Intoxilyzer 5000EN: Common Defenses

2011 DWI Technology Conference

Deandra Grant
Attorney at Law
1700 Alma Drive, Ste. 227
Plano, TX  75075
(972) 943-8500
www.TexasDWISite.com
TexasDWIGal@gmail.com
Breath Test – 6 Premises

- Equilibrium (no longer absorbing alcohol)
- Alveolar breath
- Henry’s Law – exhaled breath temp of 34C
- Blood:Breath ratio = 2100:1
- No Mouth Alcohol
- No Interfering Substances
1. **Breath Temperature**

- Recent studies show that the average temperature of expired breath is actually closer to 35 degrees Celsius (See Jones, “Physiological Aspects of Breath-Alcohol Measurement,” P. 17). A review of these studies finds a range of exhaled breath temperature from 31-36.7.

- Breath temperature is important because for every 1 degree Celsius rise over 34 degrees, the breath test result is overestimated by 6%. Thus, if the subject’s breath temperature is 37 degrees (which equates with core body temperature), the breath test result will be overestimated by 18%.

- The state of Alabama conducted a study to determine whether or not they would stick with the 5000 or switch to a different machine. Parallel testing was done with the Intoxilyzer 5000 and the Draeger Alcotest MK III. 93% of the subjects tested had breath temperatures over 34 degrees. The breath temperature range was 32.4-36.2 with a mean of 34.9. (from Breath Temperature: An Alabama Perspective, Dale A. Carpenter, Ph.D and James M. Buttram, Ph.D, IACT Newsletter, Vol. 9, Number 2, July 1998).
According to Dr. AW Jones:

- His research has consistently shown breath temperature variability affecting the test results.

- He advises in his writings that the next generation of breath-alcohol analyzers should be designed to incorporate temperature and volume sensing devices to help minimize the inherent errors in breath-alcohol analysis.


A. W. Jones, “Psychological Aspects of Breath Alcohol Measurement”

“The temperature coefficient of ethanol solubility for solutions in water and biological media is 6.5% for each degree Celsius change in the equilibrium temperature (Harger et al., 1950a; Jones, 1983a). The temperature in the lungs and upper airway is therefore an important respiratory parameter influencing the measured breath-alcohol concentration. The temperature of breath as it leaves the mouth rises from about 33.3 to 34.4 C as the volume of breath exhaled rises from 500 to 4500 ml (Jones, 1982a). Dubowski and Esary (1985) made extensive measurements of expired air temperature for a large number of healthy male and female subjects. . . . Mason and Dubowski (1974) suggest that breath-alcohol analyzers should be equipped with a fast-responding thermistor device and in this way monitor the temperature of expired breath and, if necessary, adjust the breath-alcohol reading to a constant temperature for all subjects. Factors that elevate body temperature such as a fever might be expected to cause a rise in breath temperature and therefore in the expired breath-alcohol concentrations.”

TABLE 7

List of physiological variables potentially important in connection with breath-alcohol measurement for legal purposes. Failure to adequately control these biological factors will contribute to the variations in the blood/breath alcohol relationship reported in the literature.

- Phase of ethanol metabolism
- Arterio-venous differences
- Source of blood analyzed; arterial, venous, capillary
- Blood hematology: hematocrit value, salt, fat, and protein content
- Intra-pulmonary gas pressure
- Ambient temperature and humidity
- Expired-breath temperature
- Breathing pattern; hyper and hypo-ventilation
- Bronchopulmonary disease
- Presence of mouth alcohol
- Regurgitation of stomach fluids
- Phase of exhalation; end expiratory or top-lung air
- Breath specimen; rebreathed, end-expired, mixed expired
- Body temperature; hyperthermia–hypothermia

The conclusion of the study:

“In view of the data presented and the work of several other investigators, we believe that 37 deg C (98.6 deg F) should be abandoned as a concept having any particular significance for the normal body temperature. In the early morning, 37.2 deg C (98.9 deg F) and, overall, 37.7 deg C (99.9 deg F) should be regarded as the upper limits of the oral temperature of healthy adults 40 years of age or younger, and several of Wunderlich’s other cherished dictums should be revised.”

From the article:

“The origin of 34 deg C as the average breath temperature appears to predate modern literature indicating the average to be higher (34.4 -35.1). . . . Once a suspect’s breath temperature is known, the resultant BrAC can be corrected to 34 deg C. Utilization of this breath temperature correction feature in Alabama will follow the policy of giving arrestees every benefit of the doubt.”

As a result of the study, Alabama opted to switch breath testing equipment and no longer uses the Intoxilyzer 5000.
Draeger Alcotest 7110:

In order to prevent error from temperature variations, Draeger can measure the breath temperature of the subject.
Note:
Deviation of the actual end-respiratory breath temperature from the assumed 34°C will either over or underestimate the true alcohol concentration by 6.58% per one degree Celsius.

Rather recent studies suggest that the average breath temperature is between 34.5°C and 35°C.
2. Mouth Alcohol/GERD

Slope Detector:
A “normal” breath sample will give the following slope curve:
If the rise and fall is:
> + .003 per second, **AND**
> - .005 per second,
the *Residual Alcohol Detection System* will be triggered.
This is purely a software-driven algorithm that determines changes in
the slope detector
(Δ BAC/second).

- **Decline more than 5 mg%**
- **Rise more than 3 mg%**
If these values:
> + .003 per second, **AND**
> - .005 per second,
are not exceeded, the device will NOT detect the fresh mouth alcohol.

**True BAC + Mouth Alcohol Bias** will be reported

When mouth alcohol is present in small quantities with blood alcohol, an additive effect occurs.

From the article under the heading Regurgitation or Vomiting of Stomach Fluid Contents:

“The breath-instrument operator should make careful observations of the subject and record any body movements or unusual behavior just prior to testing. Some people suffer from a complaint known as gastro-esophageal reflux and these individuals might spontaneously bring up stomach contents into the throat and mouth. Indeed, alcohol consumption itself might provoke this gastro-esophageal reflux action. . . .”

Wells, David and John Farrar, “Breath Alcohol Analysis of a Subject with Gastric Regurgitation”, 11th International Conference on Alcohol, Drugs and Traffic Safety, 1989 (study included an individual with GERD who had abnormally high BAC readings which did not match either behavior or blood test results).

Gullberg, RG, “Breath Alcohol Analysis in One Subject with Gastroesophageal Reflux Disease”, J. Forensic Sci. 2001:46(6):1498-1503. (Did not find BAC bias in his only subject but admits it is a potential problem that needs further study. Recommends operators be trained to look for signs of it and ask questions about the condition.)
Gastroesophageal Reflux Disease

- Symptoms OR mucosal damage produced by the abnormal reflux of gastric contents into the esophagus
- Often chronic and relapsing
- May see complications of GERD in patients who lack typical symptoms
- About 44% of the US adult population have heartburn at least once a month
- 14% of Americans have symptoms weekly
- 7% have symptoms daily

- American College of Gastroenterology (ACG)
Pathophysiology

- Primary barrier to gastroesophageal reflux is the lower esophageal sphincter
- LES normally works in conjunction with the diaphragm
- If barrier disrupted, acid goes from stomach to esophagus
Stomach Alcohol In GERD

- Continual flow of acid + alcohol vapors spill out of stomach, into mouth

- Concentration of alcohol does not abruptly change, unless there is a burp (bolus)

- Intoxilyzer mistakenly reads stomach-alcohol vapors as part of the normal breath alcohol

- Net result is an inflated BrAC reading
Bottom Line on GERD:

WHEN THE LAW PROVIDES THAT A PERSON CANNOT REGURGITATE FOR 15 MINUTES PRIOR TO OR DURING A BREATH TEST OR THE TEST IS INVALID, AND THE PERSON BEING TESTED IS IN A CONSTANT STATE OF REGURGITATION, THE GOVERNMENT CANNOT PROVE THE BREATH TEST IS VALID.
3. Non-Specific for Ethyl Alcohol - Interferents

The Alcohols

- Methanol (Methyl Alcohol)
- Ethanol (Ethyl Alcohol)
- Isopropanol (Isopropyl Alcohol, or 2-Propanol)
- 1-Butanol (Butyl Alcohol)
Anything other than ethanol that may be on the breath of the test subject, and that either masks or enhances the reading of alcohol, is referred to as an *interferent*.

**Interferent Properties:**

- The substance must be **volatile** - Evaporates at room temperature
- The substance must be **non-toxic** or no more toxic than ethanol.
- It must have **chemical properties** (ie. infra-red absorptive characteristics) that make it unlikely to be distinguished from ethanol by the breath testing instrument.
- It has to have a reasonable and demonstrable **route of entry** into the human body.
Chemical Exposure

Chemicals that combine into a CH3 bonding pattern have the potential to be recognized (and counted) as alcohol molecules within the sample chamber. Examples of such substances are:

- Nail polish remover
- Auto body paint
- Floor refinishers and strippers
- Petrochemical products
- Commonly used home & garage solvents

This is not an issue for those casually exposed to solvents. It is relevant only for those working in occupations with extensive exposure. Ex. Manicurists, floor refinishers, computer technicians that clean parts with acetone, mechanics working on planes.
Case Notes: THE EFFECT OF SOLVENTS ON MEASUREMENT OF BREATH ALCOHOL CONCENTRATION (BrAC) BY THE INTOXILYZER 5000

Submitted by: Jay M. Poupko, Ph.D., Air Force Drug Testing Laboratory, Brooks AFB, Texas 78235

The Intoxilyzer 5000 is used by many law enforcement agencies for evidentiary breath alcohol testing. The instrument measures infrared absorption of a breath sample in the methyl stretch region at 3.39 μm and 3.48 μm. The dual wavelength measurement is employed primarily to detect and correct for the presence of acetone, which absorbs in this infrared region. The Intoxilyzer distinguishes between ethanol and acetone based upon differing 3.39 to 3.48 absorption ratios for these two substances. During the calibration procedure, the instrument electronically balances the absorption for ethanol at 3.39 and 3.48. If acetone is present (which has a different 3.39 to 3.48 absorption ratio), the instrument detects an unbalanced signal at these two wavelengths and indicates the presence of an interferent. Depending on the concentration of breath acetone, the Intoxilyzer will either correct for the acetone to obtain a BrAC result or abort the breath test.

A number of chemical solvents other than acetone that absorb in this infrared region may have the potential to cause a false positive or falsely-elevated result. Several years ago a case report was published concerning a cabinet maker exposed to lacquers and paint thinners who tested greater than 0.20 on the Intoxilyzer (1). Analysis of blood volatiles revealed 0.026% acetone, 11mg/L toluene and no detectable ethanol. Since the instrument corrects for acetone, it was concluded that toluene present in the lacquers and thinners was responsible for the false-positive result.

In addition to toluene, other chemical solvents such as methanol, isopropanol, xylene, methyl ethyl ketone, ethyl ether and aliphatic hydrocarbons may have the potential to cause false positive or falsely elevated BrAC results on the Intoxilyzer. There are very few published studies concerning these and other potentially-interfering substances. A rather extensive study on possible interfering substances was conducted on the Intoxilyzer 4011AS-A, an early intoxilyzer model that also measures absorption at 3.39 and 3.48 (2). Of eleven substances tested in this study, three solvents, methyl ethyl ketone, toluene and isopropanol, were found to cause false positive results on this instrument. One of the authors has recently related that similar results were observed with the Intoxilyzer 5000 (3). In another study using the Intoxilyzer 5000, N-propanol, toluene, diethyl ether, acetylateddehyde, methanol, isopropanol and gasoline were found to give false positive results when introduced directly into the instrument (4). This study also reported on a subject exposed to diethyl ether, who gave false positive BrAC results for 2.5 hours postinhalation.

“Case Notes: The Effect of Solvents on Measurement of Breath Alcohol Concentration (BrAC) by the Intoxilyzer 5000”, Jay M. Poupko, Ph.D, Air Force Drug Testing Laboratory, ToxTalk, Vol 23, No 1, March 1999
From a theoretical standpoint, a chemical solvent may cause a false positive or falsely elevated BrAC result on the Intoxilyzer 5000, if it possesses the following characteristics:

1. Organic, and sufficiently volatile.
2. Limited toxicity and thus present in high enough breath concentration in a conscious person.
3. Sufficient infrared absorption at 3.39 and 3.48 m.
4. A 3.39 to 3.48 m absorption ratio similar to alcohol.

There are few chemicals in use that possess the above characteristics necessary to produce a false positive BrAC. The possibility of a false positive BrAC, however, becomes more likely with exposure to a mixture of chemical solvents as found in many industrial products. This likelihood is further enhanced when an individual consumes less ethanol than the amount needed to reach the legal limit and is also exposed to chemical solvents. Thus, it has recently been demonstrated with certain combinations of ethanol and solvent, that the Intoxilyzer does not detect and subtract interferent and produces an inaccurate BrAC reading (5).

In what appears to be a response to the above concerns, the manufacturer of the Intoxilyzer, CMI, has recently included two new channels in its latest model: one to detect toluene and the other to detect acetaldehyde interference.

The problem of other potentially interfering solvents has yet to be addressed by the manufacturer. Furthermore many law enforcement agencies are still using the old 5000's that do not have the new channels. Consequently, the possibility of inaccurate BrAC results remains an issue for evidentiary breath alcohol testing.

References

3. Personal Communication, A. Weathermon.

The opinions expressed herein are strictly those of the author and are not to be construed as reflecting the views, policies, or positions of the Department of the Air Force, the Department of Defense, or the U.S. Government.
4. Breathing Pattern

The longer you blow, the higher you go:


Study compared 6 second with 24 second blows.

Results: .02 - .04 higher for 24 second blows
“Physiological Aspects of Breath Alcohol Measurement,”

From the article under the section “Breathing Technique”:

“The subject’s manner and mode of breathing just prior to providing breath for analysis can significantly alter the concentration of alcohol in the resulting exhalation (Jones, 1932c; Schoknecht et al., 1989). The effect of hyperventilation, high frequency deep inhalations and exhalations of room air, immediately before blowing into the breath analyzer has now been well studied (Mulder and Neuteboom, 1987; Normann et al., 1988). This breathing maneuver lowers the breath-alcohol concentration by as much as 20% compared with a single moderate inhalation and forced exhalation used as control tests (Jones, 1982c). Holding the breath for a short time (20 seconds) before exhalation increases the alcohol concentration in exhaled air by 15%.”
Individuals with smaller lung size can blow a sample that has a significantly higher alcohol reading than someone with a normal or large lung capacity. Dr. Michael P. Hlastala, PhD, of the Department of Physiology and Biophysics, Division of Pulmonary and Critical Care Medicine, University of Washington, has done extensive research and study in this area. Unlike other breath testing equipment used in other states, the Intoxilyzer 5000EN does not have the capability to measure volume of breath.


The major thesis of this paper is that lung size and breathing pattern influence BrAC reading determined with a breath-testing instrument. Everything else being equal (including BAC), the subject with the smallest lung size would have the greatest BrAC.
5. Partition Ratio

Partition ratio errors represent the greatest degree of error in the breath alcohol testing process.

\[ \text{BAC} = \text{BrAC} \quad \frac{2100}{1} \]
Values in the scientific literature for this ratio range from:

900:1 - 4100:1

Dr. A.W. Jones measured the ratio at:

- 1756:1 (1983)

Dr. Jones: “Partition ratio is a moving target”

\[
0.08 \div 2100 = 0.00003809523 \\
0.00003809523 \times 1800 = 0.068
\]
Even if we accept 2100:1 as the acceptable partition ratio, a distribution bell curve would show that this ratio overestimates the BAC in almost 20% of the population.
# Reported Partition Ratios

<table>
<thead>
<tr>
<th>Researcher</th>
<th>Year</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butler et al</td>
<td>1935</td>
<td>1900:1</td>
</tr>
<tr>
<td>Timmermans</td>
<td>1960</td>
<td>1600:1</td>
</tr>
<tr>
<td>Burnett</td>
<td>1963</td>
<td>2200:1</td>
</tr>
<tr>
<td>Schaefer &amp; Daubert</td>
<td>1969</td>
<td>1500:1</td>
</tr>
<tr>
<td>Rohrschneider</td>
<td>1973</td>
<td>2300:1</td>
</tr>
<tr>
<td>Jones</td>
<td>1983</td>
<td>1750:1</td>
</tr>
<tr>
<td>Gaffney and Senum</td>
<td>1984</td>
<td>2000:1</td>
</tr>
<tr>
<td>Snider &amp; Dawson</td>
<td>1985</td>
<td>1900:1</td>
</tr>
<tr>
<td>Meylan &amp; Howard</td>
<td>1991</td>
<td>2000:1</td>
</tr>
<tr>
<td>Yaws &amp; Yang</td>
<td>1992</td>
<td>1200:1</td>
</tr>
<tr>
<td>Jones et al</td>
<td>1992</td>
<td>1663:1</td>
</tr>
<tr>
<td>Jones &amp; Andersson</td>
<td>2002</td>
<td>2450:1</td>
</tr>
<tr>
<td>Lindberg et al (Jones)</td>
<td>2007</td>
<td>2250:1</td>
</tr>
<tr>
<td><strong>Median (Average)</strong></td>
<td>72 years</td>
<td><strong>1901:1</strong></td>
</tr>
</tbody>
</table>
Gas Exchange in the Alveolar Sacs

- Alveolar Sac
- CO₂
- O₂
- Ethanol
- Permeable Wall
- Blood Vessel
- to Bronchioles
Partition 2100:1

Reads 1, assumes 2100 more

Therefore 2100 exist
IF Partition 4200:1

Reads 1, assumes 2100 more

Assumes 2100 exist
BUT 4200 actually exist
Therefore: BrAC READING HALF of true BAC Level
IF Partition 1050:1

Reads 1, assumes 2100 more

Assumes 2100 exist
BUT ONLY 1050 present
THEREFORE: BrAC DOUBLE true BAC
Special thanks to Jan Semenoff, Bruce Kapsack, Pat Arata, John Churchill, Chris Hoover and Lenny Stamm for allowing me to use some of their slides in this presentation.
AV-rated attorney Deandra Grant’s practice is focused on DWI defense in Dallas and Collin County, Texas. She is a national speaker on DWI law and science and is the co-author of *The Texas DWI Manual*, scheduled for re-release in 2011. She is also the author of the popular Texas DWI Gal blog and the founder of the Texas DWI Defenders list serve. Deandra has completed the SFST certification course, the SFST instructor course, a Drug Recognition Expert overview course and was the first (and only) Texas lawyer to pass the Forensic Sobriety Assessment Certification exam. In addition, she has completed coursework in DWI forensic blood and urine testing and was trained as an operator and maintenance technician on the Intoxilyzer 5000. Deandra is a member of NCDD, NACDL, TCDLA (2011 DWI Committee), the Dallas Bar Association, the Collin County Criminal Defense Lawyers Association and has served on the Board of the Dallas Criminal Defense Lawyers Association since 2007. *D Magazine* named Deandra to its list of Best Women Lawyers in Dallas 2010 and Best Lawyers in Dallas 2011.