Sum } (X-\bar{X})^2}{N-1}}$$

where:

N = the number of measurements,
X = the value of a single measurement, and
$\bar{X}$ = the mean of all X's.

An equivalent formula which is often more convenient for performing calculations is:

$$\text{Standard Deviation} = \sqrt{\frac{SS}{N-1}}$$

$$\text{where SS} = \text{Sum of } X^2 - \frac{(\text{Sum of } X)^2}{N}$$

3.5 *Systematic error.* The difference between the mean measured value and the known value, expressed as a percentage of the known value.

4. *Requirements.*

4.1 *Precision.* Evidential breath testers shall measure the alcohol content of vapor mixtures with an average standard deviation of no more than 0.02 mg/l (0.004 percent W/V) when tested in accordance with 5.1.

4.2 *Accuracy.* Evidential breath testers shall measure the alcohol content of vapor mixtures with a systematic error of no more than plus or minus 10 percent at an ethanol vapor concentration of 0.24 mg/l (0.050 percent W/V), and no more than plus or minus 5 percent at concentrations of 0.48 mg/l (0.10 percent W/V) and 0.72 mg/l (0.15 percent W/V), when tested in accordance with 5.2.

4.3 *Blank reading.* Evidential breath testers shall indicate an average instrument reading of no more than 0.048 mg/l (0.010 percent W/V) when breath from alcohol-free subjects is tested in accordance with 5.3.

[2] This conversion factor is based on a commonly used value recommended by the Committee on Alcohol and Drugs of the National Safety Council; that is, 2.1 liters of "deep lung" air at 34°C contains approximately the same quantity of ethanol as 1 ml of circulating pulmonary arterial blood. See, for example, R. N. Harger, R. B. Forney and R. S. Baker, "Estimation of the Level of Blood Alcohol from Analysis of Breath," Quarterly Journal of Studies on Alcohol, *17*, 1-18 (1956).

4.4 *Breath sampling.* Since the breath/blood correlation will be poor if an improper breath sample is taken, the instrument reading shall be compared with direct measurements of capillary or venous whole blood samples, in accordance with 5.4, to test for deep-lung sampling performance.

NOTE.—The use of this test in the standard does not imply that direct blood measurements are necessarily the only possible means for checking the deep-lung sampling performance of the instrument. If an acceptable performance test which involves breath alcohol measurement alone is developed, revision of this standard will be considered.

4.4.1 The limits to bias in breath/blood correlation shall be zero and −0.020 percent W/V as determined by the value of $\hat{Y}$, the evidential breath tester reading corresponding to a BAC of 0.10 percent W/V on the breath/blood correlation line drawn in accordance with 5.4.13. That is, the value of $\hat{Y}$ shall be between 0.08 and 0.10 percent W/V.

4.4.2 At least seven of the eight breath-alcohol data points calculated in 5.4.10 shall not depart from the breath/blood correlation line by more than ±0.020 percent W/V. That is, at least seven of the eight breath-blood points plotted in accordance with 5.4.12 shall lie between the two lines drawn in accordance with 5.4.14 parallel to the breath/blood correlation line and passing through the points $\hat{Y}+0.020$ and $\hat{Y}-0.020$ percent W/V.

4.5 *Power.*

4.5.1 When a.c. powered evidential breath testers are operated at a.c. line voltages of 108 volts and 123 volts (rms) in accordance with 5.5, the systematic errors shall not exceed plus or minus 5 percent, and the standard deviations shall not exceed 0.02 mg/l (0.004 percent W/V).

4.5.2 Battery powered evidential breath testers shall have an indicator which warns when the accuracy and precision requirements (4.1 and 4.2), cannot be met because of battery condition.

4.5.3 The operator's manual supplied with battery powered evidential breath testers shall state the approximate number of breath tests which can be performed before battery replacement or recharging is necessary.

4.6 *Ambient conditions.*

4.6.1 Evidential breath testers shall meet the requirements of this standard when operated within the following ambient conditions.

(a) Temperature: 20°C (68°F) to 30°C (85°F).

(b) Pressure: 635 mm (25 in) to 787 mm (31 in) Hg.

(c) Relative Humidity: 10-90 percent.

4.6.2 When an evidential breath tester is designed for operation at temperatures outside the limits specified in 4.6.1.a, the instrument shall be tested in accordance with 5.6 at each of the specified limits outside the range 20°C to 30°C. The systematic errors shall not exceed plus or minus 5 percent and the standard deviations shall not exceed 0.02 mg/l (0.004 percent W/V).

4.6.3 If a temperature correction is required, this correction shall not exceed 20 percent of the uncorrected value.

4.7 *Vibration stability of mobile EBT.* Evidential breath testers shall measure the alcohol content of vapor mixtures with a systematic error of no more than plus or minus 5 percent and a standard deviation of no more than 0.02 mg/l (0.004 percent W/V) after they have been subjected to the vibration test in accordance with 5.7.

4.8 *Electrical safety.* Evidential breath testers shall meet the following requirements of the American National Standard Electrical Safety Requirements, ANSI C 39.5-1964:[3] 3.1, Shock Hazard; 3.1.1, Grounding; 3.4, Flammability; 4.1.1, Marking of Terminals; 4.1.3, Male Plugs; 4.2.1, Internal (Wiring and Cabling); and 4.4, Over-Current Protection.

4.9 *Operator's manual.* An operator's manual shall be supplied by the manufacturer or distributor with each evidential breath tester. This manual shall clearly state the instructions for operation and maintenance of the instrument, and shall include the following information.

(a) The ranges of temperature, atmospheric pressure and relative humidity within which the instrument is designed to be operated.

(b) Any temperature corrections to compensate for ambient temperatures outside the range given in 4.6.1.a.

5. *Test methods.* The ambient conditions of temperature, pressure, and humidity shall be within the ranges specified in 4.6.1 during the tests described in 5.1, 5.2, 5.3, 5.4, 5.5, and 5.7.

5.1 *Precision test using known ethanol vapor concentrations.*

5.1.1 Connect a device which supplies known concentrations of ethanol vapor to the evidential breath tester in accordance with the instructions in the operator's manual. The device and the ethanol mixture used therein shall meet the requirements of the standard for breath tester calibrating units.

5.1.2 Flush the sampling assembly of the instrument completely with the alcohol vapor sample as described in the operator's manual.

5.1.3 Using the evidential breath tester, measure each of the three known ethanol vapor concentrations listed below ten times:

(a) 0.24 mg/l (0.050 percent W/V).

(b) 0.48 mg/l (0.10 percent W/V).

(c) 0.72 mg/l (0.15 percent W/V).

5.1.4 For each of the three sets of ten measurements made in accordance with 5.1.3, calculate the standard deviation. (See sample calculation in appendix A.) Add the three standard deviations and divide by 3 to obtain the average standard deviation.

5.2 *Accuracy test using known ethanol vapor concentrations.* Use the test

[3] Copies of this ANSI publication may be obtained from the American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018.

data obtained in accordance with 5.1 to calculate the systematic error at each of the three known vapor concentrations.

5.3 *Blank test using alcohol-free test subjects.*

5.3.1 Select five test subjects in generally good physical condition. The test subjects shall have consumed no alcoholic beverage during the 2-day period prior to testing and no more than the equivalent of 3 ounces of 100-proof liquor during the 4-day period prior to testing.

5.3.2 At least two of the five subjects selected shall be smokers and shall smoke at least once during the 2-hour period preceding the start of testing, but shall stop at least 20 minutes before the start of testing.

5.3.3 Take a breath sample from each test subject and obtain an instrument reading, allowing sufficient instrument recovery time (i.e., the time necessary to properly clear the evidential breath tester when following the operating instructions) between measurements.

5.3.4 Repeat 5.3.3 to obtain a total of ten measurements.

5.4 *Breath sampling test.*

5.4.1 Select eight test subjects in generally good physical condition.

5.4.2 The subjects' body temperatures measured orally shall be between 97.0° F and 99.5° F just prior to the start of testing.

5.4.3 Alcoholic beverages (mixed if desired with a non-alcoholic beverage) shall be consumed by the eight subjects over a period of 1 to 2 hours. A very light meal consisting of one sandwich and a non-alcoholic beverage shall be offered to the subjects before the start of the drinking period. Smoking shall be permitted if desired during the drinking period.

5.4.4 The eight subjects shall be divided into two groups of four. Each subject shall be given a different amount of alcoholic beverage to drink, to ensure that there is a distribution of BAC's within each group, and that Group I BAC's are within the range 0.04 to 10 percent W/V and Group II BAC's are within the range 0.1 to 0.2 percent W/V. Table 1 shall be used as a guide to calculate the consumption of alcoholic beverages necessary for a subject to reach a particular BAC. No constraints on body weight of subjects is implied in table 1. However, the listed amounts of liquor should be adjusted for light and heavy subjects.

TABLE 1

BAC, percent W/V	Amount of 100-proof liquor consumed	Body weight, pounds
0.05–0.06	3 ounces	175–150
0.10–0.12	5¼ ounces	175–150
0.20–0.23	10 ounces	175–150

5.4.5 A waiting period preceding the taking of a breath sample from each subject in accordance with 5.4.7.1 shall begin when he has consumed all of the alcoholic beverage given him. The duration of this waiting period shall be at least 90 minutes if capillary blood samples are to be drawn, and 120 minutes if venous blood samples are to be drawn. During the waiting period the subjects shall not consume any alcoholic beverages. Those subjects who smoke may do so, but shall stop at least 20 minutes before the testing begins.

5.4.6 Blood samples, to be taken by a medically qualified person, shall be either venous blood from the cubital arm vein or capillary blood from the finger tip.

5.4.7 Instruct each subject individually as to the manner in which a breath specimen is to be delivered to the instrument under test, in accordance with the operator's manual. The test shall then proceed as follows.

5.4.7.1 Take the subject's breath sample and obtain the instrument reading.

5.4.7.2 Take a blood sample within 2 minutes after taking the breath sample.

5.4.7.3 Repeat 5.4.7.1 taking care that the breath testing instrument has had sufficient recovery time, but allowing no more than 6 minutes between the taking of the first and second breath samples.

The blood samples shall be analyzed within 72 hours after being taken, using a method of analysis which meets the requirements of 5.8. No less than two determinations of alcohol concentration shall be made on each blood sample.

5.4.8.1 A reference sample of known concentration of ethanol in whole blood in the range between 0.05 and 0.20 percent W/V shall be prepared by the analyzing laboratory, and five determinations of the reference sample ethanol concentration shall be made concurrently with the analysis of the blood samples.

5.4.8.2 The analysis of the reference sample and the blood samples shall be considered acceptable only if—

(a) The standard deviation of the five determinations of the reference sample concentration does not exceed 0.005 percent W/V; and

(b) The systematic error of the five determinations of the reference sample concentration does not exceed plus or minus 5 percent.

5.4.9 Calculate the average of the BAC measurements for each test subject. Let the letter X equal this average BAC, and use the subscripts 1 to 8 to designate the test subjects in ascending order of alcohol concentration (i.e., X_1, X_2, * * *, X_8).

5.4.10 Calculate the averages of the duplicate instrument readings made in accordance with 5.4.7 for each test subject. Convert if necessary to the same units used in 5.4.9 (percent W/V) by means of the conversion factor 0.21 (see footnote 2). Designate each average instrument reading with the letter Y and the same subscript used to identify the subject in accordance with 5.4.9.

5.4.11 Compute the following averages, and designate them as indicated.[4]

(a) $\overline{X}_H$, as the average of X_6, X_7 and X_8.

(b) $\overline{X}_L$, as the average of X_1, X_2 and X_3.

(c) $\overline{Y}_H$, as the average of Y_6, Y_7 and Y_8.

(d) $\overline{Y}_L$, as the average of Y_1, Y_2 and Y_3.

(e) $\overline{X}$, as the average of all eight X values.

(f) $\overline{Y}$, as the average of all eight Y values.

5.4.12 Plot on graph paper the points corresponding to $(\overline{X}, \overline{Y})$, $(\overline{X}_H, \overline{Y}_H)$, $(\overline{X}_L, \overline{Y}_L)$ and the eight breath-blood points corresponding to (X_1, Y_1), (X_2, Y_2), * * * (X_8, Y_8) (see figure in appendix B).

5.4.13 Draw a straight line, referred to as the "breath, blood correlation line" through the point $(\overline{X}, \overline{Y})$ and parallel to a line (not drawn in the graph) joining the points $(\overline{X}_L, \overline{Y}_L)$ and $(\overline{X}_H, \overline{Y}_H)$.

5.4.14 Draw two lines parallel to the breath/blood correlation line and passing through the points $\overline{Y}+0.020$ and $\overline{Y}-0.020$% W/V.

5.5 *Power line voltage test.*

5.5.1 Apply line power to the a.c. powered EBT under test through a variable autotransformer having a nominal input voltage of 117 volts a.c. and an output adjustable between 0 and 130 volts, and having a current rating as required by the instrument under test. Any voltage regulating device used with the instrument shall be connected between the variable autotransformer and the instrument under test.

5.5.2 Monitor the autotransformer output voltage with an rms a.c. voltmeter having an accuracy of plus or minus 2 percent in the range of 105 to 125 volts.

5.5.3 Adjust the voltage of the EBT to 108 volts. After at least one-half hour, check the voltage and readjust if necessary. Then immediately measure a known ethanol vapor concentration of 0.48 mg/l (0.10% W/V) ten times as in the precision test (5.1).

5.5.4 Increase the voltage to 123 volts, and at least one-half hour later readjust the voltage if necessary and again measure a known ethanol vapor concentration of 0.48 mg/l (0.10% W/V) ten times.

5.5.5 Calculate the systematic errors and the standard deviations for each of the two sets of ten measurements (obtained with line voltages of 108 volts and 123 volts).

5.6 *Ambient temperature test.*

5.6.1 The test temperatures shall be constant and accurate within plus or minus 3°C throughout the duration of the testing period.

5.6.2 Allow at least 1 hour for the instrument to come to temperature equilibrium after each test temperature change.

5.6.3 Perform steps 5.1.1 and 5.1.2. Measure a known ethanol vapor concentration of 0.48 mg/l (0.10 percent W/V) ten times at each test temperature.

5.6.4 Calculate the average value of the ethanol vapor concentration measured at each test temperature. Apply any temperature corrections specified by the operator's manual to obtain the adjusted average values.

5.6.5 Using the adjusted average values, calculate the systematic error for each set of ten measurements. Also calculate the standard deviation for each set of ten measurements.

[4] See appendix B for a sample calculation. An additional example may be found on pages 5-27, paragraph 5-4.3.2 of NBS Handbook 91, "Experimental Statistics," available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

5.7 *Vibration test for mobile EBT.*[5]

5.7.1 Subject the mobile EBT to vibrations of simple harmonic motion having an amplitude of 0.015 inches (total excursion 0.03 inches) applied initially at a frequency of 10 Hz and increased at a uniform rate of 30 Hz in 2½ minutes, then decreased at a uniform rate to 10 Hz in 2½ minutes.

5.7.2 Subject the unit to vibrations of simple harmonic motion having an amplitude of 0.0075 inches (total excursion 0.015 inches) applied initially at a frequency of 30 Hz and increased at a uniform rate to 60 Hz in 2½ minutes, then decreased at a uniform rate to 30 Hz in 2½ minutes.

5.7.3 Repeat 5.7.1 and 5.7.2 in each of three directions, namely in the directions parallel to both axes of the base and perpendicular to the plane of the base.

5.7.4 Perform steps 5.1.1 and 5.1.2. Measure a known ethanol vapor concentration of 0.48 mg/l (0.10 W/V) ten times, and calculate the systematic error and the standard deviation.

5.8 *Blood alcohol methodology test.* The analytical measurement system for the blood alcohol concentration determination shall be checked in the testing laboratory at least once prior to that laboratory performing the analysis required in 5.4.8.

5.8.1 The determination of the ethanol concentrations of the reference blood alcohol samples shall be performed by the same laboratory personnel who determine the ethanol concentrations of the test subject blood samples taken in accordance with 5.4. The analysis of the reference samples shall closely parallel the analysis of the test subject blood samples, especially with respect to laboratory conditions and analytical technique.

5.8.2 Prepare with an accuracy of plus or minus 1 percent, a blank (an alcohol-free blood sample), and three reference blood alcohol samples having ethanol concentrations within plus or minus 10 percent of 0.05, 0.100 and 0.200 percent W/V, by adding known quantities of ethanol to alcohol-free whole blood containing a suitable preservative.

5.8.3 Determine the ethanol concentrations of each of the three reference samples and the blank five times.

5.8.4 Compute the means, standard deviations, and systematic errors for each of the four sets of five determinations.

5.8.5 The method of analysis shall be considered acceptable if:

(a) The apparent ethanol concentration of the blank (alcohol-free blood) does not exceed 0.002 percent W/V.

(b) The average of the standard deviations from the analyses of the three reference samples does not exceed 0.005 percent W/V.

(c) The systematic error of the analysis of the 0.05 percent W/V reference sample does not exceed plus or minus 10 percent; and

(d) The systematic errors of the analyses of the 0.100 and 0.200 percent W/V reference samples do not exceed plus or minus 5 percent.

[5] This test was taken from EIA Standard RS-204-A (July 1972) which is available from Electronic Industries Association, Engineering Department, 2001 Eye Street NW., Washington, D.C. 20006.

APPENDIX A

SAMPLE CALCULATIONS OF PRECISION AND ACCURACY

The results of ten sample measurements made in accordance with 5.1 at three known ethanol vapor concentration levels are as follows:

Measurement	0.24 mg/l (0.050 percent W/V)	0.48 mg/l (0.10 percent W/V)	0.72 mg/l (0.15 percent W/V)
1	0.045	0.092	0.148
2	.046	.097	.149
3	.049	.100	.145
4	.046	.105	.148
5	.045	.091	.146
6	.049	.098	.147
7	.047	.098	.152
8	.050	.102	.147
9	.047	.093	.154
10	.046	.091	.152
Average	.047	.097	.149
S.D	.0018	.0042	.0029
Average S.D		.0030	
S.E	−6.0	−3.0	−0.7

APPENDIX B

SAMPLE CALCULATIONS IN THE DEEP LUNG SAMPLING TEST

B.1 Breath and blood alcohol concentration measurements have been made for each of eight subjects in accordance with 5.4. The average of the BAC measurements for each subject is entered in the X column of Table 3. The average of the duplicate instrument readings for each subject is entered in column Y of Table 3.

TABLE 3

Blood	*Breath*
X % W/V	*Y % W/V*
$X_1 = 0.0510$	$Y_1 = 0.0510$
$X_2 = 0.0640$	$Y_2 = 0.0648$
$X_3 = 0.0820$	$Y_3 = 0.0717$
$X_4 = 0.0880$	$Y_4 = 0.0899$
$X_5 = 0.1250$	$Y_5 = 0.1164$
$X_6 = 0.1590$	$Y_6 = 0.1294$
$X_7 = 0.1900$	$Y_7 = 0.1577$
$X_8 = 0.2030$	$Y_8 = 0.1647$

B.2 The average values computed in accordance with 5.4.11 for the above data are:

$X_L = 0.06567\%$ W/V $\quad Y_L = 0.06250\%$ W/V

$X_H = 0.18400\%$ W/V $\quad Y_H = 0.1506\%$ W/V

$X = 0.12025\%$ W/V $\quad Y = 0.10570\%$ W/V

B.3 The data points and breath/blood correlation line are entered in the sample graph (Figure 1) as required in 5.4.12 and 5.4.13.

B.4 The value of $\hat{Y}$, as defined in 4.4.1, is equal to 0.091% W/V.

B.5 All eight of the breath/blood points lie between the two lines drawn parallel to the breath/blood correlation line and through the points

$\hat{Y} + 0.020\%$ W/V $= 0.111\%$ W/V and

$\hat{Y} - 0.020\%$ W/V $= 0.071\%$ W/V.

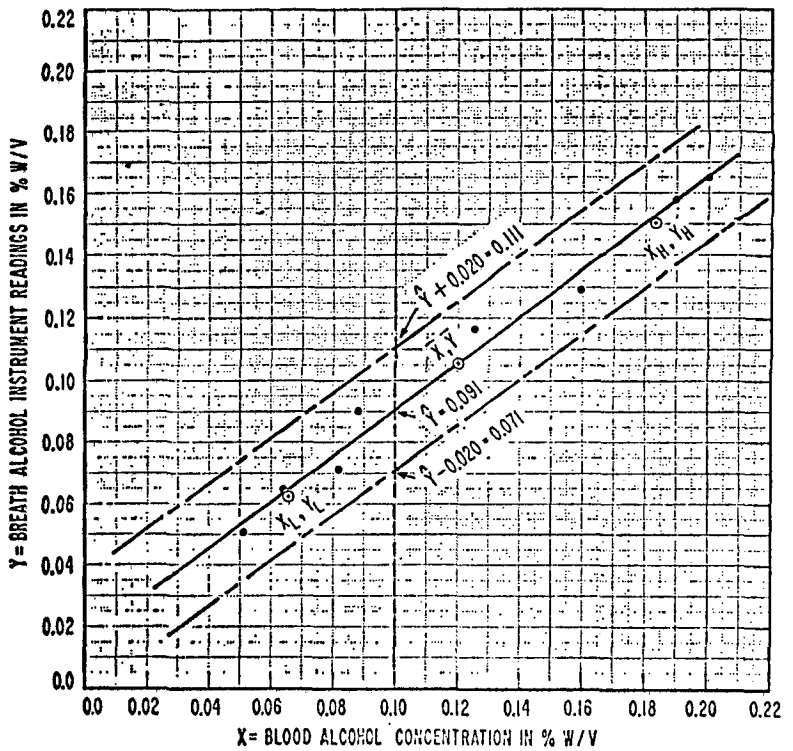

Figure 1 - Sample Data from Deep Lung Sampling Test

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