Approved February 13, 1990 Date

MINUTES OF THE HOUSE COMMITTEE ON FEDERAL AND STATE AFFAIRS.

The meeting was called to order by Representative Ginger Barr at
Chairperson

1:35 ~~a.m.~~/p.m. on February 6, 1990 in room 526-S of the Capitol.

All members were present except:

Representatives Charlton - Excused
Douville - Excused
King

Representatives Peterson
Schauf
Sebelius

Committee staff present:

Mary Galligan, Kansas Department of Legislative Research
Lynne Holt, Kansas Department of Legislative Research
Juel Bennewitz, Secretary to the Committee

Conferees appearing before the committee:

Jeanne Kutzley, Assistant Attorney General, Consumer Protection Division
Darrell Montei, Legislative Assistant, Kansas Department of Wildlife and Parks (KDWP)
John Pinegar, Deputy Director, Kansas Bureau of Investigation (KBI)

HB 2690

Jeanne Kutzley presented "clean-up" recommendations concerning the Charitable Organizations and Solicitations Act requested by the Attorney General, Attachment No. 1. At the chairman's request, Ms. Kutzley explained the purposes for the changes to Section 1 and Section 2.

There were no opponents to the bill.

HB 2695

Darrell Montei explained the bill is a KDWP bill which would amend K.S.A. 21-4206 to permit the department to receive confiscated firearms for use in the Hunter Education Program and training of law enforcement personnel, Attachment No. 2.

Committee discussion:

1. KDWP officers are duly licensed to carry firearms (9 mm is standard issue) as law enforcement officers.
2. KDWP has had occasion to seize firearms which are then turned over to the court for dispostion.
3. The enforcement officers' firearms are issued by KDWP. One member requested KDWP provide the brand name used.

John Pinegar proposed a friendly amendment to the bill to include the KBI and which would be administered by the KBI forensic laboratory, Attachment No. 3.

Committee discussion:

1. The KBI also confiscates weapons which are received from law enforcement agencies throughout the state. The KBI forensic laboratory is the primary crime laboratory in the state.
2. The KBI views the amendment as a cooperative effort with KDWP and would have occasion to turn weapons over to KDWP as well as receive them from KDWP.
3. The KBI will accept or destruct weapons with a court order. It does not receive a large number for its reference collection.
4. The agency does not sell guns.
5. Mr. Montei stated KDWP was informed of the amendment and had no objections.

There were no opponents to the bill.

Attachment No. 4 is a chart reflecting the number of Children in Need of Care placements from initial date to closure for FY 1989.

Attachment No. 5 is a letter from Reverend Richard Taylor opposing HCR 5038 which would permit casino gambling.

CONTINUATION SHEET

MINUTES OF THE House COMMITTEE ON Federal and State Affairs,

room 526-S, Statehouse, at 1:35 ~~a.m.~~/p.m. on February 6, 1990

Representative Wagnon moved to approve minutes of the January 18, 22, 23, 1990, meetings, seconded by Representative Jenkins. The motion was adopted.

HB 2512

Representative Aylward moved to report the bill adversely, seconded by Representative Jenkins. The motion was adopted.

SB 213

Representative Wagnon moved to adopt the amendment submitted by the Department of Corrections and approved by Representative Hensley. Representative Sughrue seconded the motion which was then adopted.

Representative Wagnon made a motion to report the bill favorably, as amended, seconded by Representative Sughrue. The motion was adopted.

SB 296

Chairman Barr appointed a subcommittee to further study the merits of the bill.
Representative Jenkins, Chairman
Representative Douville, Member
Representative Roy, Member

During the January 16, 1990, hearing of SB 296, conferee Jim Rumsey offered to submit material regarding the effects of radio waves on breath alcohol testing devices, Attachments No. 6, 6A, 6B & 6C. Chairman Barr announced copies of the material would be provided to the subcommittee. Other copies may be obtained from the committee secretary on request.

The meeting was adjourned at 2:04 p.m. The next meeting of the committee will be February 8, 1990, 1:30 p.m. in Room 526-S.

GUEST LIST

FEDERAL & STATE AFFAIRS COMMITTEE

DATE February 6, 1990

(PLEASE PRINT)

NAME	ADDRESS	WHO YOU REPRESENT
Jack Smarcky	R1 Perry KS	A.C.C.H.
Josie McBride	Topeka	Observer

STATE OF KANSAS

OFFICE OF THE ATTORNEY GENERAL

2ND FLOOR, KANSAS JUDICIAL CENTER, TOPEKA 66612-1597

ROBERT T. STEPHAN
ATTORNEY GENERAL

MAIN PHONE: (913) 296-2215
CONSUMER PROTECTION: 296-3751
TELECOPIER: 296-6296

TESTIMONY OF
ASSISTANT ATTORNEY GENERAL D. JEANNE KUTZLEY
TO THE COMMITTEE ON FEDERAL AND STATE AFFAIRS

RE: H. B. 2690

February 6, 1990

Madam Chairman and Members of the Committee:

Attorney General Stephan offers this bill as clean up on the Charitable Organizations & Solicitations Act enacted last year. These changes are all the result of specific issues raised by organizations and our office in the course of enforcement.

I will address the changes in the order of the bill.

SECTION 1. Clarifies some of the exempt organizations. We received phone calls from some political groups. The present act is not very clear. It was not the intent to include them originally.

Humane purposes was added because the "charitable purpose" definition would have to be read very broadly to include these organizations. The present language appears to apply to "persons" only. Animal charities may not be included, therefore, might not be regulated. There are several which solicit in Kansas.

New language was added to the definition of fund raiser. The new definition includes some language from the National Association of Attorneys General Model Act. At least one fund raiser has tried to raise the defense that they are not fund raisers because they do not "handle" the actual funds raised. This definition would clearly include them.

SECTION 2. Under the present act the bond runs to the Secretary of State. In at least one instance where we collected on the bond, we had some difficulties getting the bond money to the damaged donors. This was because the Secretary of State's Office was not set up to pay this money out. If the payee were the State of Kansas, the bond money could be paid into the Attorney General's Office and paid to consumers from there. We do have this mechanism since we regularly pay out funds from judgments on consumer cases.

SECTIONS 3 and 4. These changes will allow county and district attorneys to prosecute cases. This was an apparent oversight in the original legislation.

The present act does state in the civil penalties section that county and district attorneys may sue for and collect investigative fees and expenses and describes how civil penalties collected by county and district attorneys are to be distributed. However, the county and district attorneys are not mentioned in the actual enforcement sections. This change would clear up that issue.

SECTION 5. Originally, this section referred to the Kansas Consumer Protection Act for the description of deceptive and unconscionable acts. When the present act was passed, this seemed easy enough. However, in reality only a few sections apply to charitable organizations. Also, if an interpretation questions arose, the judge or jury might try to apply a consumer transaction standard to a charities question. This change includes the specific deceptive and unconscionable sections which apply to charities.

Examples of deceptive acts: A humane organization solicits using a project called "National Animal Protection Fund". The project is not national in scope. The solicitations talk about the animal shelter but do not mention that the group has endorsed animal euthanasia (without any attempt at adoption). Two organizations have used solicitations which look like confirmations of pledges when no pledge was made by the person.

Examples of unconscionable acts: An elderly woman was called repeatedly at her home. She was asked to give donations. When she said her money was tied up in an annuity, the caller masqueraded as her nephew when he called the annuity company and obtained information on her annuity. Two callers then pressured her into giving several thousand dollars. Many organizations mislead the elderly with the solicitations about social security and health issues.

New subsection (f) applies to groups which use a name which sounds like a charitable organization but which is a for-profit group. The phone sales pitches often sound like a charitable solicitation. Missouri sued a similar group because the company defined a handicapped worker as one with hay fever, hang nail or pregnancy.

New subsections (g), (h) and (i) were added to clarify the charitable purpose language. Many organizations claim big bucks on "public education". Some of them do not even state that as a purpose on registration documents. For others, the education consists of small blurbs on the back of envelopes or on solicitations. One charity which was supposed to be dedicated to educating the public on emergency medicine was involved in low income housing projects. Even if the donor had asked for financial statements and a statement of purpose before giving, the donor would probably not have known the donation would go for that use.

SECTION 6. This mirrors the Kansas Consumer Protection Act venue section. It allows county and district attorneys to bring actions in their own counties if solicitations were received in counties other than Shawnee. This venue section may be implied, but this makes it clear.

Again, Attorney General Stephan urges you to approve this bill.

H.B. 2690

FSA
1-4
2-6-90

H.B. 2695

Testimony Provided to House Federal and State Affairs Committee

February 6, 1990

Prepared by Kansas Department of Wildlife and Parks

H.B. 2695 would amend K.S.A. 21-4206 to provide additional firearms disposition authority to various law enforcement agencies. Confiscated firearms, when no longer needed for evidentiary purposes, may be returned by the court to the enforcement agency seizing the firearm. The receiving enforcement agency shall either sell the firearms with proceeds used for law enforcement purposes or trade the firearms for materials to be used for law enforcement.

H.B. 2695 would provide authority to law enforcement agencies to donate confiscated firearms to the Department as another option. Those agencies would retain the right to use whatever option they deem appropriate.

These firearms will benefit the Department's Hunter Education program and the many volunteer instructors who are the backbone of that program. Certain firearms would be of benefit to our animal damage control efforts and will enhance training programs for our law enforcement personnel.

The Department Supports H.B. 2695.

HOUSE FEDERAL & STATE AFFAIRS
Attachment No. 2
February 6, 1990

JAMES G. MALSON
DIRECTOR

KANSAS BUREAU OF INVESTIGATION

DIVISION OF THE OFFICE OF ATTORNEY GENERAL
STATE OF KANSAS
1620 TYLER
TOPEKA, KANSAS 66612-1837
(913) 232-6000

ROBERT T. STEPHAN
ATTORNEY GENERAL

Proposed Amendment to

HOUSE BILL No. 2695

AN ACT concerning disposition of certain firearms forfeited to law enforcement agencies; amending K.S.A. 21-4206 and repealing the existing section.

Be it enacted by the Legislature of the State of Kansas:

Section 1. K.S.A. 21-4206 is hereby amended to read as follows: 21-4206. (1) Upon conviction of a violation of sections K.S.A. 21-4201, 21-4202 or 21-4204, and amendments thereto, any weapon seized in connection therewith shall remain in the custody of the trial court.

(1) Any stolen weapon so seized and detained, when no longer needed for evidentiary purposes, shall be returned to the person entitled to possession, if known. All other confiscated weapons when no longer needed for evidentiary purposes, shall in the discretion of the trial court, be destroyed, preserved as county property, forfeited to the law enforcement agency seizing the weapon or sold and the proceeds of such sale shall be paid to the state treasurer pursuant to K.S.A. 20-2801, and amendments thereto. All weapons forfeited to any law enforcement agency **may** be traded for materials for use by such law enforcement agency or sold and the proceeds thereof used for law enforcement purposes, **or such agency may donate any such weapons to the department of wildlife and parks,** <u>or the Kansas Bureau of Investigation for law enforcement, testing, comparison or destruction by the Kansas Bureau of Investigation forensic laboratory.</u>

Sec. 2. K.S.A. 21-4206 is hereby repealed.

Sec. 3. This act shall take effect and be in force from and after its publication in the statute book.

*Language which is underlined is suggested by the KBI as an amendment to the bill.
#005

HOUSE FEDERAL & STATE AFFAIRS
Attachment No. 3
February 6, 1990

KANSAS YOUTH SERVICES
CHILD TRACKING SYSTEM
Number of CINC Placements BY
Length of Time From Date of Initial
Custody to Time of Closure

FY-1989

Time in Custody

Number of Placements	0-1 Year	2-3 Years	4-6 Years	7-9 Years	10 or More Years	TOTAL
0-3	1083	144	49	6	15	1297
4-8	334	118	86	22	15	575
9-13	23	19	14	7	3	66
13 Plus	8	6	10	4	2	30
TOTAL	**1448**	**287**	**159**	**39**	**35**	**1968**

HOUSE FEDERAL & STATE AFFAIRS
Attachment No. 4
February 6, 1990

Dear Member of the Kansas Legislature,

When voters approved state owned and operated lottery gambling in November of 1986, they did not know this included all forms of gambling. Should casino gambling be permitted in Kansas without a vote of the people?

The House Federal & State Affairs Committee may introduce legislation outlawing casino gambling in Kansas, but that changes nothing. Casino gambling could come at any time with a simple majority vote of the legislature.

Concerned Kansans want constitutional freedom from casino gambling. They believe it is a very important issue and should require a vote of the people, not just a vote of the legislature.

Because people did not understand what would happen if they voted YES, you will spend most of the session dealing with problems caused by the reappraisal and classification amendment.

Because people did not understand what would happen if they voted YES, here is a way to deal with problems caused by the lottery gambling amendment.

1. Let HCR 5038 lay in committee and die a quiet, unmourned death.

2. If the legislature believes Kansas should be in the gambling business, approve a constitutional amendment that would restrict money lottery ticket gambling to what is now being conducted.

If in the future the legislature wants state owned and operated casino gambling, such an amendment could be approved and submitted to the electors for their approval or rejection.

Voters back home now know that every lawmaker who votes YES for HCR 5038 is voting to permit the legislature to approve state owned and operated casino gambling in Kansas , if current interpretations are correct.

Should casino gambling at a state resort near one of our fine lakes or a casino gambling boat operated out of Leavenworth be permitted without a vote of the people?

Respectfully yours,

Richard Taylor

HOUSE FEDERAL & STATE AFFAIRS
Attachment No. 5
February 6, 1990

James E. Rumsey
Attorney at Law

1031 Vermont - P.O. Box 612
Lawrence, Kansas 66044
(913) 841-9950

January 19, 1990

Representative Ginger Barr
Chairperson of the House Federal
& State Affairs Committee
State Capitol
Topeka, Kansas 66612

RE: Senate Bill No. 296 Concerning Admissability of Breath or Blood Test Results in DUI Cases

Dear Representative Barr:

Enclosed are three articles I have photocopied from the CHAMPION magazine describing the effects of radio waves on breath alcohol testing devices and other defects that can occur when doing breath or blood alcohol testing. One of your Committee members was very interested in seeing these articles. You will note there is a page missing from one of the articles as there was an advertisement on that page.

I hope you find these articles helpful.

Very truly yours,

James Rumsey

James E. Rumsey

JER:rsh
Enclosures

HOUSE FEDERAL & STATE AFFAIRS
Attachment No. 6
February 6, 1990

RFI Testing on Breath Alcohol Measuring Devices:

The NBS-NHTSA Cover-Up*

by James H. Kaster

A. INTRODUCTION—The Final Report

On May 24, 1983, the Final Report was released.[1] The Federal Government, through the National Bureau of Standards (NBS), had conducted a testing project on RFI, or radio frequency interference, as it related to breath alcohol measuring devices.

The results of these tests were eagerly awaited by all parties involved in drunk driving cases since the time Smith and Wesson, manufacturer of the Breathalyzer, revealed the RFI problem. In its September, 1982 "Customer Advisory," (the Advisory) Smith and Wesson sent shock waves through the drunk driving enforcement system, announcing that its Breathalyzer models 900 and 900A could render erroneous readings because of electromagnetic waves from such common devices as police radios. The Smith and Wesson Advisory was the first public notice that the Breathalyzers 900 and 900A could render erroneous readings from RFI.[2] The Advisory precipitated public concern over the accuracy of all breath testing equipment—whether manufactured by

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James H. Kaster is a 1979 graduate of Marquette University Law School in Milwaukee, Wisconsin. He is a partner with the law firm of Nichols, Kruger, Starks & Carruthers in Minneapolis, Minnesota, where he practices principally in the area of general criminal litigation. He is also a contributing editor to the Drinking/Driving Law Letter *(Chandler Publishing, Minneapolis, Minnesota).*

**The author gratefully acknowledges the valuable help of Mr. John A. Tarantino, Esq., of Adler, Pollack and Sheehan, Providence, Rhode Island, and Dr. James Feldman, Professor of Electrical and Computer Engineering, Northeastern University, Boston, Massachusetts.*

1. Limited Electromagnetic Interference Testing of Evidential Breath Testers, NHTSA Techincal Report DOTHS-806-400 (May 1983), [hereinafter referred to as the "Final Report"].

2. Smith and Wesson notified its customers in January of 1982 that its Breathalyzer Model 1000 could be affected by RFI, but proclaimed in the same notice that the Models 900 and 900A are "not sensitive to radio frequency interference." Later, in September of 1982, Smith and Wesson issued its "Customer Advisory," which stated that the 900 and 900A could be affected by RFI. Drinking/Driving Law Letter, Vol. 1, No. 20, October 8, 1982 (Chandler Publishing, Minneapolis, Minnesota). Subsequent independent testing illustrated that the 900 was not affected by common levels of RFI, but that the 900A was susceptible.

HOUSE FEDERAL & STATE AFFAIRS
Attachment No. 6A
February 6, 1990

Smith and Wesson or other companies.[3]

NBS in Boulder, Colorado, under contract with the National Highway Traffic Safety Administration (NHTSA), was charged with the responsibility of determining whether RFI could affect the accuracy of all evidential breath testers (EBT's). The NBS tests were to consider the Smith and Wesson Breathalyzer's as well as other brands of breath analyzers on NHTSA's list of qualified products (QPL). The QPL is a list promulgated by NHTSA of "qualified" breath analysis products meeting minimum performance standards. NHTSA stated initially that 28 EBT's would be tested.[4]

Some time after completion of the NBS testing, NHTSA released the "Final Report." To a great extent, the Final Report on the NBS tests was consoling to

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3. A memorandum dated 11/18/82 from James Frank to T.E. Anderson within the Department of Transportation indicates that the National Highway Traffic Safety Administration (NHTSA) was collecting newspaper articles from around the country regarding RFI. Another memorandum from Dr. James Frank to T.E. Anderson dated 11/16/82 indicates NHTSA's concern regarding a Ms. Joan Molillo of ABC News in New York contacting NHTSA about the RFI problem. Finally, the FOIA documents suggest that Mr. Fred Graham from CBS News also inquired about the RFI problem, and sought access to the test data from Boulder, Colorado. All of these inquiries were apparently cause for great concern within NHTSA and NBS.
4. The original description of work set out in the NHTSA-NBS contract, aptly placed under the heading "Work Description" in the contract, calls for the contractor (NBS) to perform electromagnetic interference tests on all 28 devices on the qualified products list. U.S. Department of Transportation, National Highway Traffic Administration, RFP/Contract Continuation Sheet (undated), enclosed with June 10, 1982 letter from the National Bureau of Standards in Washington, D.C. to the U.S. Department of Transportation, National Highway Traffic Safety Administration. Apparently because of malfunctions in 12 of the machines, or because they were unavailable for testing for RFI through the manufacturer's lack of complete cooperation, only 16 machines were eventually tested. There is no full and complete explanation regarding why 12 of the 28 machines were not tested. There has been no disclosure of which machines were not tested.

Postscript:

The States Response to the RFI Problem

In October of 1983, the National Center for State Courts in Williamsburg, Virginia (the Center), published a memorandum[1] (the State Courts' Report) detailing its research on the effects of radio frequency interference (RFI) on evidential breath testers (EBT's), with particular emphasis on the Smith & Wesson Breathalyzer Model 900A. The Center, through the Research and Information Service, conducted a telephone survey (the Survey) encompassing 30 states. The Survey was conducted from September 19 to October 5 of 1983. The states were contacted based on their use of Smith & Wesson Breathalyzers as reported by the National Highway Traffic Safety Administration (NHTSA) and on the basis of both past and pending reports of RFI challenges. The following is a summary of the material gathered from the Survey.

USE OF SMITH AND WESSON BREATHALYZERS AND TESTING FOR RADIO FREQUENCY INTERFERENCE[a]

a All data provided by Dr. Art Flores from a National Highway Traffic Safety Administration survey (1980), unless otherwise noted.

b MN = Testing procedure developed by Minnesota.
S/W = Procedure recommended by Smith and Wesson.
NHTSA = Procedure outlined by National Highway Traffic Safety Administration.
Mod. = Testing agency modified procedure noted.

c Supplementary information provided by state source.

d See text of memorandum for additional information explanation.

State	Predominant Chemical Breath Testing Instrument	Received S/W Advisory	Received NHTSA Advisory	Testing Procedure[b]	Comments
Alaska	900, 900A	Yes	Yes	MN	Intoximeter 3000 is now predominant instrument used[c]
Arkansas	900, 900A, 1000	Yes	Yes	S/W NHTSA	
Colorado	900, 900A, 1000	Yes	Yes	Mod. S/W	Approximately [c] years ago, switched to use of Intoxilyzer[c,d]

1. National Center for State Courts Report Ref. No. RIS 83.112 (October 1983).

FSA 6A-2 2-6-90

the prosecution, and, for the same reason, disconcerting to the defense. While admitting that more than half the machines tested could potentially be affected by RFI, the Final Report called the effect "minimal." It characterized the problem as "rare," and easily rectified where a problem existed. The report also noted that since the laboratory tests were conducted at the relatively high power level of 10 volts per meter, it was, according to the Final Report, "reasonable to assume that the EBT's would be less susceptible to EMI at lower field strengths than those used in these tests." Finally, the report concluded that "it is unlikely that an EBT would be operated at a location that would contain laboratory instruments that could potentially cause EMI."

So much for RFI. The federal government conducted RFI testing and concluded that its effects were "minimal," reportedly affecting less than "1" percent of all machines in use.[5] The tests were conducted on 16 different machines under controlled conditions at NBS's well regarded Boulder laboratory. The results, it would seem, had to be reliable.

B. QUESTIONS ABOUT THE FINAL REPORT

On closer examination, it became apparent that the Final Report itself left something to be desired. The different machines tested in Boulder were not identified by manufacturer; rather they were identified only as machine "A, B, C," etc. It was impossible to determine, therefore, which machines were "potentially" susceptible to RFI and which were not.

The tests results themselves were also difficult to interpret. Only the "average" change from the presence of an electromagnetic field was reported. If, for example, the presence of a field caused the machine to yield a 10% higher result on one test, and a 10% lower result on another, the average of the two tests was zero change: a perfect result. That machine, according to reported data, would show no interference due to electromagnetic interference (EMI).[6]

5. Final Report at "Foreward," p. 1, 2.

District of Columbia	1000	Yes	Yes	Mod. S/W	
Florida	900, 900A	No other information available			
Hawaii	900	No other information available			Switched to CMI Intoxilyzer since survey was conducted
Illinois	1000	Yes	Yes	S/W	
Indiana	900, 900A	Yes	Unknown	Mod. S/W MN[c] NHTSA[c]	
Kentucky	900, 900A	Yes	Yes	Mod. S/W	
Maryland	900, 900A	Yes	Yes	S/W MN NHTSA	
Massachusetts	900, 900A	Yes	Yes	S/W NHTSA	
Michigan	900, 900A	Yes	Yes	MN	
Minnesota	900, 900A	Yes	Yes	MN	Purchase of new instruments pending
Missouri	900	Yes	Yes	Mod. S/W	Alco-Analyzer Gas Chromatograph also in use[c]
Nevada	900A	No other informtion available		S/W[c]	State provided RFI information to local agencies for action at their discretion[c,d]
New Hampshire	900, 900A	Yes	Yes	Mod. S/W	Predominant instrument is new Intoximeter 3000
New Jersey	900, 900A	Yes	Unknown	Mod. S/W	
NEW YORK					
New York City	900A	Yes	Yes	S/W	
Municipalities	900A	Yes	Yes	Mod.S/W	
State Police	900, 900A	Yes	Yes	S/W	
North Carolina	900A, 900[c]	Yes	Yes	S/W	

C. THE FREEDOM OF INFORMATION ACT REQUEST

It was obvious that the data that served as the empirical base for the report might be more informative than the report itself. From confidential sources, the law firm of Nichols, Kruger, Starks & Carruthers, Minneapolis, obtained information that the preliminary data was significantly different than the public position the agency would take in its Final Report. As rumor had it, a "preliminary report" was rejected by NBS headquarters in Gaithersburg, Maryland, as well as NHTSA. So different was the preliminary report from the proposed final report, as the story went, that the NBS scientist in charge of the RFI testing refused to sign the "edited" revisions. On behalf of Chandler Publishing Co., Inc. the law firm of Nichols, Kruger, Starks & Carruthers, Minneapolis sought to recover information from both NBS and NHTSA regarding the RFI tests. That Freedom of Information Act (FOIA) request was designed to determine the truth of these rumors, and to obtain the RFI test preliminary data, including the names of the machines tested. It accomplished that and much more.

The FOIA request sought:

1. Any and all notes, memoranda, preliminary or final reports, or other papers relating to testing of any evidential breath testers (EBT's) for radio frequency interference (RFI) or electromagnetic interference (EMI), which testing was conducted in 1982 or in 1983 under the direction of the National Bureau of Standards (NBS) or the National Highway Traffic Safety Administration (NHTSA), or both.

2. Any and all written correspondence between the NBS, or any of its agents,

6. The original data which served as the basis for the final report contains specific information on how each machine tested performed on each RFI test. See text accompanying FN. 15 infra.

7. Amended Freedom of Information request dated May 20, 1983. The original FOIA request was mailed out December 10, 1982. On April 11, 1983, a lawsuit was filed in United States District Court, District of Minnesota, entitled *Kaster vs. National Bureau of Standards and National Highway Traffic Safety Administration.* (D.C. File No. 3-83-456.)

North Dakota	900, 900A	Yes	Yes	Mod.S/W	
Ohio	900, 900A 1000	Yes	No	Mod. NHTSA	Extensive testing regimen developed and conducted on all units[c,d]
Oklahoma	900, 900A	Yes	Yes	None	
Pennsylvania	900	No other information			Some S/W 1000s in use. S/W tested some machines[c,d]
Rhode Island	900 2000[c]	No	No	S/W	900As removed from service 1000s decertified, state developed additional guidelines[c,d]
South Carolina	900A	Yes	Yes	S/W	
Texas	900, 900A	Yes	Yes	Mod. MN	State developed testing procedures; Intoxilyzer 4011 only instrument now in use[c,d]
Utah	900, 900A	Yes	No	S/W[c]	Switching to Intoxilyzers[c]
Virginia	900A	Yes	Yes	Mod.S/W	
Washington	900, 900A	Yes	Yes	S/W Mod. MN	Currently considering purchase of other instruments[c]
West Virginia	900, 1000	Yes	Yes	Mod. S/W	
Wisconsin	900, 1000	Yes	Yes	S/W NHTSA	
Wyoming	900, 900A	Yes	Yes	S/W Mod. NHTSA	

It appears that none of the states surveyed followed the recommendations made in the Adams Report[2] to rectify potential RFI problems. Rather, most states merely used the procedures outlined in the Final Report[3] or the criteria set forth in Smith & Wesson's Customer Advisory (the Advisory)[4] for suggested

2. Preliminary Report of the National Bureau of Standards on the effects of radio frequency interference on evidential breath testers.
3. Final Report of the National Bureau of Standards on the effects of radio frequency interference on evidential breath testers.
4. Smith & Wesson Customer Advisory "Guidelines for Radio Frequency Interference Testing" (September 10, 1982).

and the NHTSA, or any of its agents, regarding testing conducted in 1982 or in 1983 under the direction of the NBS or the NHTSA, or both.[7]

From the outset, however, it was apparent that recovering the information was not going to be easy. One of the administrative appeals within NHTSA was partially denied by a person whose title was "Associate Administrator for Administration." The position title alone indicated that this was the quintessence of Bureaucracy. The bureaucracy was operating like Newton's rules of physics—"things inert tend to stay inert." The bureaucracy would not give in easily. Throughout the administrative appeals process, none of the key documents were released.

1. Who Conducted These RFI Tests Anyway?

After exhaustion of administrative remedies, an action was filed in Federal District Court in Minneapolis against both agencies. At the time the action was filed, neither the supposed "preliminary report" nor the identity of the machines tested was disclosed. The pressures of litigation eventually came to bear, however. Through settlement efforts with the United States Attorney's Office for the District of Minnesota, the agencies released the sought-after information.[8] Along with it, other information was released which revealed the incomplete nature of the Final Report. The information released in the FOIA action will be hereinafter collectively referred to as the "FOIA documents." The FOIA documents revealed that Mr. John Adams, original author of a "preliminary report," had in fact refused to sign the edited version.[9] Adams' preliminary report went through two complete revisions. The first was done by NBS in Gaithersburg, the second by NHTSA. Adams' name does not appear on either report, and FOIA documents confirm

8. Along with stipulation for compromise and settlement between the parties in *Kaster v. NBS*, (D. Minn. File 3-83-456) the defendant agencies agreed to pay the plaintiff's attorney's fees.
9. Memorandum from Raymond A. Peck, Jr. to the "Secretary" within NHTSA dated April 28, 1983.

RFI testing. The Advisory's test protocol (the "Advisory Protocol") focused on "Background RFI," "Base station RFI" and "Mobile and Hand-held Transmitter RFI." The Advisory acknowledges that the purpose of the suggested tests is to determine "possible interference by steady source radio frequency energy originating from such sources as AM-FM radio stations, TV broadcasts, military installations, etc."[5] (Background RFI); to "determine possible interference by radio frequency energy originating from base station transmitters"[6] (Base station RFI); and finally, to determine possible interference by radio frequency energy originating from mobile and hand-held transmitters.[7] (Mobile and hand-held transmitter RFI).

The Advisory further acknowledges that if background RF energy exists in the test environment, the normal movement of a person or persons in close proximity to the Breathalyzer during the test "may produce reflections of the radio frequency field."[8] The Advisory suggests that "in order to simulate the variations affecting the instrument under these conditions, the instrument is tested in each of four positions."[9] The Advisory Protocol does not subject the Breathalyzer to specified RF sources; rather, it is a "hit or miss" testing method. As such, its scientific reliability is both questionable and suspect. Moreover, the Advisory Protocol differs substantially from the Adams Report and its recommended on-site testing of RFI. Absent use of the near field probes recommended in the Adams Report, it is difficult, if not impossible to determine what RF problems exist with particular EBT's, where those devices are situated in the law enforcement environment. The Advisory Protocol also fails to take into account the problem with resonances[10] referred to in the Adams Report. None of the states included in the State Courts' Report even mentions testing for resonances.

Based on the testing recommendations made in the Adams Report, one can conclude that the Advisory Protocol is an incomplete and perhaps inaccurate testing method for RFI. Despite the apparent scientific problems with the Advisory Protocol, states have tested and are continuing to test for RFI solely on that basis. As a result, rather than substantiating the "rare" problem in EBT's, the State Courts' Report merely demonstrate that the Advisory Protocol fails to *detect* RFI problems.

The recommendations made in the Adams Report indicate that current testing done by the states for RFI is inadequate, incomplete and possibly scientifically unsound. If the states are going to test for RFI, in fairness to alleged drunk drivers, a much more reliable method of testing must be used. The State Courts' Report concludes by stating that "[a]lthough defense attorneys repeatedly have raised RFI as an issue at trial, states have generally defended such challenges successfully through the presentation of expert testimony that *explains* the RFI testing procedures."[11] (Emphasis added). The testing procedures outlined in the Final Report and those advanced in the Advisory Protocol may not yield scientifically acceptable results; each will, however, routinely win convictions.

5. *Id.* at 4.
6. *Id.* at 7.
7. *Id.* at 12.
8. *Id.* at 4.
9. Id.
10. The Breathalyzer and its component parts represent a system of electromagnetically resonant structures. As a resonant structure, the Breathalyzer stores energy and, therefore, at particular field strengths and frequencies the Breathalyzer will have a reaction to electromagnetic interference.
11. Note 1 *supra.*

FSA
6A-5
2.6.90

that he refused to sign the first edited version.[10]

Thus, the Final Report suffers from the most ironic and basic of flaws. The scientist in charge of testing, whose research served as the report's empirical base, refused to claim it. The "Acknowledgments" portion of the Introduction to the Final Report states merely: "The experimental test program was developed and laboratory tests were performed by staff members of the NBS Electromagnetic Fields Division."[11] Even more ironic is the Final Report's claim that "technical assistance" was provided by Dr. Art Flores of the Transportation Systems Center (TSC). Flores himself has publicly acknowledged his own lack of competence in the RFI area;

> Defense Counsel: Do you consider yourself an expert in radio frequency interference?
>
> Dr. Art Flores: No
>
> Defense Counsel: Electromagnetic interference?
>
> Dr. Art Flores: No.[12]

Without Adams support, the technical expertise for the conclusions in the Final Report presumably came from Flores. Flores himself disclaimed expertise in the relevant areas. The likely conclusion is that the Final Report lacks the support of a competent scientific expert.

2. The Revelations of the "Adams Report"

The preliminary report [hereinafter "Adams Report"] was also released with the FOIA documents. It was strikingly different from the Final Report both in style and in content. The stylistic difference is the first thing that catches the eye. The Adams Report is eleven pages long, simple in language and logic. The final report is thirty-three pages, qualified by confused and technical language. The Adams Report contains no adjectives like "minimal effect." Nowhere in the Adams Report is there any language or data which suggests that the RFI problem should be taken lightly. Specific differences between the Adams Report and other FOIA documents and the Final Report will be discussed in more detail later.

D. THE PUBLIC IS GIVEN A "PRESS RELEASE"

Along with the Final Report, NHTSA mailed out a press release informing the world of the results of its RFI testing. This press release, like the Final Report, minimized the RFI problem. Like the Adams report, an earlier "draft" press release is remarkably different from the final press release.

On April 25, 1983, NBS in Gaithersburg, Maryland, through Mr. Marshall Treado, submitted a draft press release to NHTSA for "immediate release." The draft press release was entitled:

NBS STUDY CONFIRMS RADIO INTERFERENCE CAN AFFECT BREATH ALCOHOL TEST DEVICE READINGS

The draft press release continued: "Electromagnetic interference from police radio transmitters can cause some breath alcohol devices to give inaccurate readings, according to a report prepared for the National Highway Traffic Safety Administration by the Commerce Department's National Bureau of Standards." The unreleased draft continues: [T]he errors caused by radio frequency interference probably represent potential problems that could be encountered when (the EBT's are) subjected to similar conditions."

The final edited version of the NHTSA press release, dated May 24, 1983, took a quite different approach. The released press statement was captioned:

STUDIES SHOW POLICE RADIO INTERFERENCE WITH BREATH TEST DEVICES CAN BE AVOIDED

The press release continued. "Breath test devices used by police in drunk driving investigations are not significantly affected by interference from police radio signals, under proper operating conditions, the National Highway Traffic Safety Administration (NHTSA) said today."

There is no indication in any of the documents that these two press releases were based upon one piece of additional or different information. Rather, they represent different "interpretations" of the same information; the NHTSA press release taking a dramatically more pro-prosecution approach.

E. THE FINAL REPORT vs. THE PRELIMINARY DATA

1. Identifying the Machines

There are some other dramatic differences between the FOIA documents, including the Adams Report and NHTSA's "Final Report." First, the Final Report used code names for the manufacturers' machines. The FOIA documents revealed the actual machines tested. The final report contained the graphic summary of the test results shown in Figure 1.[13]

Through the FOIA litigation, the identity of the sixteen machines by NBS was disclosed. Those machines were identified as follows:

Code Letter	Instrument
A	Alert J3AC
B	Breathalyzer 900A
C	Breathalyzer 900
D	Intoxilyzer 4011 AW
E	Intoxilyzer 4011 AS
F	Intoxilyzer 4011 AS-A
G	Intoxilyzer 4011 A
H	Intoxilyzer 4011 (Omicron)
I	Alco Senser III
J	Intoximeter 3000
K	Intoxilyzer 4011 (CM)
L	Mark IV GC
M	Mark II GC
N	Breathalyzer 2000
O	Breathalyzer 1000
P	Alco Tester 500

Using the chart from the Final Report and the code translation revealed in the FOIA litigation, the test results can now be openly interpreted.[14]

10. *Id.*
11. Final Report at p. ii.
12. Trial testimony of Dr. Arthur Flores in *Heddan vs. Dirswager*, 336 N.W.2d 54 (1983).
13. *Drinking/Driving Law Letter*, Vol. 2, No. 17, p. 1, (Chandler Publishing, August 19, 1983).
14. *Id.*

FSA
6A-6
2-6-90

Unit	46 MHz	160 MHz	160 MHzV	460 MHz	850 MHz
A	0[a]	0	0	S[b]	0
B	S	S	S	0	0
C	0	0	0	0	0
D	0	0	0	0	0
E	0	0	0	0	0
F	0	0	0	S	0
G	0	0	0	0	0
H	??	S	NR	NR	0
I	0	0	0	0	0
J	0	0	0	0	0
K	??	NR	NR	NR	NR
L	0	S	S	S	S
M	S	S	S	0	0
N	0	0	–	S	S
O	NR	NR	–	NR	S
P	S	S	S	0	S

[a] Measurements made at 40 MHz.
[b] Measurements made at 410 MHz.

NOTES:

0 – The average reading of five alcohol vapor samples in the presence of EM fields was within ±5 percent of the average of five readings without a field, and a standard deviation was less than 0.0042.

?? – Unit showed small but measurable change in the average alcohol vapor reading or a small increase in the standard deviation of the reading in the presence of EM fields. (0.0042 SD 0.008)

S – The average reading of five alcohol vapor samples in the presence of EM fields differed from the average of five readings without a field by more than ±5 percent or the unit showed large variability in measured alcohol concentration in the presence of EM fields. (SD 0.008)

NR – Unit ceased operation, blanked display, or gave an error flag in the presence of EM fields.

FIGURE 1.

The FOIA documents also contain Adams' original data, which was summarized by computer printout. While too lengthy to summarize, the computer data is more useful than the Final Report since it contains data on how particular machines performed on individual tests, instead of merely using averages of several tests.[15]

2. NBS Interprets the Test Results

Another problem with the Final Report is interpreting the code summaries of test results. Even with the paragraph summaries of the meaning of "NR" and "??" from the Final Report, it is difficult to determine their significance. Another FOIA document obtained from NBS in Gaithersburg contains more "earthy" descriptions of the test results (see Figure 2).

As far as interpreting test results, one final difference should be noted between

FIGURE 2.

		Gaithersburg			Boulder	
A	(Alert J3AC)	Good	1		Good 460 Only	
B	(Breathalyzer 900A)	Bad	1	1	Bad	1
C	(Breathalyzer 900)	Good			Good	
D	(Intoxilyzer 4011 AW)	Good			Good	
E	(Intoxilyzer 4011 AS)	Good			Good	
F	(Intoxilyzer 4011 AS-A)	Bad			Good 460 only	
G	(Intoxilyzer 4011 A)	Good			Good	
H	(Intoxilyzer 4011 [Omicron])	Bad	1	1	Bad	1
I	(Alco Senser III)	Good			Good	
J	(Intoximeter 3000)	Good			Good	
K	(Intoxilyzer 4011 [CM])	Bad	1	1	Bad	1
L	(Mark IV GC)	Bad	1	1	Bad	1
M	(Mark II GC)	Bad	1	1	Bad	1
N	(Breathalyzer 2000)		1	1	B – 2000 "borderline"	1
O	(Breathalyzer 1000)	Bad	1	1	Bad B –1000	1
P	(Alco Tester)	Bad	1	1	Bad	1
16		n = 10		8		n = 8[16]

15. The original data can be obtained by contacting Chandler Publishing Company, P.O. Box 2153 Loop Station, Minneapolis, Minnesota 55402, telephone 612/338-8589.

FSA
6A-7
2-6-90

the Final Report and the Adams Report. The Final Report states that since the testing was conducted at 10 volts per meter, it is logical to assume that the machines would perform more accurately at lower power levels. The Adams report takes a contrary position. Adams states that: "These results *cannot* be extrapolated to predict how individual EBT's would be affected at other levels of field strengh or at other frequencies."[17]

F. WHAT SHOULD BE DONE ABOUT THIS RFI PROBLEM

To remedy this "rare" RFI problem, the Final Report recommended that each state test its EBT's for RFI following a videotape procedure sent by NHTSA to each state's Highway Safety Representative. NHTSA recommended that states *should* conduct such tests, but were not required to do so. This recommendation is the only affirmative remedial step recommended by NHTSA in its Final Report.

There are many other ways to deal with the problem—some more exhaustive and scientifically acceptable than the Final Report recommendation. Each will be reviewed here.

1. Should the Qualified Products List be Amended?

At the time the tests for RFI were undertaken, a suggestion was made that the QPL (Qualified Products List) would have to be amended to adopt standards for RFI. The QPL is a performance standard published by NHTSA setting out minimum acceptable performance levels for EBT's. In fact, the contract under which the RFI tests were conducted states: "The most recently amended QPL for evidential breath test devices was published in the Federal Register on March 23, 1982. It now appears those existing standards may need to be revised."[18] There is no suggestion in the Final Report that there will be any amendment of the qualified products list in order to require standards for RFI immunity.

2. Should a Modification Be Proposed?

There is continuing reference in the FOIA documents to a proposed modification of EBT's which would make them impregnable to common levels of RF. One particular memorandum confirms that the equipment "can be modified to reduce or eliminate electromagnetic susceptibility." That memorandum goes on to suggest internal shielding indoor filters to reduce EM (electro magnetic) susceptibility to an acceptable threshold, or as an alternative, "internal fuses that would alert the user that EMI (electro magnetic interference) is occurring."[19] Another proposed alternative would be to modify the room in which the machine is located, using shielding or other devices which reflect RF.[20]

No recommendation for a proposed modification can be found in the Final Report. The Final Report says merely: "It is unlikely that an EBT would be operated at a location that would contain laboratory instruments that could potentially cause EMI."[21]

3. What RFI Tests Should be Conducted by the States?

The Adams Report makes very specific recommendations for future efforts needed by states and manufacturers to rectify potential RFI. Tests, according to the Adams Report, must be conducted to determine: "(1) What field strength levels (EM environment) exist around law enforcement agencies where EBT's are used. (2) How can EBT's be tested to determine whether they can operate in an EM environment around law enforcement agencies."

The Adams Report makes the strong suggestion that near field instrumentation that utilize "isotropic, broad band probes" are commercially available and should be obtained. The Adams Report says further: "These should be evaluated to determine if they are suitable and reliable for this type of measurement environment. If one or more are satisfactory, these could be a useful tool for states or law enforcement agencies to use in evaluating their operational sites and present EBT's."[22]

The Adams Report implies that on-site testing of RFI, such as that recommended by NHTSA in the Final Report, is not effective without near field probes. A probe is a measuring device for determining what level of RF problems exist in a certain law enforcement environment.

The FOIA documentation confirms the agencies' own doubts about the validity of on-site testing without the use of near field probes. Without near field probes, the documents reveal that one "doesn't know what field strength the equipment is exposed to."[23] That same document goes further and states that "without proper near field probes" . . . the tests are "probably not valid."[24]

The Final Report recognizes the value of near field instrumentation to determine the exact level of EM fields. That report states: "[N]ear field probes are the key to making accurate EMI measurements on EBT's. The probes have a broad band, isotropic nonperturbing response. With this instrumentation, it is possible to:

1. Measure the levels that characterize the appropriate EM environment;
2. Set up test fields; or,
3. Detect resonances."[25]

Nevertheless, there is no recommendation in the Final Report that individual states conduct testing using near field probes.

(continued on page 30)

16. The graphic description of the test results from the text may in fact indicate that NBS in Gaithersburg conducted its own RFI tests which illustrated that 10 of the 16 machines were susceptible to RFI, not 9 of the 16 machines as indicated by earlier testing. There is no other documentary support in the FOIA Documents for the existence of independent tests conducted by NBS in Gaithersburg.
17. Effects of Electromagnetic Fields on Evidential Breath Testers by John W. Adams, Electromagnetic Fields Division, National Bureau of Standards, Boulder, Colorado (undated). [Hereinafter "The Adam's Report"], at 8.
18. U.S. Department of Transportation, National Highway Traffic Administration, RFP/Contract Continuation Sheet (undated), enclosed with June 10, 1982 letter from National Bureau of Standards in Washington, D.C. to the U.S. Department of Transportation, National Highway Traffic Safety Administration.
19. Unidentified memorandum outlining "Approaches to Problem."
20. *Id.*
21. Final Report at 4.
22. Adams Report at 8.
23. Unidentified handwritten notes.
24. *Id.*

FSA
6A-8
2-6-90

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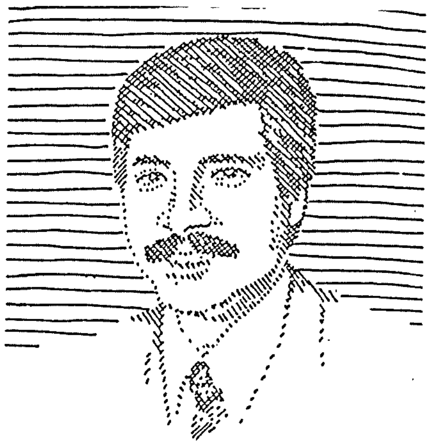


by John Tarantino

This month's column examines an interesting analysis of the accuracy of the breath alcohol test results. Dr. James Woodford, an NACDL member, has obtained good results both in the laboratory and in the courtroom using a technique known as the respiral breath test.

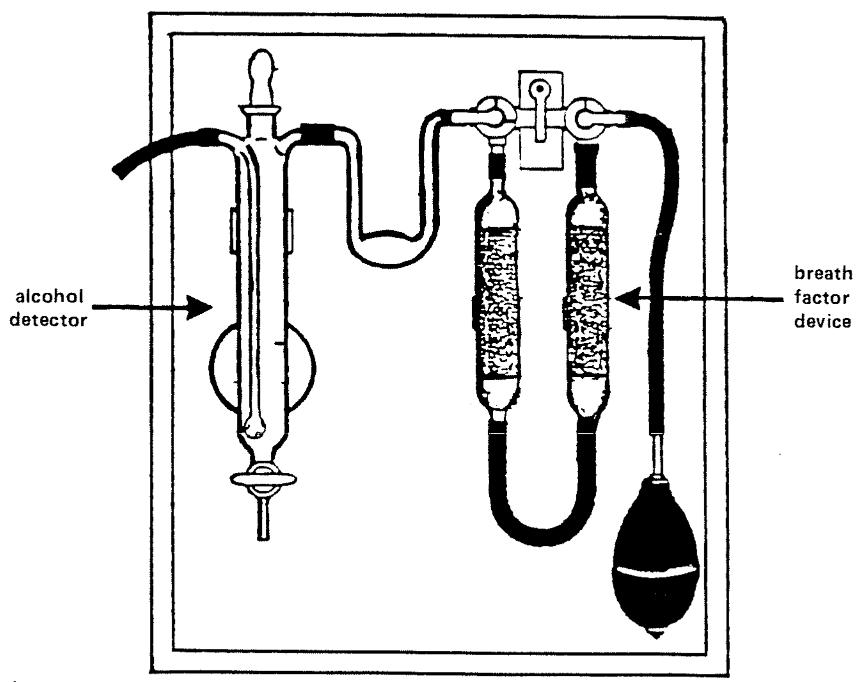
All breath alcohol testing devices are calibrated to the standard breath factor of 2100 to 1. This means that the breath alcohol testing devices assume that each person will have 2100 times as much alcohol in his blood as in his breath. Therefore, the machines are factory calibrated to multiply the breath reading by 2100 to obtain a blood alcohol content. As most DWI defense attorneys know, however, an individual's actual blood-breath ratio can be far different than the 2100 to 1 calibrated into the machines. Actual ranges in blood-breath ratios have been reported from 1004 to 1 to 7289 to 1. *See* Frajola and Tarantino, *Defending Drinking Drivers*, Section 13, page 43 (James Publishing 1984) for a discussion of the blood-breath deviations and reported blood-breath alcohol ratios.

To help in understanding the problem in the 2100 to 1 ratio, Dr. Woodford has differentiated between two type breathers: "thick breathers" who exhale more alcohol and "thin breathers" who exhale less alcohol. The 2100 to 1 blood-breath ratio is, therefore, a mathematical average between the "thick breathers" and "thin breathers." Since the 2100 to 1 ratio is merely a mathematical average between the "thick breathers" and the "thin breathers" and each breath testing machine, no matter who manufactures it, is based on that average, if the Defendant's normal breath ratio is greater or less than 2100 to 1, the blood breath ratio must be adjusted accordingly. That adjustment, which should take into account the individual's blood-breath ratio, will either raise or lower the final readout from the breath alcohol testing machine. According to Dr. Woodford, the respiral breath test, which can be conducted anytime, either before or after the arrest, can determine whether the Defendant is a "thick breather" or a "thin breather" and can then adjust for that difference thereby eliminating the machine's bias.

The respiral breath test is important in interpreting breath test results. The original breath alcohol analyzers consisted of a breath sampling chamber which was fitted with an alcohol detector. The problem with these early breath analyzers was that the data obtained were o unreliable because the alcohol detectors could not differentiate between the thick and thin alcohol breathers. According to Dr. Woodford, researchers soon discovered way to correct test results: "Since the carbon dioxide content of alveolar air (deep lung expelled air) is constant, this gives a means of estimating the alveolar alcohol in any sample of breath." *73 Science* 1892, page 10 (1931). The early researchers then described the device shown in illustration 1 below as a means of determining any person's actual blood-breath ratio along with the alcohol detection step.

This method gained court acceptance because it allowed the police officer or testing official to correct any alcohol measurement to the Defendant's actual blood-breath ratio. The problem with that particular testing process was that it

Illustration 1



Device for Simultaneous Determination of Alcohol and Breath Factor

HOUSE FEDERAL & STATE AFFAIRS Attachment No. 6B February 6, 1990

Table 1

Breath Factors and Their Corresponding Constants

FACTOR	CONSTANT	FACTOR	CONSTANT	FACTOR	CONSTANT	FACTOR	CONSTANT	FACTOR	CONSTANT	FACTOR	CONSTANT
1000	0.476190	2275	1.083333	3550	1.690476	4825	2.297619	6100	2.904762	7375	3.511905
1025	0.488095	2300	1.095238	3575	1.702381	4850	2.309524	6125	2.916667	7400	3.523810
1050	0.500000	2325	1.107143	3600	1.714286	4875	2.321429	6150	2.928571	7425	3.535714
1075	0.511905	2350	1.119048	3625	1.726190	4900	2.333333	6175	2.940476	7450	3.547619
1100	0.523810	2375	1.130952	3650	1.738095	4925	2.345238	6200	2.952381	7475	3.559524
1125	0.535714	2400	1.142857	3675	1.750000	4950	2.357143	6225	2.964286	7500	3.571429
1150	0.547619	2425	1.154762	3700	1.761905	4975	2.369048	6250	2.976190	7525	3.583333
1175	0.559524	2450	1.166667	3725	1.773810	5000	2.380952	6275	2.988095	7550	3.595238
1200	0.571429	2475	1.178571	3750	1.785714	5025	2.392857	6300	3.000000	7575	3.607143
1225	0.583333	2500	1.190476	3775	1.797619	5050	2.404762	6325	3.011905	7600	3.619048
1250	0.595238	2525	1.202381	3800	1.809524	5075	2.416667	6350	3.023810	7625	3.630952
1275	0.607143	2550	1.214286	3825	1.821429	5100	2.428571	6375	3.035714	7650	3.642857
1300	0.619048	2575	1.226190	3850	1.833333	5125	2.440476	6400	3.047619	7675	3.654762
1325	0.630952	2600	1.238095	3875	1.845238	5150	2.452381	6425	3.059524	7700	3.666667
1350	0.642857	2625	1.250000	3900	1.857143	5175	2.464286	6450	3.071429	7725	3.678571
1375	0.654762	2650	1.261905	3925	1.869048	5200	2.476190	6475	3.083333	7750	3.690476
1400	0.666667	2675	1.273810	3950	1.880952	5225	2.488095	6500	3.095238	7775	3.702381
1425	0.678571	2700	1.285714	3975	1.892857	5250	2.500000	6525	3.107143	7800	3.714286
1450	0.690476	2725	1.297619	4000	1.904762	5275	2.511905	6550	3.119048	7825	3.726190
1475	0.702381	2750	1.309524	4025	1.916667	5300	2.523810	6575	3.130952	7850	3.738095
1500	0.714286	2775	1.321429	4050	1.928571	5325	2.535714	6600	3.142857	7875	3.750000
1525	0.726190	2800	1.333333	4075	1.940476	5350	2.547619	6625	3.154762	7900	3.761905
1550	0.738095	2825	1.345238	4100	1.952381	5375	2.559524	6650	3.166667	7925	3.773810
1575	0.750000	2850	1.357143	4125	1.964286	5400	2.571429	6675	3.178571	7950	3.785714
1600	0.761905	2875	1.369048	4150	1.976190	5425	2.583333	6700	3.190476	7975	3.797619
1625	0.773810	2900	1.380952	4175	1.988095	5450	2.595238	6725	3.202381	8000	3.809524
1650	0.785714	2925	1.392857	4200	2.000000	5475	2.607143	6750	3.214286	8025	3.821429
1675	0.797619	2950	1.404762	4225	2.011905	5500	2.619048	6775	3.226190	8050	3.833333
1700	0.809524	2975	1.416667	4250	2.023810	5525	2.630952	6800	3.238095	8075	3.845238
1725	0.821429	3000	1.428571	4275	2.035714	5550	2.642857	6825	3.250000	8100	3.857143
1750	0.833333	3025	1.440476	4300	2.047619	5575	2.654762	6850	3.261905	8125	3.869048
1775	0.845238	3050	1.452381	4325	2.059524	5600	2.666667	6875	3.273810	8150	3.880952
1800	0.857143	3075	1.464286	4350	2.071429	5625	2.678571	6900	3.285714	8175	3.892857
1825	0.869048	3100	1.476190	4375	2.083333	5650	2.690476	6925	3.297619	8200	3.904762
1850	0.880952	3125	1.488095	4400	2.095238	5675	2.702381	6950	3.309524	8225	3.916667
1875	0.892857	3150	1.500000	4425	2.107143	5700	2.714286	6975	3.321429	8250	3.928571
1900	0.904762	3175	1.511905	4450	2.119048	5725	2.726190	7000	3.333333	8275	3.940476
1925	0.916667	3200	1.523810	4475	2.130952	5750	2.738095	7025	3.345238	8300	3.952381
1950	0.928571	3225	1.535714	4500	2.142857	5775	2.750000	7050	3.357143	8325	3.964286
1975	0.940476	3250	1.547619	4525	2.154762	5800	2.761905	7075	3.369048	8350	3.976190
2000	0.952381	3275	1.559524	4550	2.166667	5825	2.773810	7100	3.380952	8375	3.988095
2025	0.964286	3300	1.571429	4575	2.178571	5850	2.785714	7125	3.392857	8400	4.000000
2050	0.976190	3325	1.583333	4600	2.190476	5875	2.797619	7150	3.404762		
2075	0.988095	3350	1.595238	4625	2.202381	5900	2.809524	7175	3.416667		
2100	1.000000	3375	1.607143	4650	2.214286	5925	2.821429	7200	3.428571		
2125	1.011905	3400	1.619048	4675	2.226190	5950	2.833333	7225	3.440476		
2150	1.023810	3425	1.630952	4700	2.238095	5975	2.845238	7250	3.452381		
2175	1.035714	3450	1.642857	4725	2.250000	6000	2.857143	7275	3.464286		
2200	1.047619	3475	1.654762	4750	2.261905	6025	2.869048	7300	3.476190		
2225	1.059524	3500	1.666667	4775	2.273810	6050	2.880952	7325	3.488095		
2250	1.071429	3525	1.678571	4800	2.285714	6075	2.892857	7350	3.500000		

was time consuming. According to Dr. Woodford, the operation of the breath factor required approximately 25 minutes of sampling, testing and calculating before the breath test report could be finalized. Contrast that time commitment with the 60 seconds it takes for the actual alcohol detection.

Efforts then were focused on economizing the testing procedures. By the 1950s, experiments had shown an average blood-breath ratio of approximately 2000 to 1. This 2000 to 1 ratio eventually won acceptance by the "economy minded" branch of the scientific community. *See Public Health Reports*, Volume 75, No. 5 (1958). The 2000 to 1 blood-breath ratio became law in 1958, but was amended in 1973 to the current 2100 to 1 ratio. *See Federal Register*, November 5, 1973, page 30,459. With the acceptance of the 2100 to 1 blood-breath ratio, the breath factor attachment became unnecessary. All machines manufactured after 1973 were calibrated to the 2100 to 1 ratio. As pointed out by critics of the 2100 to 1 ratio, including Dr. Woodford, the only time the 2100 to 1 ratio is proper is when the person being tested actually conforms to that ratio. Many clinicians, including those highly respected in the blood alcohol analysis field, have questioned the 2100 to 1 blood-breath ratio. *See* Mason and Dubowski, "Breath-Alcohol Analysis: Uses and Methods and Some Forensic Problems" 21 *J. Forensic Science* 9-41 (1976). The 2100 to 1 ratio is particularly disturbing because of the new .10 per se laws. If a person is a "thick breather," a 2100 to 1 ratio will compute alcohol levels too high and persons with blood alcohol contents below .10 may be found guilty under the per se laws. Dr. Woodford gives the following examples of how respiral testing of persons who have failed two or more breath alcohol tests actually revealed they were "thick breathers" whose factors measured lower than 2100 to 1.

Example: On a 2100 to 1 calibrated machine, a woman given a breath alcohol test registered 0.12 mg. percent alcohol content. In those per se jurisdictions, if the breath test was admitted into evidence, the woman would be found guilty. The woman then obtains a respiral breath test to determine her individual blood-breath ratio. The respiral test is given and the woman's blood-breath ratio is found to be 1475 to 1. Using Table 1, she then can determine her corresponding constant for 1475, which is 0.70. Using the original 2100 to 1 blood-breath ratio, coupled with her individual breath factor constant, allows the following correction calculation which arrives at her true breath alcohol readout: 0.12 mg. % x 0.70 = 0.08 mg. %. Under this analysis she may be found not guilty of driving under the influence.

The respiral test works both ways, however. As another example, a man whose breath factor is 3150 to 1 may be actually intoxicated to the 0.12 mg.% level, yet show only a 0.08 mg.% on those breath alcohol devices calibrated to 2100 to 1.

The argument is often made by law enforcement officials that the 2100 to 1 blood-breath ratio benefits 86 percent of the population. That may be true; however, the 14 percent of the population who are disadvantaged may take issue with that statement. What is important is that the criminal law must treat an individual as an *individual* and not merely as an *average person*. The respiral breath test allows the individual to be treated as an individual. The additional time involved is well worth the peace of mind in knowing that our criminal laws are treating individuals fairly. The respiral breath test allows for independent testing conducted at any time either prior to or after the offense. For those attorneys representing Defendants in "borderline" cases, it may be worthwhile to consult an expert about the respiral breath test. For more details Dr. Woodford can be contacted at Web of Research, P.O. Box 5437, Atlanta, Georgia 30307, (404) 373-5939.

Next month: Some recent DWI cases.

Wilkesworld

continued from page 40

The Croats were in shock. They didn't know how to react. Insult humor had not yet come into vogue in the fashionable nightclubs and the Croats were totally unprepared for it in a luncheon speaker.

But Wilkes was only warming up. Grinning evilly, he continued, "I heard the women of this city recently quit using vibrators." Wilkes paused to scan the audience, then served up the punch line: "Too many chipped teeth."

I cringed. That ought to do it. But no! A few Croats chuckled, as did a few reporters.

"And do you people know what they call a Puerto Rican with a vasectomy?" Wilkes continued. "A dry Martinez." More laughs.

On it went. The more ethnic groups, religions, races, creeds, and political parties Wilkes slandered, the more laughs he got, the Croats loved it. And when he ran out of those jokes, he resorted to the vulgar ("What's green and flies over Germany?—Snatzis"). To no avail. The more he tried, the more he failed. He was a huge success.

Lube job

A week before the election, despite his harikari attempt, Wilkes pulled even with Junior in the polls. Junior and the politicos panicked. They challenged Wilkes to a debate on election eve. We couldn't believe it. Wilkes quickly called a press conference to announce his acceptance.

"God! I feel great," he said to the assembled news boys. "My hangover's in remission, business is booming, and Junior wants to debate. I accept on behalf of the cash-poor lawyers of this city."

One of the paper boys asked what the hell he meant by that and Wilkes answered, "Junior's got a reputation in the civil court as being serviceable, which means if a lawyer greases him he gets a Cadillac for a result instead of an Edsel. It's called a 'lube job' in the trade—you pull into chambers and Junior holds out his hand and says 'fill er up.' "

"So why are you accepting on behalf of lawyers tight on cash?"

"Because we need to know if the scumbag takes BankAmericard."

NEXT ISSUE: Election Week

Science, the Intoxilyzer, and Breath Alcohol Testing

by Ken Smith, Ph.D.

Part I

Introduction

Breath-alcohol testing and its application in law enforcement are central to the litigation of alcohol-intoxication-related offenses. The proliferation of per se statutes has considerably augmented the importance of breath-alcohol-test evidence. Presentation of breath-test evidence raises questions on the definition of intoxication, relevance of a breath test to evaluate intoxication, design and operation of the analytical instrument used, and application of fundamental scientific principles in forensic practice.

History of Intoxication Standards

With widespread private ownership of the automobile in the 1920's, auto accidents became an everyday occurrence, and a substantial connection between automobile accidents and alcohol[1] consumption by motorists[2] became apparent. Litigation of driving-while-intoxicated (DWI) cases required quantification of the relationship between alcohol consumption and motor-vehicle operation. In 1936, the National Safety Council (NSC) formed the Committee on Tests for Intoxication[3] to study means for ascertaining an individual's degree of intoxication. The NSC Committee and the Committee on Medicolegal Problems, established by the American Medical Association (AMA), have assembled much of the information used by legislators to establish criteria for the legal definition and forensic determination of intoxication.

The 1938 report of the AMA Committee for Medicolegal Problems adopted the definition of intoxication used by the Arizona courts at that time:

> The phrase "under the influence of intoxicating liquor" covers not only the well-known and easily recognized conditions and degrees of intoxication, but also any abnormal mental or physical conditions which is the result of indulging in any degree in intoxicating liquors and which tends to deprive the driver of that clearness of intellect and control of himself which he would otherwise possess. If the ability of a driver of an automobile has been lessened in the slightest degree by the use of intoxicating liquors, then that driver is deemed to be under the influence of intoxicating liquor. The mere fact that the driver of an automobile has taken a drink does not place him under the ban of the statute, unless such drink has some effect upon him, lessening in some degree his ability to handle said automobile.[4]

The Committee on Medicolegal Problems made the following recommendations, which were adopted both by the House of Delegates of the American Medical Association and (in similar form) by the National Safety Council:

> 1. [P]ersons with a concentration of alcohol of less than 0.05 percent w[eight]/v[olume] (50 milligrams/100 milliliters) in blood or its equivalent in urine, saliva or breath should not be prosecuted for driving while under the influence of alcoholic liquor.
> 2. All persons show a definite loss of that clearness of intellect and control of themselves which they would ordinarily possess when the concentrations are above 0.15 percent w/v (150 mg/100 ml) in the blood or its equivalent in other body fluids or breath and should, therefore, be considered as [sic] under the influence.
> 3. When the alcohol concentrations are between 0.05 percent w/v (50 mg/100 ml) and 0.15 percent w/v (150 mg/100 ml) in the blood, a great many of the persons will be under the influence of alcohol, but the committee recommends prosecution only when the circumstances and results of physical examination give definite confirmation of such influence.[5]

By 1962, thirty-six states had enacted chemical-test laws;[6] in some instances the

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Dr. Ken Smith, of Rice University, is a frequent lecturer on the Intoxilyzer and is a recognized expert witness on its use in DWI criminal proceedings.

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1. There are many different alcohols. In this article, "alcohol" refers to ethyl alcohol (ethanol), which is the alcohol present in beer, wine, and distilled liquors.
2. *See* Mason & Dubowski, *Alcohol, Traffic, and Chemical Testing in the United States: A Resume and Some Remaining Problems*, 20 CLINICAL CHEMISTRY 126, 127 (1974).
3. This committee was later incorporated into the National Safety Council's Committee on Alcohol and Drugs. Mason and Dubowski, *Breath-Alcohol Analysis: Uses, Methods, and Some Forensic Problems—Review and Opinion*, 21 J. FORENSIC SCI. 11 (1976).
4. Porter, *Value and Purpose of Chemical Tests*, in COMMITTEE ON MEDICOLEGAL PROBLEMS, AMERICAN MEDICAL ASSOCIATION, CHEMICAL TESTING FOR INTOXICATION MANUAL 2, 2 (1959).
5. COMMITTEE ON MEDICOLEGAL PROBLEMS, AMERICAL MEDICAL ASSOCIATION, ALCOHOL AND THE IMPAIRED DRIVER, 145 (1968) [hereinafter cited as AMA].
6. Mason & Dubowski; *supra* note 2, at 128.

HOUSE FEDERAL & STATE AFFAIRS
Attachment No. 6C
February 6, 1990

committee's recommendations were incorporated almost verbatim.[7] The 1953 symposium on Alcohol and Road Traffic,[8] however, responding to growing dissatisfaction with legal definitions of *intoxication,* spawned a committee comprising well-known spokesmen in the field of alcohol and traffic safety (including some individuals who had served on the National Safety Council Committee a few years before) to reconsider the definition issue. Without offering a reason for the change, or defining *impairment,* the Symposium Committee issued a statement declaring that a blood-alcohol concentration (BAC) of 0.05 percent w/v would definitely impair the driving ability of some persons and that the driving ability of all persons with a BAC of 0.10 percent w/v is definitely impaired.[9] Noted DWI defense attorney Richard Erwin suggests that since the courts had been taking a BAC of 0.15 percent w/v to be a minimum requirement for an intoxication finding, many culpable persons had escaped conviction.[10] In 1953, there were no *per se* statutes and the Symposium Committee's recommendations were made in a legal environment in which the relationship between BAC and intoxication was cast as a rebuttable presumption.

BAC as a formula is meaningless while alcohol is being absorbed into the blood.

In 1960, the AMA Committee on Medicolegal Problems and the National Safety Council Committee on Alcohol and Drugs both recommended that a BAC level of 0.10 percent w/v be presumptive of intoxication; during the next eight years, most states amended their DWI legislation accordingly.[11] In 1971, the National Safety Council Committee on Alcohol and Drugs proposed that all persons with BACs of more than 0.08 percent w/v should be considered intoxicated.[12] In that same time period statutes began to be modified to include the *per se* offense of having a BAC in excess of 0.10 percent w/v while operating a motor vehicle.[13]

Physiological Factors

In the prosecution of most offenses, guilt or innocence centers on whether a specific act was committed. In alcohol-related offenses, however, where driving after consuming alcohol is not itself a crime, guilt is determined by the degree of the defendant's alleged condition (intoxication). Adjudicating the question of degree brings issues of toxicology, physiology, chemistry, physics, and psychology into court. This section outlines some of the physiological factors relevant to alcohol-intoxication cases involving breath-test evidence.

Alcohol Absorption Into and Removal From the Body

When one consumes alcohol, it passes through the mouth and the esophagus *en route* to the stomach. Subsequently, it passes into the small intestine where it is absorbed into the blood. In combination with the blood the alcohol is distributed throughout the body.[14] Symptoms of intoxication appear when alcohol permeates brain tissue. The amount of time which passes between the consumption of alcohol and its arrival in the brain can vary widely, depending on individual physiology, the amount and kind of food eaten prior to or during the ingestion of alcohol, and the type of alcoholic beverage consumed.[15]

Most of the early studies on alcohol's effect on the human body relied on measurements of blood-alcohol concentration (BAC), focusing on both the absorption

7. *See, e.g.,* Texas Unif. Veh. Code §11-902 (1944).
8. AMA Medicolegal Committee Meeting, held at Indiana University, December 1953. *See also* AMA, *supra* note 5, at 146.
9. R. ERWIN, DEFENSE OF DRUNK DRIVING CASES (3d ed. 1984) at 13-14.
10. *Id.* at 14-16.
11. AMA, *supra* note 5, at 146.
12. Mason & Dubowski, *supra* note 3, at 11.
13. See, *e.g.*, Thompson, *The Constitutionality of Chemical Test Presumptions of Intoxication in Motor Vehicle Statutes*, 20 SAN DIEGO L. REV. 301, 317 (1983).
14. Sedman, Wilkinson, Sakmar, Weidler & Wagner, *Food Effects on Absorption and Metabolism of Alcohol*, 37 J. STUDIES ON ALCOHOL 1197 (1976) [hereinafter cited as *Food Effects*]. Blood absorbs very little alcohol (or anything else) from the stomach; most of the transfer of food nutrients and alcohol occurs in the small intestine.
15. *See* C. LEAKE & M. SILVERMAN, ALCOHOLIC BEVERAGES IN CLINICAL MEDICINE 49 (1966).

and elimination rates of alcohol, as well as on alcohol's influence on such functions as coordination and judgment.[16] Presumably for the sake of establishing a consistent procedure, the human subjects in these studies usually consumed a "dose" of a strong alcoholic beverage (such as whiskey or vodka) on an empty stomach. Subsequent blood-alcohol concentrations, measured at regular intervals, revealed the alcohol-transfer rates into and out of the blood. These measurements also provided a BAC figure for evaluating judgment and coordination tests. These early studies presented a consistent picture of alcohol's absorption into the bloodstream, indicating that a subject's BAC rises to a peak about forty-five minutes after the alcohol "dose," thereafter decreasing. This model of alcohol absorption by the blood has often been presented in expert testimony,[17] but it does not correspond to the (more normal) social alcohol-consumption scenario in which one may drink beer, wine, or mixed drinks in conjunction with food over a substantial period of time.

Alcoholic beverages consumed on an empty stomach pass quickly into the small intestine where the alcohol transfers efficiently into the blood. A number of factors can retard the rate of alcohol transfer from the small intestine into the blood. The effect of food eaten before or during drinking is known even by occasional drinkers and in now well-documented laboratory research.[18] Alcohol and food consumed simultaneously remain together in the stomach during digestion. Some researchers suggest that alcohol absorption by food in the stomach explains the decreased rate and amount of alcohol absorbed into the blood in the small intestine of a person who eats while drinking.[19] Metabolites, which are products of digestion, are released into the bloodstream and are also thought to reduce the blood-alcohol concentration.[20] Furthermore, BAC histories measured after consumption of alcohol on an empty stomach, after a high-fat meal, and after a high-carbohydrate meal differ substantially. (See **Fig. 1**)[21]

Laboratory studies have demonstrated that there are significant differences among the BACs attained after subjects consume equivalent amounts of alcohol in different alcoholic beverages (beer, wine, distilled liquor, etc.). Leake and Silverman compiled results showing that a given amount of alcohol in the form of beer produces a lower-peak BAC that is achieved at a much later time than the same amount of alcohol taken as gin or vodka. (See **Fig. 2.**)[22]

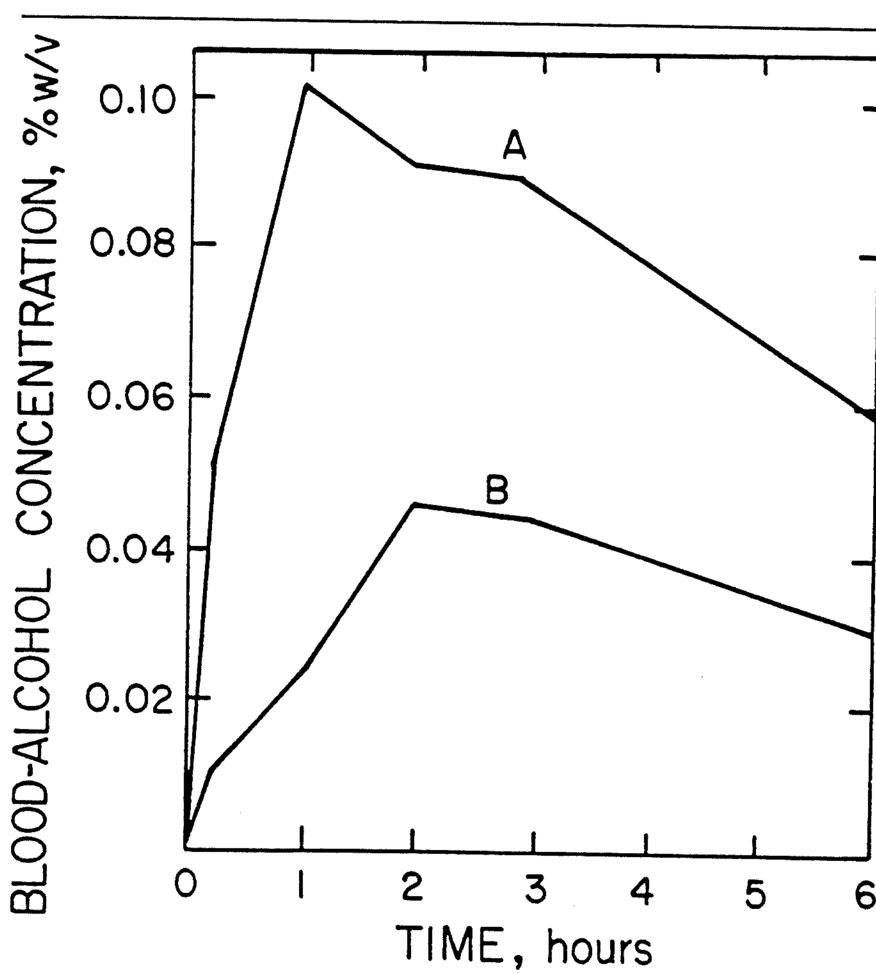

Figure 1. Blood-alcohol concentrations attained by consuming a given amount of alcohol on an empty stomach (A) and after a high-carbohydrate meal (B). ***See*** **footnote 21.**

16. *See, e.g.*, E. Widmark, Principles and Applications of Medicolegal Alcohol Determination (R.C. Baset, trans. 1981); Bernhard & Goldberg, *Aufnahme and Verbrennung des Alkohols bei Alkoholisten*, 86 Acta Med. Scandinavica 152 (1935); Goldberg, *Quantitative Studies on Alcohol Tolerance in Man*, 5 Acta Physiologica Scandinavica 1 (Supp. 16, 1943); Dept. of Transportation, Alcohol, Drugs and Driving (DOT HS-801 096, 1974); Dept. of Transportation, Alcohol Experiments on Driving-related Behavior: A Review of the 1972-1973 Literature, Alcohol Countermeasures Literature Review (DOT HS-801 266, in 1974).

17. Fitzgerald & Hume, *Erroneous Expert Opinions in the Civil and Criminal Trial of Intoxication Cases: Widmark Revisited*, The Champion, Dec. 1983, at 6.

18. *Food Effects*, *supra* note 14, at 1197.

19. E. Widmark, *supra* note 16, at 81-82.

20. Miller & Stirling, *The Effect of a Meal on the Rate of Ethanol Metabolism in Man*, 25 Proc. of the Nutrition Soc'y xi (1966).

21. Dept. of Transportation, Alcohol and Highway Safety: A Report to the Congress From the Secretary of Transportation 3-7 (Aug. 1968); illustration reproduced from Fitzgerald and Hume, *The Single Chemical Test for Intoxication: A Challenge to Admissibility*, 66 Mass. L. Rev. 23 (Winter, 1981).

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They also hypothesize that differences in BAC resulting from consumption of different alcoholic beverages could be due to the stomach's reaction to non-alcoholic constituents of the beverages consumed.[23]

Alcohol absorption into the blood is further affected by the rate at which the stomach transfers its contents to the small intestine. Severe trauma, emotional disturbance, and some drugs can cause abnormally long gastric food retention, effecting a delay in the appearance of alcohol in the blood.[24]

22. C. LEAKE & M. SILVERMAN, *supra* note 15, at 54. Illustration reproduced from Fitzgerald & Hume, *The Single Chemical Test for Intoxication: A Challenge to Admissibility*, 66 MASS. L. REV. 23 (1981), reprinted in THE CHAMPION, June 1984, at 8.

23. *Id.* at 50.

24. Rose, *Factors Influencing Gastric Emptying*, 24 J. FORENSIC SCI. 200 (1979). *See also* WORLD HEALTH ORGANIZATION, THE INFLUENCE OF ALCOHOL AND DRUGS ON DRIVING 5-7 (Euro Reports and Studies 38, 1981).

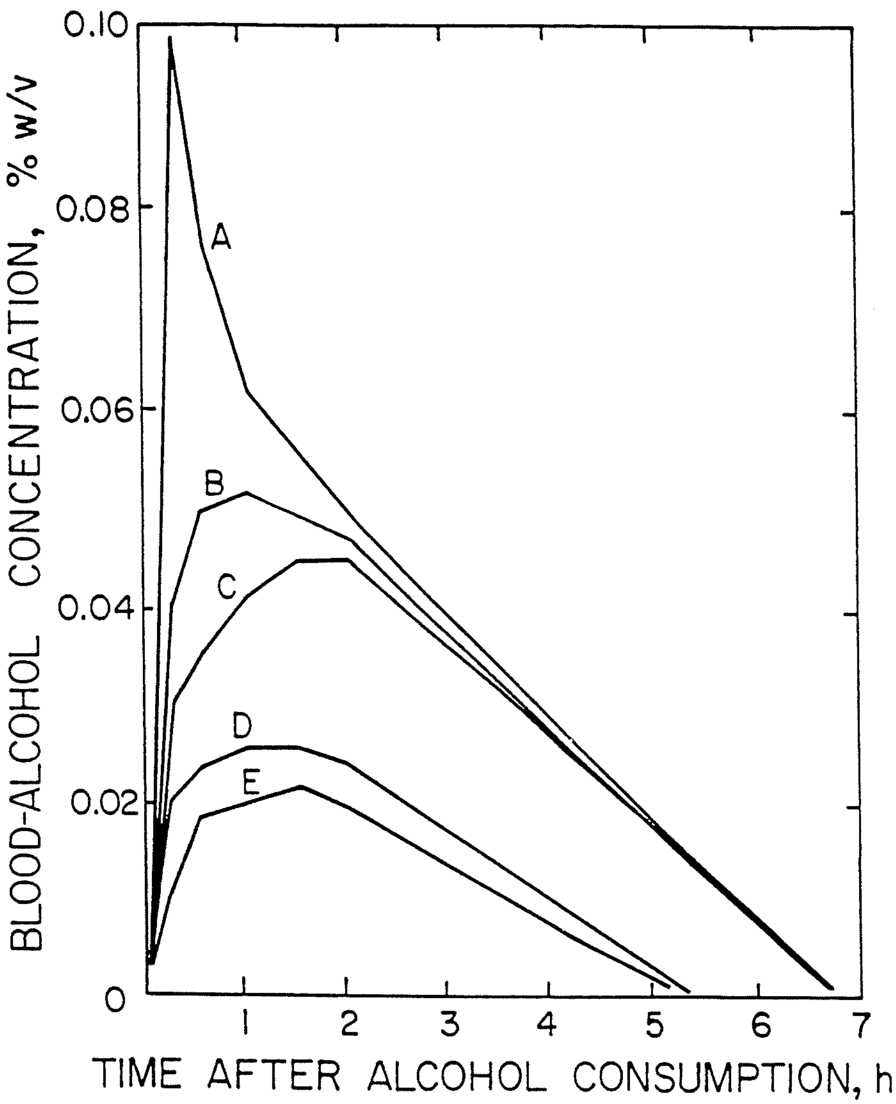

Figure 2. Blood-alcohol concentrations attained by consuming a fixed amount of alcohol in different beverages: (A) gin or vodka on empty stomach; (B) table wine on empty stomach; (C) beer on empty stomach; (D) table wine with meal; (E) beer with meal.

Once alcohol enters the bloodstream, the body begins to remove it. Though urine, breath, and perspiration eliminate some alcohol directly, the liver destroys over 90 percent of consumed alcohol by producing chemicals that convert the alcohol into carbon dioxide and water.[25] The earliest studies of alcohol-removal rates revealed large subject-to-subject variations. Published in 1932, the work of Widmark[26] showed an average alcohol-removal rate equivalent to approximately 0.015 percent w/v per hour. This figure represents an average of rates for 20 male and 10 female subjects. The alcohol-removal rates Widmark reported ranged from 0.011 to 0.024 percent w/v per hour. Alcohol-removal rates for over 900 men, measured by K.M. Dubowski, ranged from 0.006 to 0.04 percent w/v per hour.[27] Other clinical research[28] has confirmed Dubowski's findings and has shown that the removal rate not only varies from individual to individual, but also is not constant for a particular person.[29] The removal rate depends in part on the subject's blood-alcohol concentration: when his BAC is high, the alcohol-removal rate is also usually higher than when his BAC is low.[30]

Estimation of BAC Based on Body Weight and Amount of Alcohol Consumed (Widmark's r-Factor)

In his pioneering research, Dr. Widmark[31] sought a simple means of determining a subject's blood-alcohol concentration (BAC) from his body weight and the weight of alcohol present in his body. The research was directed toward finding

25. Garriott, *Forensic Aspects of Ethyl Alcohol*, 3 CLINICS IN LABORATORY MED. 385, 389 (1983).

26. E. WIDMARK, *supra* note 16, at 74.

27. Address by K. Dubowski, in U.S. DEPT. OF HEALTH, EDUCATION AND WELFARE, ALCOHOL AND TRAFFIC SAFETY (Public Health Service, Publ. No. 1043, 1961), cited in R. ERWIN, *supra* note 9, at 15-24.

28. Address by R. Radlow & C. Conway, American Psychological Ass'n Convention (1978) cited in Radlow & Hurst, *Delayed Blood Alcohol Determinations in Forensic Applications*, 2 CRIM. JUSTICE J. 281, 282 (regarding consistency of alcohol absorption in human subjects).

29. Sturtevant, *Chronopharmacokinetics of Ethanol. I. Review of the Literature and Theoretical Considerations*, 3 CHRONOBIOLOGIA 237, 250 (1976).

a constant (designated **r**) which, if divided into the fraction of alcohol in the whole body (the ratio of ingested alcohol weight to total body weight), would yield the BAC. This relation is algebraically represented as:

Equation #1

$$\text{BAC} = \frac{\text{Weight of alcohol in body}}{\text{body weight} \bullet \text{r}}$$

However, while alcohol is being absorbed into the blood, any such formula is meaningless, since the BAC is changing relatively rapidly, while the total amount of alcohol in the body is changing slowly. It might be possible to find a value of **r** that would be valid for a particular individual after *all* alcohol has been absorbed from the digestive tract into the blood. Since the elimination of alcohol begins immediately upon its appearance in the blood, it is never possible to find a time when all of the alcohol consumed is present in the blood. In overcoming this experimental difficulty, Widmark realized that the only time at which one can know the amount of alcohol in the body is immediately after the initially alcohol-free subject has rapidly consumed a known amount of alcohol and before his body has had the chance to remove any alcohol from the blood. A BAC measurement at that time is of little interest, however, because none of the alcohol has entered the blood.

Widmark assumed that the alcohol-removal rate (the amount of alcohol removed from the blood per hour) is constant for each individual and that *all* the alcohol consumed had been transferred to the subject's bloodstream approximately one hour after the alcohol dose. By extending the falling BAC curve (as shown by the dotted line in **Fig. 3**) back to the alcohol-ingestion time, Widmark hoped to show what the BAC would have been *if all the alcohol consumed had been instantaneously transferred to the blood.* This technique yielded reproducible values of **r** for specific individuals. Widmark's **r**-measurements for thirty subjects ranged from 0.47 to 0.86, with the average **r** for men being 0.68 and that for women, 0.55. Most expert testimony,[32] as well as most published charts and graphs[33] relating an amount of *alcohol consumed* to a BAC rely directly on the assumption that *all* individuals have the average values of **r** that Widmark reported, even though: (1) he claimed no universal applicability for his **r**-factors; (2) the range of **r**-values measured was wide; (3) the drinking procedure (rapid consumption on an empty stomach) did not correspond to normal social practice; (4) there were no studies of the relative effects of consuming different alcoholic-beverage types; and (5) the sample of only 30 subjects was too small to produce statistically meaningful conclusions about the general population.

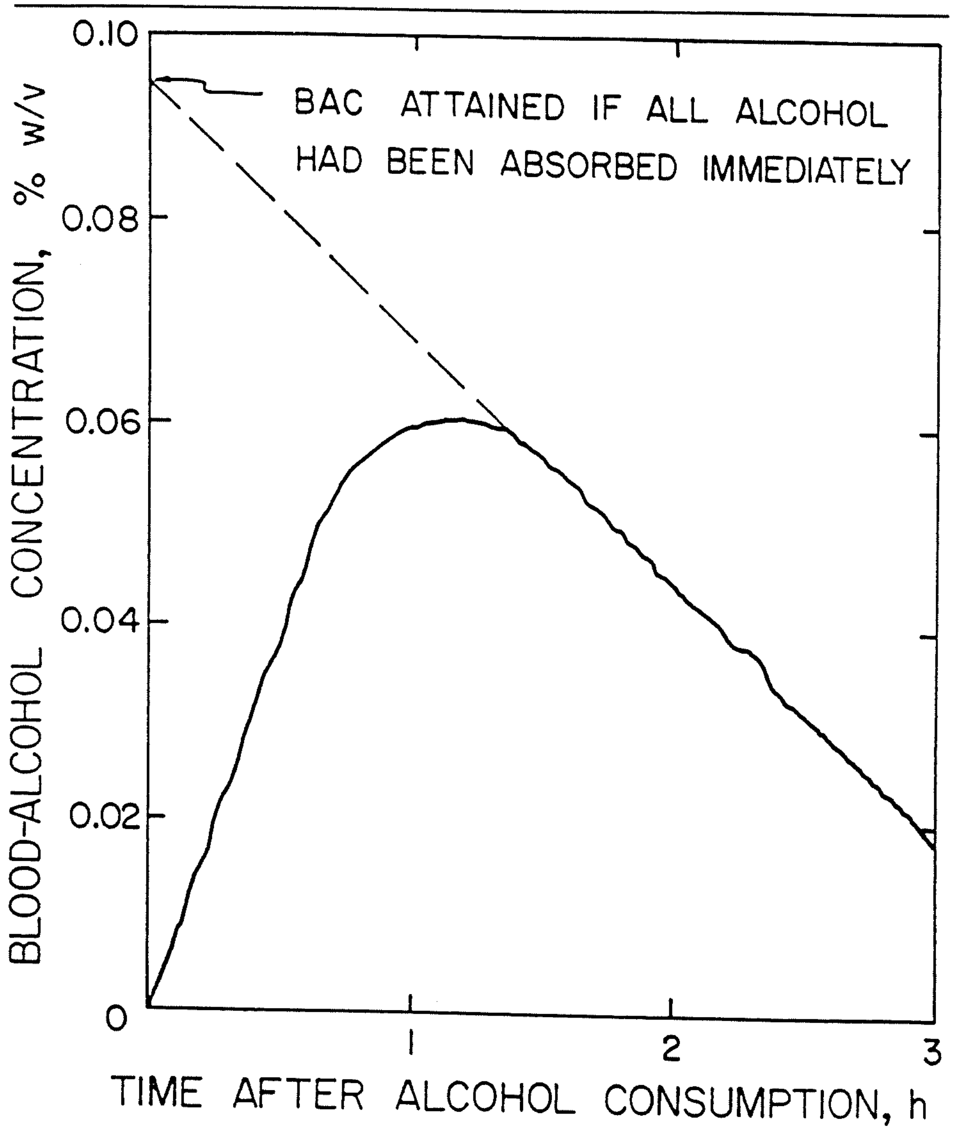

Figure 3. Widmark's technique for r-factor determination. Solid curve represents subject's blood alcohol as a function of time. Dashed curve is Widmark's extrapolation of falling part of BAC curve back to the time of alcohol consumption.

30. Bogusz, Pach & Stasko, *Comparative Studies on the Rate of Ethanol Elimination in Acute Poisoning and in Controlled Conditions*, 22 J. Forensic Sci. 446, 448 (1977).

31. *See* Fitzgerald & Hume, *supra* note 17, at 18.

32. *Id.* at 19.

33. *E.g.*, Colorado Mountain Industries, Inc., Intoxilyzer 4011AS-A, "Physiology and Pharmacology" chapter, at 3 (manual used in instruction course given by CMI to Texas DPS technical supervisors in April 1980) [hereinafter cited as CMI Manual]; Fitzgerald & Hume, *supra* note 17 at 27.

Partition Coefficient

Trace amounts of alcohol in the breath of individuals who had been consuming wine were first reported in 1847.[34] For several years, it has been common practice among law-enforcement agencies to find a value for a DWI suspect's *blood*-alcohol content (BAC) by measuring his *breath*-alcohol content. The idea of breath testing rests on the assumption that there is a *quantitative* relationship between the concentrations of alcohol in breath and blood; specifically, the *partition coefficient* is the ratio of the weight of alcohol in a fixed amount of a subject's blood to the weight of alcohol in the same *volume* of his breath.[35] (To evaluate an individual's partition coefficient, blood-alcohol and breath-alcohol concentrations must be measured simultaneously.) A typical statute defines *alcohol concentration* to be "grams of alcohol per 100 milliliters [100 milliliters = 0.1 liter] of blood" or "grams of alcohol per 210 liters of breath."[36] This definition appears to rely on the premises (1) that a fixed blood/breath partition coefficient exists and (2) that the ratio is 2100:1 for all individuals.

The partition coefficient is, however, not a constant. It is a physiological quantity that differs from individual to individual and is not even a fixed value for a specific individual.[37] Many studies of partition coefficient variation have been performed.

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34. Bouchardat & Sandras, *De la Digestion des Boissons Alcooliques et de leur role dans la Nutrition*, 21 ANNALES DE CHIMIE ET DE PHYSIQUE 448 (1847).

35. *See* Jones, *Determination of Liquid/Air Partition Coefficients for Dilute Solutions of Ethanol in Water, Whole Blood, and Plasma*, 7 J. ANALYTICAL TOXICOLOGY 193, 194 (1983).

36. TEX. REV. CIV. STAT. ANN. art. 6701*l*–1(a)(1)(A), (B) (Vernon Supp. 1987). This definition is particularly convenient, since most breath-testing devices used in Texas were manufactured and purchased when the law made reference only to blood-alcohol concentration (BAC). The Intoxilyzer printout gives a *blood*-alcohol value (grams of alcohol per 0.1 liters of blood) obtained by multiplying the measured breath-alcohol concentration by 2100. *If the printed result is* interpreted *as breath-alcohol concentration*, the result is, therefore, expressed in units of "grams of alcohol per 210 liters of breath."

37. Alobaidi, Hill & Paine, *Significance of Variations in Blood: Breath Partition Coefficient of Alcohol*, 2 BRIT. MED. J. 1479 (1976).

The results of twenty-seven such investigations were tabulated by Mason and Dubowski, who noted, "A rather surprising range of values for the blood/breath ratio for ethanol is to be found in the literature of the last forty-five years."[38] Partition coefficients measured by several researchers ranged from about 1000:1 to over 3000:1.

Forensic scientists have attempted to account for the wide divergence in partition coefficients observed in blood/breath comparisons. No single explanation has emerged, but a number of factors have been shown to influence the partition coefficient for a given individual. These include: temporal variation in the measured BAC, body temperature, the rate of alcohol transfer to the bloodstream at the time of the breath measurement, relative amounts of solid material in the blood (hematocrit level), the presence of lung disease, and the ability of the breath-test instrument to take an adequate sample of the subject's breath. The following section discusses the relationship of these factors to forensic "alcohol concentration" measurements.

Blood-Alcohol Concentration (BAC)

Determination of a subject's partition coefficient requires simultaneous measurement of both *blood* and *breath* alcohol. Even though measurements of blood-alcohol concentration are more direct and, therefore, more likely to provide a reliable indication of intoxication than breath-alcohol measurements, they can be inaccurate. Erwin has reviewed sources of BAC-measurement inaccuracies,[39] which include contamination of the subject's blood sample during or after the blood-drawing process, the use of improperly compounded chemicals, and dubious laboratory procedures.

The result of a blood-alcohol concentration measurement may depend on the exact time at which the blood sample is taken. Using an instrument that continuously monitored blood-alcohol concentration, H. Leithoff measured the sudden peaks in his subjects' blood-alcohol concentrations.[40] Such short-term fluctuations in BAC undermine the forensic utility of BAC measurements, since they make it more difficult to relate the result of a BAC measurement after an arrest to the blood-alcohol concentration at the time of arrest. A further discussion of direct BAC determinations is beyond the scope of this article, but any measurements purported to correlate blood-alcohol with breath-alcohol concentration necessarily invoke uncertainties regarding the independent determinations of both quantities.

Most published charts and graphs relating an amount of alcohol consumed to a BAC rely on the average values of r that Widmark reported.

Alcohol-Vapor Transfer in the Lungs

A basic assumption in forensic breath-alcohol testing is that the alcohol measured in a subject's breath has been transferred from the subject's blood to his breath in the lungs. The lungs' primary function is to exchange gases between the blood and the breath. The gas exchange occurs in millions of microscopic sacs called *alveoli,* which receive air via the bronchial tubes. The alveolar walls are only one cell thick and are lined with capillary blood vessels of a similar wall thickness. Oxygen, carbon dioxide, and other gases easily pass through the thin alveolar and capillary walls.[41] If alcohol is present in the blood, it evaporates and passes through the cellular membranes into the alveolar air. During each normal breath, some air in the alveoli is exhaled and replaced with air from outside the body. Any variation in the efficiency of alcohol-vapor transfer in the lungs will alter an individual's partition coefficient.

Henry's Law. To assert any quantitative relationship between the alcohol contents of subject's breath and blood, one must at least assume that the concentration of alcohol in the alveolar air is proportional to the concentration of alcohol in the blood. A principle of physics known as Henry's Law,[42] which describes the evaporation of solution components, is often used to support this assumption. A *solution* is a "homogeneous material [or mixture] that does not have a definite composition,"[43] (for example, alcohol dissolved in water—in any proportion—forms a solution). Henry's Law predicts the relative amounts of solution-component vapors found in contact with the solution in a closed, narrowly defined system. Consider, for example, a closed jar containing a solution of alcohol and water. The jar's contents are assumed to be a constant temperature and pressure; and the liquid and vapor in the jar are assumed to be in *equilibrium,* meaning that the vapors are re-dissolving into the liquid as fast as they are evaporating out of it.[44] In this example, Henry's Law asserts that, in equilibrium, the alcohol concentration (weight per volume) of the gas in contact with the liquid is proportional to the alcohol concentration of the liquid; that is, if the concentration of alcohol in the liquid is doubled, then the concentration of alcohol vapor in the gas also doubles. The breath simulator routinely used to check the operation of breath-test machines consists of a jar containing an alcohol/water solution through which air is bubbled. Henry's Law would be expected to apply well to the air- and alcohol-in-

38. Mason & Dubowski, *supra* note 3, at 23-26, 27.
39. R. Erwin, *supra* note 9, §17.
40. Leithoff, *Die Aufstellung von Blutalkoholkurven im Trinkversuch mit einer neuen Methode der Kontinuierlichen Blutalkoholbestimmung*, 2 Blutalkohol 541 (1964), cited in Mason & Dubowski, *supra* note 3, at 29.
41. *See* Comroe, Forster, Dubois, Briscoe and Carlsen, The Lung—Clinical Physiology and Pulmonary Function Tests, ch. 1 (1955) [hereinafter cited as The Lung]. *See also* Comroe, Physiology of Respiration, 11-16 (1970).
42. L. Pauling, College Chemistry 381 (1955). Henry's Law was formulated in 1803 by British chemist William Henry.
43. *Id.* at 372.
44. *See id.* at 40-41. In this example, the equilibrium concentration of alcohol vapor thus represents the maximum amount of such vapor that can be present. When the jar is first filled, the liquid and vapor are not in equilibrium, which takes some time to occur; Henry's Law does not speak to the time required to establish equilibrium.

water solution in the breath simulator.

There *is* reason to question the straightforward application of Henry's Law to the interchange of gases in the lungs. Henry's Law applies *only* to a system that has reached equilibrium. An unknown amount of time is required for fresh air introduced to the lungs to attain an equilibrium concentration of alcohol. The breathing process constantly introduces fresh air, and it may well be that an equilibrium between alcohol in the blood and alcohol vapor in the lung air is rarely (if ever) established. Furthermore, Henry's Law applies to a solution in direct contact with its vapor; the alcohol-blood "solution" and the alveolar air are not in direct contact with one another, but are separated by the alveolar and capillary walls. For instance, laboratory research has demonstrated that Henry's Law does not apply to the more complex exchange of oxygen and carbon dioxide in the lungs.[45] The only available data that address the applicability of Henry's Law to alcohol-vapor exchange in the lungs are measurements of individuals' partition coefficients, wherein, as noted above, there is a considerable variation among different subjects. It is not readily possible to determine how much of the variation observed in measured partition coefficients is due to the inapplicability of Henry's Law to alcohol vapor exchanges in the lungs.

Body Temperature. If one *could* assume that the evaporation of alcohol in the lungs proceeds in accordance with Henry's Law and conforms to the other known properties of simple solutions (notwithstanding the cautionary dicussion above), then one could predict the consequences of body temperature on breath-test results. Under this assumption, the alcohol concentration of the subject's breath would increase by approximately seven percent for each increase of one degree Centigrade[46] (or 1.8 degrees Fahrenheit) in his body temperature.[47] For example, a one-degree Centigrade increase in body temperature would raise a 0.100 percent breath-alcohol result to 0.107 percent.[48] If a subject's body temperature were measured at the time of the test, one could at least attempt to make a correction in the breath-alcohol reading for the effects of abnormal body temperature. The Texas DPS Regulations require no measurement of the subject's body temperature at the time of a breath-alcohol test. In fact, in Texas law-enforcement practice, such measurements are rarely (if ever) made.

Rate of Alcohol Absorption into the Blood. Studies by A.W. Jones[49] reveal that the ratio of blood-alcohol concentration (BAC) to breath-alcohol concentration depends on the rate of alcohol transfer from the small intestine to the blood at the time of the breath test. Shortly after alcohol consumption, when the BAC is increasing rapidly, the alcohol concentration in the arteries is higher than the alcohol concentration in the veins.[50] Since blood in the lungs is most accurately described as arterial, a breath-alcohol test given during the early (rapid) phase of alcohol transfer will give an artificially high result.[51]

Any measurements purported to correlate blood-alcohol with breath-alcohol concentration necessarily invoke uncertainties.

Based on a single measurement of breath-alcohol concentration, it is not possible to ascertain the rate of change of alcohol in the bloodstream. If two or more measurements were made at different times, one would at least find out if the blood-alcohol concentration is increasing rapidly, permitting an approximate correction for the difference in alcohol content of the arterial and venous blood during the early phase of alcohol absorption by the blood. The present law enforcement practice in Texas is to make only one breath-alcohol measurement for each subject.

Solids in the Blood and the Hematocrit Level. Blood is a complex mixture that contains water as well as blood cells and other substances that do not absorb or release alcohol rapidly. Breath-alcohol levels correspond to the amount of alcohol dissolved in the *water* of the blood.[52] The fraction of whole blood's volume occupied by blood cells is called the *hematocrit level*.[53] The hematocrit level and the blood's water content are correlated: if the hematocrit level is high (a relatively large percentage of blood volume occupied by cells), then the blood's water content is low, and vice versa.[54] DWI laws usually state the BAC in terms of the "alcohol concentration" of whole blood (including cells, water, dissolved materials, etc.). If two individuals have the same legally defined BAC, the one with the smaller amount of water in his blood (i.e., the higher hematocrit level) will give a higher breath-test result, because there is less water available to dissolve the same amount of alcohol, resulting in a higher alcohol concentration in the water part of the blood.[55]

However, different individuals have different hematocrit levels. While the normal range for men is 40 percent to 54 percent, it is only 37 percent to 47 percent for women.[56] Since women's hematocrit readings are usually lower, on the average, a woman with a given BAC would show a lower breath-test result than a man with an

45. *Cf.* Piiper and Scheid, *Respiration: Alveolar Gas Exchange*, 33 ANN. REV. OF PHYSIOLOGY 131, 131-136 (1971).

46. To convert from Fahrenheit (°F) to Centigrade (°C): °C = (5/9) x (°F-32).

47. *See* TEXAS DEPARTMENT OF PUBLIC SAFETY, OPERATOR MANUAL FOR TEXAS BREATH ALCOHOL TESTING PROGRAM 5-9 (1982) [hereinafter cited as TBATP MANUAL].

48. The author has not found any reports of experiments that measure the effect of body temperature on the results of breath-alcohol tests of human subjects.

49. Jones, *Variability of the Blood: Breath Alcohol Ratio in Vivo*, 39 J. STUDIES ON ALCOHOL 1931, 1937 (1978).

50. Mason & Dubowski, *supra* note 3, at 28.

51. Jones, *supra* note 49, at 1937.

52. Jones, *supra* note 35, at 194 (defining *partition coefficient* to be the ratio of the concentration of alcohol vapor in equilibrium with an alcohol-containing solution to the concentration of alcohol in the solution). In the present article "partition coefficient" is given a more specific definition—the ratio of blood-alcohol concentration to breath-alcohol concentration.

53. SEIVERD, HEMATOLOGY FOR MEDICAL TECHNOLOGISTS 323 (1983).

54. Jones, *supra* note 35, at 195.

55. *Cf. id.*

56. SEIVERD, *supra* note 53, at 323.

FSA
6C-8
2-6-90

identical BAC. Differences in individual hematocrit levels may help to explain the wide range of the blood/breath partition coefficients found in research reports.[57] The author has found no studies isolating the relationships among breath-alcohol test results, and hematocrit levels for human subjects. Recent measurements made with alcohol-containing blood, however, show that the relative amount of blood solids does affect the amount of alcohol vapor in equilibrium with the blood,[58] suggesting potential variations in individual breath-test of up to 10 percent of the test result obtained.

Lung Disease. To complicate matters, not all individuals have healthy, normal lungs. Russell and Jones examined the consequences of chronic lung disease in breath-alcohol tests, noting that impaired lung function in the subject increases the uncertainty in such measurements.[59] Most of the study's subjects had lung disease that reduced their lung capacity and diminished the rate at which they could exhale. In these individuals, the breath-alcohol concentration during the exhaling period did not vary in the same way as it did for normal subjects. Instead, for some patients with obstructive lung disease, the breath-alcohol levels increased suddenly near the end of expiration.[60]

Collection of a Meaningful Breath Sample

As discussed above, breath-testing relies on Henry's Law to relate blood-alcohol content to breath-alcohol content. Henry's Law expressly applies only to gas that has come into equilibrium with the solution to which it is exposed. For *breath* testing to have any validity, it must at least be *feasible* to acquire a sample of lung air that has come into equilibrium with the blood. Equilibrated lung air has absorbed the maximum possible amount of alcohol from the blood and can absorb no more alcohol, even if it remained in the lung forever. Unless an equilibrated sample is tested, one cannot expect to obtain an accurate indication of blood alcohol, or even to get the same result upon repeating the measurement.

In forensic breath testing, an equilibrated breath sample often seems to be equated with an *alveolar* sample, meaning simply, a specimen "relating to the air pockets [alveoli] in the lungs."[61] The design of most breath-testing machines relies on the assumption that, as the subject exhales, the breath's alcohol concentration ultimately reaches a relatively constant value, indicating that the air being exhaled is almost an equilibrated sample.[62] The breath period in which the alcohol concentration is presumed to be constant is sometimes designated the "alveolar region."[63] The act of breathing, however, replenishes the alveolar air with air from the atmosphere, maintaining the alveolar air in a constant state of *non*-equilibrium. R.W. Hawker, author of a recent text on clinical physiological measurements asserts, "It is not possible to measure directly the composition of mixed alveolar gas,"[64] because the relative amounts of alveolar gas constituents vary substantially during the breathing cycle.

Using an apparatus that continuously monitors the alcohol concentration of breath, J.C. Russell and R.L. Jones have

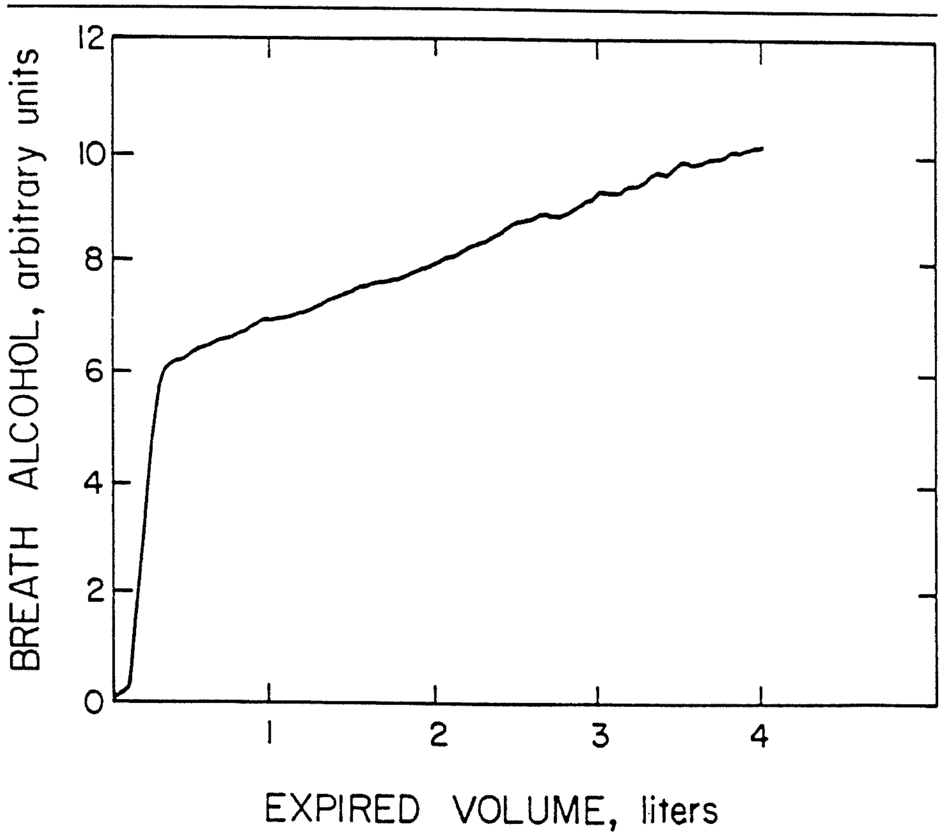

Figure 4. Variation of breath-alcohol concentration while subject is exhaling. This data, from Note 49, shows that an individual's breath-alcohol concentration is not constant during the course of a single breath.

57. *See* Jones *supra* 35, at 195. *See also* Mason & Dubowski, *supra* note 3, at 25.
58. Jones, *supra* note 35, at 195.
59. Russell & Jones, *Breath Ethyl Alcohol Concentration and Analysis in the Presence of Chronic Obstructive Pulmonary Disease*, 16 CLINICAL BIOCHEMISTRY 182, 183 (1983).
60. *Id.* at 184.
61. WEBSTER'S NEW TWENTIETH CENTURY DICTIONARY 54 (1979) [hereinafter cited as WEBSTER'S].
62. *See* Mason & Dubowski, *supra* note 3, at 22.
63. CMI MANUAL, *supra* note 33 "Intoxilyzer Operation" chapter, at 11.
64. R.W. HAWKER, NOTEBOOK OF MEDICAL PHYSIOLOGY: CARDIOPULMONARY–WITH ASPECTS OF CLINICAL MEASUREMENT AND MONITORING 156 (1979).

FSA
6C-9
2-6-90

shown that the breath-alcohol concentration rises rapidly as a healthy subject begins to exhale, but then continues to rise at a reduced rate until he has reached the limit of his ability to exhale.[65] (See **Fig. 4**.) This data clearly proves that *there is no so called "alveolar region."* A healthy subject's breath-alcohol concentration continues to increase linearly until the end of exhalation, leading credence to the apparent impossibility of obtaining an equilibrated breath sample. Russell and Jones's work also shows that the rate at which the breath-alcohol concentration rises changes suddenly after about 0.25 liters of breath has been exhaled. This abrupt shift presumably occurs when most of the air in the bronchial tubes has been expelled and when the breath-alcohol concentration is only slightly more than half of the final value observed. *If* the "knee" of the curve is assumed to indicate that an "alveolar region" has been reached, then the "alveolar" breath sample taken at that time has a much lower alcohol concentration than a sample taken later during the same act of exhaling.

The only time at which one can know the amount of alcohol in the body is immediately after the initially alcohol-free subject has rapidly consumed a known amount of alcohol and before his body has had the chance to remove any alcohol from the blood.

Since the breath-alcohol concentration varies during exhaling, and since some time is required for air to equilibrate with the blood in the lungs, one might expect that the way in which the subject breathes may affect breath-test results. A controlled experiment carried out recently in England showed that breathing technique alone can produce up to 30 percent variation in breath-test results. If the subjects held their breath prior to delivering a breath sample, the breath-test results were increased. If the subjects hyperventilated before a sample delivery, the test results were decreased.[66]

Intoxilyzer: Instrumentation and Procedure

Texas law enforcement agencies rely almost exclusively on breath testing to measure DWI suspects' "alcohol concentrations." The only breath-test instrument in widespread use in Texas is the Intoxilyzer 4011AS-A, manufactured by Colorado Mountain Industries (CMI).[67]

Technical information about the Intoxilyzer has proved difficult to obtain, both from CMI and from the Texas Department of Public Safety (DPS), which is ultimately responsible for the maintenance, calibration, and certification of all evidentiary breath-testing devices used in Texas. The following discussion of breath-testing instrumentation and procedures has been assembled from the text of a training course given at CMI for Texas DPS technical supervisors,[68] from analysis of the electrical and mechanical drawings of the machine contained therein, and from a court-ordered hands-on examination of an Intoxilyzer 4011AS-A by the author.

The Intoxilyzer, shown in **Figure 7,** is not a field instrument; it is maintained in a fixed location, and subjects are brought to the machine for their breath-alcohol tests. The apparatus makes a physical measurement of the breath sample's properties. Unlike Smith & Wesson's Breathalyzer (which was previously used in Texas), no chemical reaction takes place during the assay.

Infrared Light Absorption

The phenomenon of infrared light absorption[69] by a gas is the basis for the Intoxilyzer's design. Alcohol and many thousands of other compounds[70] absorb infrared light in the 3.3-3.5-micron wavelength range.[71] When infrared radiation of this wavelength range passes through a sample of material containing alcohol, some light will be absorbed.[72] By measuring the fraction of light energy lost, one can estimate the number of alcohol molecules present in the sample.

A breath-alcohol test given during the early (rapid) phase of alcohol transfer will give an artificially high result.

The Intoxilyzer passes beams of 3.39-and 3.48-micron infrared light through a sample chamber[73] containing the subject's breath and quantitatively measures the decrease in intensity of the 3.48-micron beam passing through the chamber. A well-established principle of physics, called the Beer-Lambert Law,[74] states that the intensity of a light beam passing through an absorbing medium is given by the equation:

65. Russell & Jones, *supra* note 59 at 183.

66. Jones, *How Breathing Technique Can Influence the Results of Breath-Alcohol Analysis*, 22 MED. SCI. L. 275 (1982).

67. Colorado Mountain Industries (CMI), 41011 Old Highway 6, P.O. Box 40, Minturn, Colorado, manufactures and markets the Intoxilyzer. CMI is a subsidiary of Federal Signal Corporation.

68. CMI MANUAL, *supra* note 32.

69. Within this article, the term *absorption* is used in two unrelated contexts: one is the post-ingestion absorption of alcohol by the blood and the other is absorption of light energy by alcohol molecules.

70. Almost any compound that contains an individual hydrogen atom bonded to a carbon atom absorbs infrared light in the 3.4- to 3.5-micron wavelength range. Common substances that absorb these wavelengths include alcohols, natural gas, gasoline constituents, industrial solvents, and many plastics.

71. A micron is one-millionth of a meter. Visible light wavelengths lie between 0.4 and 0.6 microns.

72. When light of about 3.5-micron wavelength is absorbed by a molecule, it causes a hydrogen atom in the molecule to move rapidly back and forth with respect to the carbon atom to which it is attached. This motion is known as molecular vibration in a C-H stretch mode. In the process of light absorption, some light energy is converted to molecular vibration, reducing the intensity of light passing through the light-absorbing material.

73. Ethyl alcohol easily absorbs infrared light of wavelengths between 3.3 and 3.5 microns.

FSA
60-10
2-6-90

Equation #2

$$I = I_0 e^{-nsl}$$

where **I** is the light intensity remaining after the light of initial intensity, I_0 has passed a distance l through an absorbing gas of density **n** (the number of gas molecules in a fixed volume), having an absorption constant of s (a number that depends on the particular gas and light wavelength used). The expression **e** is a mathematical constant with the approximate value of 2.78. When a light beam travels a known distance through a light-absorbing gas, the Beer-Lambert formula indicates that the light absorption that occurs is predictably related to the density of the gas.

The Intoxilyzer measures I_0 when no light-absorbing material is present in the sample chamber and measures **I** when a breath sample is present. Next, the instrument then computes the difference I_0-I, which is the amount of light *absorbed* as the light beam passes through the breath-filled sample chamber. The absorption constant s (assumed to be that characteristic of ethanol for infrared light of 3.48 micron wavelength) and path length l (assumed to be accurately known and stable) are "programmed" into the machine when it is calibrated at the factory. With this information, the Intoxilyzer circuitry converts the measured light absorption to a number proportional to the density of alcohol molecules in the sample chamber.

Operational Overview of the Intoxilyzer

The Intoxilyzer's principal operating components and their interrelationship are depicted schematically in **Figure 5**. Infrared light from an incandesent lamp penetrates filters mounted on a rotating wheel. The filter wheel contains one filter that passes only 3.48-micron light, another filter that passes only 3.39-micron light, and a small hole that transmits all light ("white" light). As the wheel rotates, beams of 3.39-micron, 3.48-micron, and white light come through the filter-wheel assembly in succession and then enter the breath-sample chamber (cell). If the chamber contains alcohol vapor (or any other substance that absorbs the filtered infrared light), the light beam's intensity attenuates as it travels through the cell. The light beam emerging from the chamber strikes a detector that converts the light's energy to an electrical signal, which is then amplified and separated into three signals: (1) one signal results from the white light coming through the hole in the wheel; (2) another is produced by the 3.39-micron wave length light; and (3) the remaining signal comes from the 3.48-micron light. (The white light signal is used to synchronize the processing of the other two light signals.)

Intensities of the 3.39-and 3.48-micron signals are compared in the chemical-interference detector, where the Intoxilyzer 4011AS-A uses the comparison to sense the presence of acetone.[75] When the operator initiates a measurement sequence, a pump fills the sample chamber with room air. An "automatic 'zero'-setting curcuit," measures and then "memorizes" the signal magnitude produced by 3.48-micron light coming through the sample cell. The

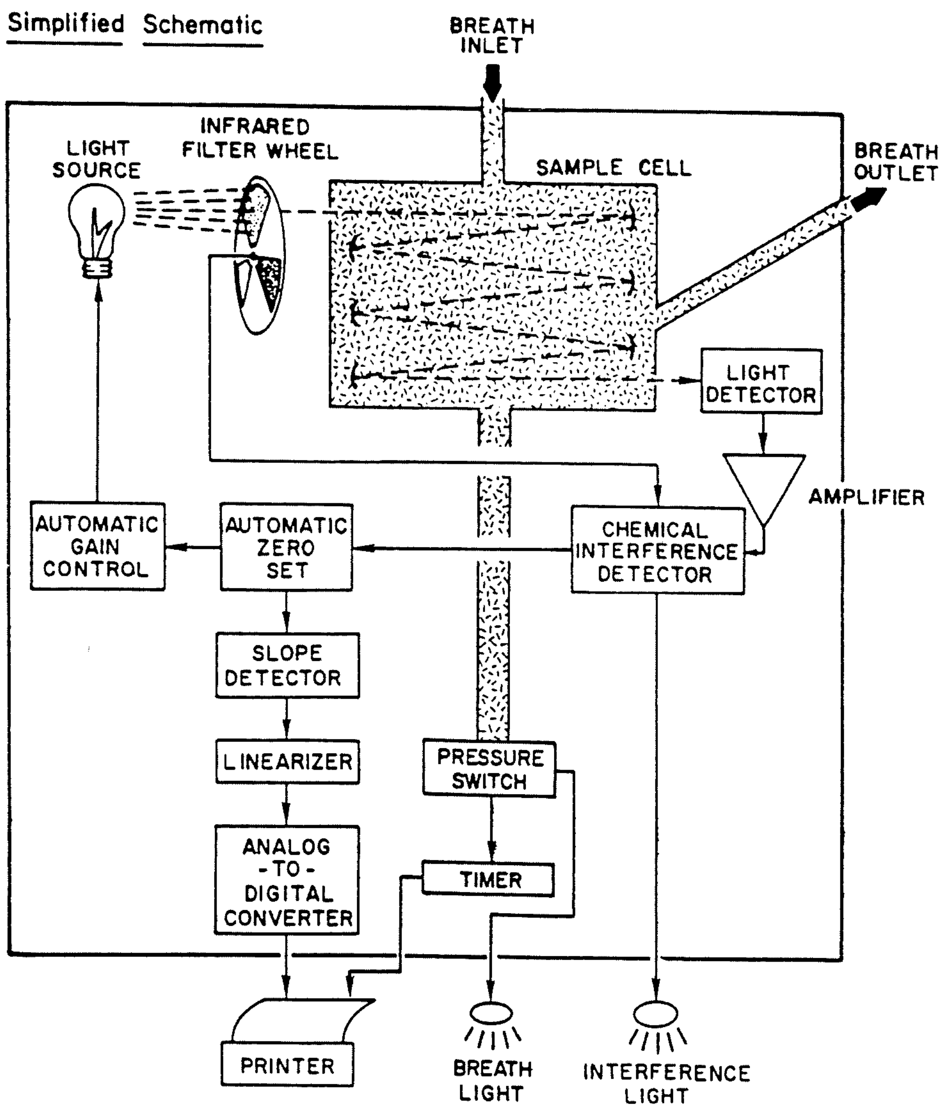

Figure 5. Relationship of main functional elements of Intoxilyzer.

74. The law in its present form was stated by Johann Heinrich Lambert (1728-1777).

62-11
2-6-90

memorized voltage is taken to correspond to "zero" light absorption (I_0 in Equation 2). A circuit designated the "automatic gain control" regulates the source lamp's intensity, causing the signal produced by 3.48-micron light to be set to a predetermined value when no alcohol vapor is present in the chamber.

Breath delivery into the machine activates a pressure switch (mounted on a tube connected to the sample chamber), which starts a timer. Another circuit (the "slope detector") monitors the 3.48-micron light signal to determine when the rate of light absorption by the subject's breath ceases to change rapidly. CME claims that the combination of breath-pressure measurement, breath-duration timing, and slope detection isures that an alveolar breath sample is measured.[76]

Light absorption by a gas is a non-linear process. The Beer-Lambert formula (Equation 2, above) predicts that if the density of absorbing molecules is doubled, the amount of absorption increases, but by less than a factor of two. The light detector used to convert light energy to an electronic signal is also non-linear.[77] If the light energy striking the detector is cut in half, for example, the detector output does *not* drop by exactly half. Consequently, the Intoxilyzer employs a compensating circuit called the "linearizer," which was designed to correct these non-linear relationships. An analog-to-digital converter translates the linearizer's electrical output into a number proportional to the alcohol density present in the sample chamber. The number, printed as the machine-output, is pre-

75. Acetone is a chemical commonly found in human breath and readily absorbs infrared light between 3.2 and 3.5 microns. If one had vapor samples of acetone and ethanol that had equal absorbances at the 3.39-micron wavelength, the ethanol would absorb almost three times as much light as the acetone would at the 3.48-micron wavelength.

76. *Cf.* CMI MANUAL, *supra* note 33, "Intoxilyzer Operation" chapter, at 10, 11.

77. *Id.*, "Implementation" chapter, at 5.

sumed to correspond to the subject's "alcohol concentration" as defined by Texas DWI law.

Breath Simulator Operation

Texas breath-testing procedures require the test operator to check the Intoxilyzer by running a "control" sample provided by a breath simulator after each subject's breath assay.[78] The simulator's function is to produce an alcohol-vapor sample of known concentration. While the breath simulator is not an Intoxilyzer part, it is an accessory essential to each breath-alcohol test, as well as to field calibration of the machine. There are a number of breath simulators on the market, but the discussion herein bears most directly on the Smith & Wesson model Mark IIA, in widespread use in Texas.

The simulator is a glass jar containing a known alcohol-water mixture. (See **Fig. 6**.) Its sealed lid supports a stirring apparatus, two thermometers, a heater, a gas-inlet tube, and an outlet tube. The tubes penetrate the jar's cover, with the gas-inlet tube extending to the jar's bottom, while the outlet tube terminates near the top of the jar. In normal operation, the stirrer circulates simulator solution, keeping it in contact with the heater and thermometers. One thermometer serves as the heater's thermostat, maintaining the solution temperature at 34°C, plus or minus 0.2°C. The other thermometer enables the operator to see whether the thermostat and heater are working.

The concentration of alcohol in the vapor leaving the solution depends directly on the concentration of alcohol in the simulator solution. At 34.0°C, the simulator solution must contain 0.1226 grams of alcohol per 100 milliliters of solution (i.e., 0.1226 percent w/v) for the vapor sample produced to have an alcohol concentration of 0.10 grams per 210 liters.[79] The Intoxilyzer design follows the assumption of a 2100:1 blood/breath partition coefficient, presuming that a blood-alcohol concentration of 0.10 grams per 100 millitiers corresponds to a breath-alcohol concentration of 0.10 grams per 210 liters. Nevertheless, the alcohol concentration of the *simulator* sample must be 0.1226 percent w/v in order for the machine to register an "alcohol concentration" of 0.10 percent w/v during the simulator measurement. Blood and water are not similar media. In fact, blood contains solids that do not readily absorb or release alcohol. Furthermore, the concentration of alcohol vapor in equilibrium with blood relates mostly to the concentration of alcohol in the *water* part of the blood.[80] It is important to remember that blood is about 80 percent water.[81] In order to achieve the same alcohol *vapor* concentration in equilibrium with equal volumes of blood and water, the blood must contain only about 80 percent as much alcohol as the water.

There is no so-called "alveolar region."

For the simulator portion of the breath test, the Intoxilyzer's pump delivers air to the simulator input tube, while the outlet tube is connected to the Intoxilyzer breath tube. Air pumped through the simulator's inlet tube bubbles into the simulator solution through small holes in the tube's immersed end. As the bubbles rise, alcohol evaporates from the liquid and reaches an equilibrium concentration within each bubble. Rising through the liquid, the alcohol-carrying vapor returns to the Intoxilyzer breath chamber via the breath tube. The

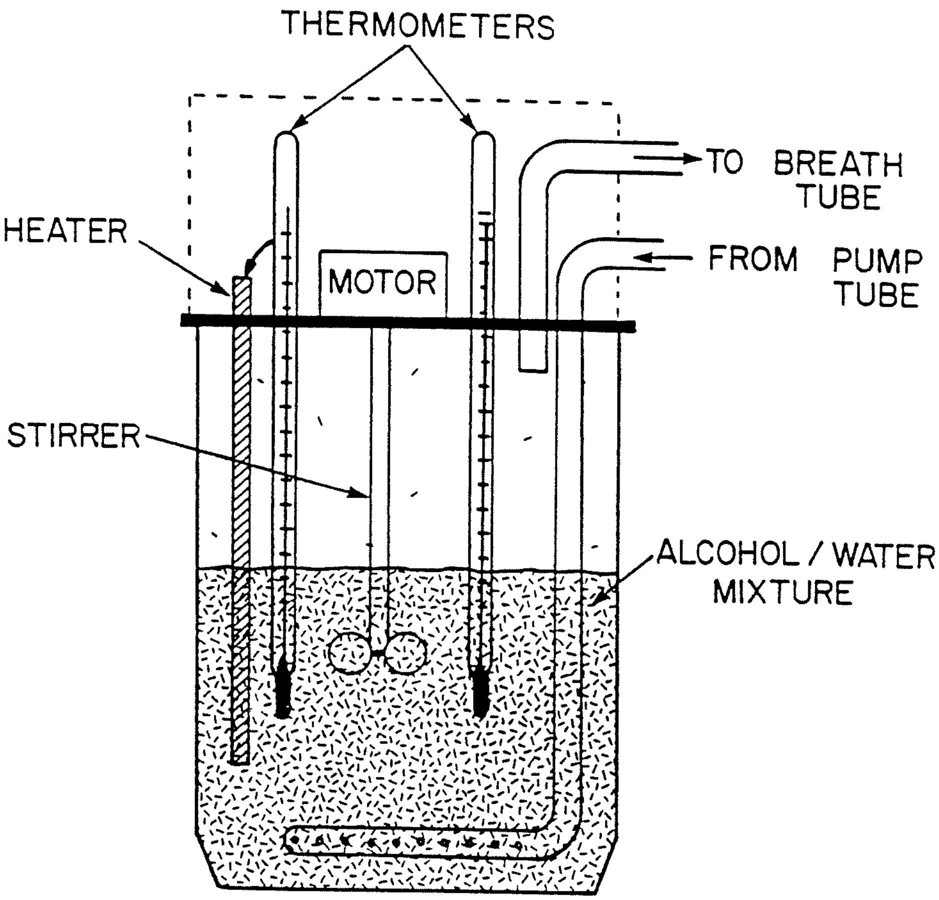

Figure 6. Reference sample instrument (breath simulator).

78. TBATP MANUAL, *supra* note 47, at 3-5.

79. Dubowski, *Breath-Alcohol Simulators: Scientific Basis and Actual Performance*, 3 J. ANALYTICAL TOXICOLOGY 177, 178 (1979).

80. Jones, *supra* note 35, at 195-196.

81. *Id.*

6C-13
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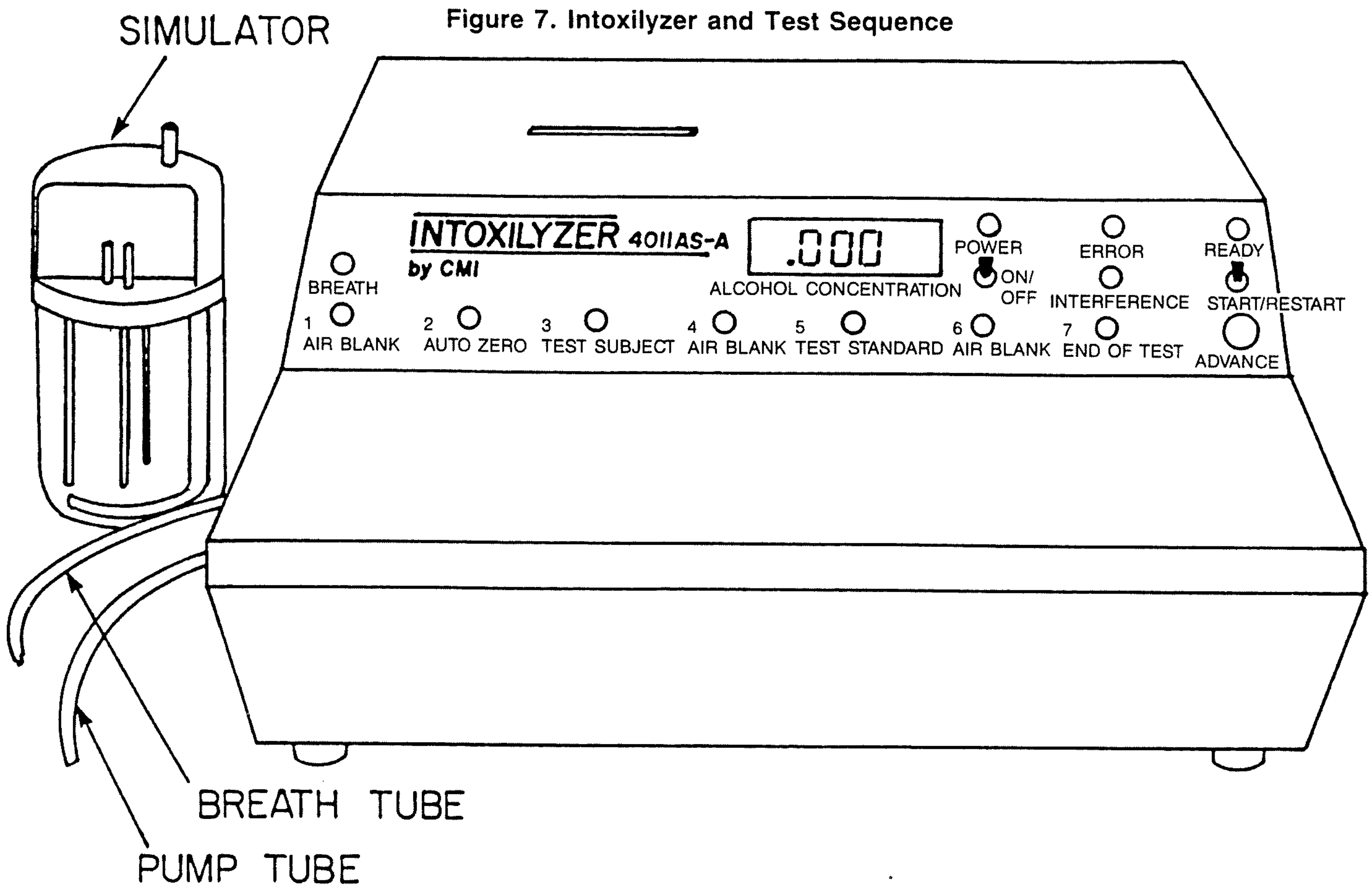
Figure 7. Intoxilyzer and Test Sequence



PRELIMINARY TEST INSPECTION: steps which must be completed before the test is begun

A. Reference Sample Device Inspection
   1. Check the THERMOMETER to verify that the solution is at the proper temperature.
   2. The proper temperature range for the Alcoholic Breath Simulators is 34°C+/−0.2°C (33.8°C to 34.2°C).
   3. Check to see that the device is properly sealed.
   4. Check the date and the Test Record Number which indicates when the solution was last changed. Determine the number of tests conducted using this solution from the information in the Intoxilyzer Log Book. The reference analysis solution should be changed at least every two weeks or 25 analyses, whichever comes first.

B. Intoxilyzer Instrument Inspection
   1. Instrument Indicators:
      a. POWER indicator should be illuminated.
      b. READY indicator should be illuminated.
      c. ERROR indicator should not be illuminated.
      d. INTERFERENCE indicator should not be illuminated.
   2. Alcohol Concentration Display should be illuminated.

To begin test, press start. Then follow instructions for indicators 1 through 7—SEQUENCE INDICATOR #1 should illuminate.

1. AIR BLANK
   - CHECK REFERENCE SAMPLE READY—check temperature and seal
   - 15 MINUTE OBSERVATION OF SUBJECT
   - READY LIGHT ON
   - BREATH TUBE HOUSED—the breath tube should remain in the instrument to keep it warm.
   - CONNECT PUMP TUBE TO BREATH TUBE
   - INSERT TEST RECORD CARD
   - PRESS ADVANCE—the instrument will automatically purge itself with room air.
   - WAIT FOR LIGHT 2
2. AUTO ZERO
   - PRESS ADVANCE
   - WAIT FOR LIGHT 3—when SEQUENCE INDICATOR LIGHT #3 illuminates, the operator should check the ALCOHOL CONCENTRATION DISPLAY and verify that it indicates 0.000 percent.
3. TEST SUBJECT
   - DISCONNECT PUMP TUBE FROM BREATH TUBE
   - EXTEND BREATH TUBE
   - INSERT MOUTHPIECE
   - TEST SUBJECT—have the subject give a long continuous breath
   - HAVE SUBJECT BLOW UNTIL LIGHT 4 COMES ON—SEQUENCE INDICATOR 4 will not illuminate until the subject has delivered a proper sample and has ceased to exhale.
   - OBSERVE BREATH LAMP WHILE SUBJECT IS BLOWING—the subject must deliver a continuous sample sufficient to illuminate the BREATH FLOW INDICATOR for a minimum of 5 seconds.
4. AIR BLANK
   - REMOVE MOUTHPIECE
   - HOUSE BREATH TUBE
   - CONNECT PUMP TUBE TO BREATH TUBE
   - PRESS ADVANCE—the instrument will automatically purge itself with room air.
   - WAIT FOR LIGHT 5
5. TEST STANDARD
   - CONNECT REFERENCE SAMPLE—attach connector's [sic] of the same color together.
   - PRESS ADVANCE
   - WAIT FOR LIGHT 6
6. AIR BLANK
   - DISCONNECT REFERENCE SAMPLE
   - HOUSE BREATH TUBE
   - CONNECT PUMP TUBE TO BREATH TUBE
   - PRESS ADVANCE—the instrument will automatically purge itself with room air.
   - WAIT FOR LIGHT 7
7. END OF TEST
   - REMOVE TEST RECORD CARD—examine all copies for clarity.

bc-14
2-6-90

Intoxilyzer then measures an "alcohol concentration" for that air/alcohol/water-vapor mixture.

Test Sequence

The Intoxilyzer operator conducts five measurements to achieve a single breath-alcohol test result:[82] (1) an "air blank" measurement; (2) the subject's breath test; (3) a second "air blank" measurement; (4) a simulator test; and (5) a third "air blank" measurement. After each step, the machine prints a number corresponding to the "alcohol concentration" in the sample chamber during the step just completed.

The Intoxilyzer is not fully automatic. The Intoxilyzer's front panel has twelve indicator lights. Seven of these cue the operator as to which test step is in progress, five provide additional information about the status of the test; the operator must watch the indicators and execute a series of checks and manipulations to obtain a breath test result. (See **Fig. 7.**)[83] Additional steps in the procedure (such as checking the subject's mouth for foreign materials) would be prudent, but this regimen represents the only steps required (in the absence of "interference" or other "error" indications).

Breathing technique alone can produce up to 30 percent variation in breath-test results.

First Air-Blank Measurement and Auto-Zero

After the Intoxilyzer has warmed up for a few minutes, the "ready" light illuminates, signifying that the breath-sample chamber has reached the operating temperature. The best operator connects the breath tube to the pump tube,[84] and initiates the test by pressing the "advance" button. The Intoxilyzer's air pump then injects room air into the breath tube, flushing out the breath-sample chamber (this takes about 25 to 30 seconds). The machine then measures the light intensity passing through the breath-sample chamber. During this phase, the automatic gain control adjusts the voltage applied to the light source, changing the light's intensity until the signal produced by the 3.48-micron light reaches a preset "zero" light-absorption level. The Intoxilyzer then stores the value of the 3.48-micron light signal for use as a reference level in the next three measurement steps. The reference-level storage is designated as the "auto-zero" step. The machine then registers the amount of light absorbed by the room air in the sample cell, converts this measurement to an "alcohol concentration," and then prints the result on the test-record card. Since the light intensity has been *set* so that light transmitted by the room-air sample produces a signal equal to the reference level corresponding to "zero" light absorption, the "alcohol concentration" printed should be zero. A result other than zero would indicate a serious malfunction.

Subject's Breath Test

The operator disconnects the breath tube from the pump tube, installs a saliva-trapping mouthpiece on the breath tube, and presents the tube so that the subject can blow into it. As the subject delivers breath through the breath tube, the sample-cell pressure increases enough to close a pressure switch, which causes the illumination of the "breath" lamp on the Intoxilyzer front panel and the starting of a four-second timer. As exhalation begins, breath-alcohol concentration is relatively low, but increases rapidly if the subject has alcohol in his blood. During breath delivery, the Intoxilyzer repeatedly measures the breath "alcohol concentration" and presents these results on the front panel LED[85] display for the operator (and subject) to observe. If the force of the subject's breath has been sufficient to keep the pressure switch closed for the timer period (about four seconds) and unless machine circuitry indicates that the sample's alcohol concentration is changing too rapidly to be presumed "alveolar," the apparatus prints the most recently measured value of the subject's breath "alcohol concentration" when the pressure switch opens near the end of the breath delivery.

Second Air-Blank Measurement

After the breath-sample measurement, the operator re-joins the pump tube and breath tube, allowing the internal pump to fill the sample chamber with air from the environment, discharging the subject's breath from the machine. When the pump cycle is complete, the Intoxilyzer prints the "alcohol concentration" for the sample-chamber contents. This result should be zero, indicating that the "zero"-level voltage is the same as that found in the first measurement.

Simulator Test

The operator connects the breath simulator to the Intoxilyzer pump and breath tubes. The pump blows room air into the simulator jar. Vapor bubbling through the simulator solution (containing a known proportion of alcohol to water), acquires alcohol and returns to the Intoxilyzer breath chamber. When the pump stops, the "alcohol concentration" measured for the simulator-produced sample is printed.

Third Air-Blank Measurement

The operator now disconnects the simulator and re-connects the pump and breath tubes. After the internal pump once again fills the absorption chamber with air from the environment, the pumnp cycle is completed, and the "alcohol concentration" of the chamber's room-air sample is printed. Again, a non-zero result indicates a machine malfunction.

Next month—Part II.

82. *See* CMI MANUAL, *supra* note 33, "Intoxilyzer Operation" chapter, at 6; TBATP MANUAL, *supra* note 47, ch. 3.

83. The test sequence herein described is from TBATP MANUAL, *supra* note 47, at 3-3 to 3-6. Parenthetical remarks and instructions for filling out paperwork have been omitted. Other jurisdictions' procedures may differ.

84. Two flexible tubes pass through the Intoxilyzer's side panel. One (the pump tube) is connected to the exhaust of a small air pump inside the Intoxilyzer, and the other (the breath tube) goes to the breath sample chamber.

85. The Intoxilyzer's light-emitting diode (LED) display is similar to that on some pocket calculators, microwave ovens, etc.