The Intoxilyzer™ 9000

by Mark Ryan Thiessen

Photographs and diagrams by Jan Semenoff
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CMI Inc.’s newest Driving While Intoxicated (DWI) breath testing device is being introduced to various states: the Intoxilyzer™ 9000 (hereinafter referred to as the “9000”). In my home state of Texas, we began breath alcohol testing on a statewide level in 1968 using the Breathalyzer. In 1980, Texas began using the Intoxilyzer 4011AS-A and in 1988 the Intoxilyzer 5000 was introduced. Currently, the Intoxilyzer 5000-68 EN (hereinafter referred to as the “5000”) is exclusively used in Texas for forensic breath alcohol testing. However, Texas is currently transitioning to the Intoxilyzer 9000 and training breath test operators through local technical supervisors. Implementation of the Intoxilyzer 9000 was scheduled for Summer 2015, but due to software issues and bugs, the machines have not been approved for evidential use. While we can only speculate at the actual software that will eventually be approved, much is already known about the Intoxilyzer 9000 from use in other states. Georgia and Colorado both now use the Intoxilyzer 9000 for evidentiary breath testing purposes.

By understanding the information and studies from other states regarding inherent shortcomings, a criminal defense lawyer can prepare to challenge the Intoxilyzer 9000 regardless of the final software. This article will equip the DWI trial attorney with the science of infrared spectroscopy and intimate knowledge of the Intoxilyzer 9000 needed to effectively represent clients.

How breath contains alcohol

All humans must breathe to stay alive. Breathing involves the absorption of oxygen from the environment and the elimination of carbon dioxide from the blood stream. We breathe through our mouth or nose and the air is transported by the trachea or windpipe into the lungs. In the lungs, the trachea branches into smaller air tubes called bronchi, which continue to branch and eventually terminate in small air sacs called alveoli. Capillaries, that are elastic in nature, surround these alveoli. It is in these pulmonary alveoli that blood is able, by diffusion, to release carbon dioxide and absorb oxygen for use throughout the body. If alcohol is present in the blood, it will also diffuse across the alveolar blood membrane into the breath in a fixed proportion to the alveolar blood alcohol concentration and the core body temperature.

The chemical principle that governs the diffusion of gases between the blood and the breath in the pulmonary alveoli is *Henry’s Law*. Henry’s Law states that the concentration of a material in the gas state above a liquid containing the dissolved material will be proportional to the concentration of the material in the liquid state. Henry’s Law applies to alcohol vapor (gas) in the lung in contact with blood (liquid) containing alcohol. Alcohol continuously diffuses across the one cell thick semi-permeable membrane of the capillaries into the air of the lung in proportion to its concentration in the blood. Ultimately, if given enough time, the breath alcohol concentration (BrAC) will reach a defined balance with the blood alcohol concentration (BAC) in accordance with Henry’s Law. This balance is called *equilibrium*.

At equilibrium, the relationship between the concentration of alcohol in the blood and the breath can be described by the blood to breath ethanol partition ratio. At 34 degrees Celsius, the purported average temperature of human breath, this blood to breath air ethanol partition ratio has been legislatively determined to be approximately 2100:1. Theoretically, at 34 degrees Celsius, there is the same amount of alcohol in 100 mL of blood as there is in 210 L of air in contact with...
that blood in a closed container. This assumes that the air within the container has had sufficient time to reach equilibrium with the liquid state. Thus, it is necessary to try to obtain an air sample from a defendant that has reached sufficient equilibrium between the air in the lungs and the pulmonary blood to satisfy accuracy and reliability.

(See the article in this issue of Counterpoint that focuses on Absorption – Editor)

**Infrared spectroscopy**

Before examining the specific issues with the Intoxilyzer 9000, a brief overview of Infrared Spectroscopy (IR) is needed. Depending on their atomic and electronic structure, molecules absorb energy (light) of well-defined wavelengths. For molecules, the relative intensity of infrared light absorption at different wavelengths functions as a molecular “fingerprint” specific to a given molecule. Thus, by evaluating the relative intensity of absorption at specific wavelengths of infrared light, one can specifically identify ethanol and hopefully differentiate its infrared response from other volatile compounds. Additionally, by measuring the amount of infrared light absorption at specific wavelengths, one can use a standard differential absorption technique to determine the amount of a given molecule in a sample. The Beer-Lambert Law dictates that the quantity of light absorbed will always be proportional to the concentration of the molecule in solution. This is the physical principle the Intoxilyzer 9000, and many other instruments, use to determine the amount of ethanol in a breath sample.

(For more information on this principle, see the article in the Introductory Issue of Counterpoint that introduces infrared spectroscopy – Editor)

### The Intoxilyzer™ 9000

The heart of the Intoxilyzer 9000 is its optical or analytical bench (see Figure 2 below). At one end of the bench (left side), an infrared LED source generates energy in the infrared region of the spectrum, which is pulsed through the sample chamber at a defined frequency. In the sample chamber, the infrared energy passes through a breath sample. If the breath is alcohol free, the infrared light should pass through the sample chamber freely; however, if alcohol is present, specific frequencies (or wavelengths) of infrared energy will be absorbed. At the opposite end of the sample chamber (right side), a lens focuses the energy (in the form of infrared light) onto a set of infrared energy (or light) detectors - four in total.

Prior to it reaching the detectors, four single-wavelength filters (that are integrated into the detector unit) filter the infrared light. Once the light passes through the filters and strikes the detectors, the detectors generate and electric signals proportional to the amount of light striking them. These signals are then transmitted to a Central Processing Unit that interprets the electrical signals.

![Figure 2 - The optical bench on the Intoxilyzer 9000](image-url)
Prior to the delivery of a breath sample, the instrument is designed to establish a zero reference point by measuring the amount of energy (light) striking the detector when the sample chamber is filled with ambient (or room) air. During a breath test, as the amount of alcohol vapor in the sample chamber rises, the amount of infrared energy (light) reaching the detector falls relative to the zero point measurement. By determining the difference in the amount of energy (light) striking the detector between the two measurements, the instrument is able to mathematically calculate the breath alcohol concentration in the test sample. The instrument then analyzes at the relative response at each of the four detectors to confirm the identity of ethanol to the exclusion of other substances, if possible.

In summary, the Intoxilyzer 9000 looks for the presence and amount of ethanol in a breath sample. It uses infrared light to both identify and quantify ethanol because ethanol absorbs infrared light in a unique way. The pattern of absorption is used to identify alcohol and the amount of absorption is used to quantify alcohol in a breath sample. The Intoxilyzer 9000 then reports the analytical result in grams of alcohol per 210 liters of breath.

**Inherent issues in the Intoxilyzer™ 9000**

**Non-specificity for ethanol**

The main difference between the Intoxilyzer 5000-EN and 9000 is in how the units determine the ethanol “fingerprint.” While the 5000 measured the carbon-hydrogen (C-H) bond vibrations in the 3-micron region of ethanol’s molecular fingerprint; the 9000 is measuring the carbon-oxygen (C-O) vibration in the 9 micron region. The problem exists that other molecules are commonly found in the human body with this same C-O stretching. Specifically, other organic molecules, which can potentially contaminate breath samples, also absorb IR radiation at 9 microns.\(^1\)

These include other alcohol, esters, and ethers that contain both the methyl group and carbon-oxygen bonds in their molecular structures. Dimethyl Sulfoxide (DMSO) exhibits IR absorption in both the 3.4 and 9.4-micron regions. DMSO is a common solvent for organic compounds and is also used in the treatment of interstitial cystitis (aka painful bladder syndrome) and scleroderma, with rapid absorption occurring through the skin and mucous membranes.

Additionally, diethyl ether, has been found to produce false ethanol readings at 3.4 and 9.5 microns, the latter overlapping absorption at 9.4 microns. Diethyl ether is widely used as a solvent for waxes, fats, oils, perfumes, alkaloids, and gums. Exposure to ether vapor is highly problematic because of its high tissue solubility and its low partition ration in humans. Among the numerous esters that can contaminate breath samples, ethyl formate, methyl butanoate, propyl acetate, and pentylation are noteworthy because they are synthetic flavoring agents that allow many products, including ice cream, soft drinks, candy and other foods to taste natural in flavor.

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\(^1\) Labianca, Dominick; Breath-alcohol analysis: a commentary on ethanol specificity in the 3 micron and 9 micron regions of the IR spectrum; Journal of Forensic Toxicology v. 24, pg. 92 (2006).
Furthermore, the GBI cited problems with the lack of sensitivity to compounds other than alcohol when evaluating the 9000.\(^1\) The 9000 actually scored the lowest of any competitor on the GBI survey to a list supplied by CMI to rate the specificity/selectivity for ethanol.\(^2\) Clearly breath-alcohol analysis via IR at 3.4 and 9.4 microns is not entirely ethanol specific and any subject’s employment, medical or eating history can and should be ascertained through appropriate evaluation of the subjects and the compounds.\(^3\)

**Important evidence in the histogram**

The 9000 produces a graphical representation of the breath flow, breath volume, blow duration and breath alcohol concentration for every subject test.\(^4\) Georgia and Colorado both produce variations of the histogram/graph. From this graph, the skilled defense attorney could determine:

- Was the breath flow was continual or spiked?
- Did the breath sample achieve sufficient slope to be considered a valid test?
- Was the slope indicative of mouth alcohol?
- Was the exhalation time sufficient to create a level slope? and;
- What was the breath alcohol concentration at any given point during the exhalation?\(^5\)

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\(^1\) GBI Evaluation of Breath Alcohol Testing Instruments to Replace the Intoxilyzer 5000, pg. 65 (September 2012). Compounds that were analyzed by the 9000 for specificity included: acetone, acetaldehyde, methanol, 2-propanol, toluene, ethyl acetate, 2-butanone, 2-butanol, 1-propanol, acetonitrile, methane chloride, and 2-methyl propanol. *Id.* at 93.

\(^2\) GBI Evaluation of Breath Alcohol Testing Instruments to Replace the Intoxilyzer 5000, pg. 64 (September 2012).

\(^3\) Labianca, Dominick; Breath-alcohol analysis: a commentary on ethanol specificity in the 3 micron and 9 micron regions of the IR spectrum; Journal of Forensic Toxicology v. 24, pg. 94 (2006).


The Texas Department of Public Safety (DPS) has chosen not to save or include the histogram next to the sample result. Why? Why wouldn’t Texas DPS provide all the information possible? The 9000 is absolutely capable and does produce a histogram with every breath test, but the software determines what is printed. In fact, the entire report format of the breath test results is configurable by CMI technical personnel per customer requirements.¹

**Texas failure to produce even more information**

According to the Texas 9000 breath test slip obtained by the author, Texas will also not produce the following information:

- The observation period start time;
- Observation period ended;
- Last instrument calibration date;
- Whether the observation period was conducted by a certified Breath Test Operator (BTO);
- Last BTO certification date;
- The BTO had the subject remove any foreign material from the mouth cavity;
- The subject was deprived access to foreign material during the observation period;
- The subject did not belch, regurgitate, or intake any foreign material into the mouth during the observation period; and
- The uncertainty measurement for the result.

All of this information is readily accessible and capable of being produced if Texas decided to do so.² The skilled trial lawyer will bring this to the jury’s attention and ask them to demand more open and honest forensic science. If there is nothing to hide, then why not provide all of the information possible?

¹ GBI Evaluation of Breath Alcohol Testing Instruments to Replace the Intoxilyzer 5000, pg. 54 (September 2012).

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**What is a histogram?**

A histogram is a graphical representation of the distribution of numerical data. Whether formatted as a pie chart, a bar chart, or a graph, the diagram representing those numbers is a histogram. Histograms are used by various breath test devices to graphically represent the numerical data produced by a breath alcohol device. The Intoxilyzer 9000 is the most recent evidentiary device to incorporate a histogram in its printout.

The histogram printed out on the Intoxilyzer 9000 breath test record sheet contains the following information:

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Figure 4 - The histogram printout from the Intoxilyzer 9000 with an explanation of the readout properties. Note that the BrAC Axis on the left has NO numerical values provided. Also note that the horizontal Time Axis can vary with the length of the subject's exhalation.

-Editor
Four filters with no Zero Set

The original 5000 used a tungsten filament light source that provided continuous IR and visible radiation to a 5-filter chopper/filter wheel that rotated in front of the detector. The 9000 use a grey-body infrared light that pulses the energy through the sample chamber to a stationary detector that contains four filters, each for a specific wavelength of IR radiation. Where the 5000 had a blank or a zero filter in the wheel, the 9000 does not have a detector for a true zero. Instead, the machine assumes or is programmed to read zero if the filters do not detect other samples besides alcohol.\(^1\) How can the machine be sure that it didn’t miss one of the contaminants listed above? If the detector has never been programmed or tested with the contaminants listed above, how can it truly be a zero? The answer is that it assumes that it is a zero. That’s not good enough for forensics.

Common issues between the 5000 and 9000

The 9000 still maintain several similar problems that juries have been responsive to. First, both Colorado and Georgia still use a 20-minute deprivation or observation period.\(^2\) Presumably, this is because CMI suggests this, but until CMI publishes it’s own operator manual, we will not actually know for sure.

Second, the CMI warranty is only valid for one year from the date of invoice to the initial purchaser. The warranty extends only to the original purchaser and does not include abuse, misuse, cables, switches, or use of the product for other than its intended purpose.\(^3\) Additionally, the warranty does not apply if the product is in any way tampered with or modified without express written permission from CMI, Inc.

CMI sells an extension of the warranty for one year for $125. The warranty argument will come into play after the first year since purchase, which should be soon with the delayed implementation in Texas.

Third, CMI still won’t sell the new source code or COBRA V5 software to the 9000 without a protective order and non-disclosure agreement. Any viewing of the source code must be done at CMI and may not be sent outside for independent analysis.

Fourth, CMI still won’t sell private citizens their machine.

Fifth, the breath tests must still be within 0.02 of each other.

Sixth, the 9000, although capable of running a dry gas simulator, Texas has chosen a wet bath compatible option like the 5000 simulator sample. As with any preparation of a simulator solution, human error is always a factor.

New 9000 issues

First, as discussed above, the optical bench is the heart of the 9000. The optical bench is shielded by a metal case that allegedly protects it from ambient electromagnetic radiation. However, it also has a radio frequency detection circuit that will still cause it to read radio frequency interference detected if a source is sufficiently strong and in the vicinity during the breath test. Why have the antenna and prompt if the optical bench is absolutely protected by the metal case?

Second, the new software has so many bugs and issues that the machines have been delayed for implementation until they can be “solved.”

Third, the sample chamber in the 9000 is only 6 inches long where the 5000’s was 10 inches long. This is a lot less room and a smaller sample being analyzed; therefore, any mistake will have a conversely larger effect in the measurement.
Finally, the 5000’s 3 way-mac valve has been replaced by a valve of least resistance in the 9000 that can actually go back and forth. Arguably, any valve that can go back and forth could allow contamination in from previous samples, ambient air, or even the simulator solution.

Why is Texas still with CMI?

In a comprehensive analysis of the Intoxilyzer 9000, the Swedish made Evidenzer 240 Mobile, and the DataMaster were tested in comparison to the Intoxilyzer 9000; the Intoxilyzer scored last in the diagnostic criteria where each machine was tested to determine whether it possessed all the necessary diagnostic elements to ensure accurate and reliable testing.\(^1\) Additionally, the evaluation clearly showed the users, supplied by the manufacturer, ranked the 9000 lowest in the specificity/selectivity of the machine to be completely specific for ethanol.\(^2\) Does Texas have some sort of exclusivity contract with CMI? Did Texas conduct its own evaluation against other machines? Can we see that report?

The Intoxilyzer 9000 was chosen and will eventually make its way into the hands of Texas breath test operators. It’s not a good sign that the machine already has software issues that delayed its initial implementation. However, the DWI trial attorney must be ready for the inevitable implementation. Like any machine, it is not perfect. It will not behave perfectly. The Intoxilyzer has certain inherent scientific issues that are ripe for cross-examination. Just as the State will always strive to bring the best in forensic science, we as defense attorneys must always challenge the State in their methodology and instrumentation. Only through these checks and balances will the citizens charged with DWI actually receive reliable and accurate forensic chemical testing.

\(^1\) GBI Evaluation of Breath Alcohol Testing Instruments to Replace the Intoxilyzer 5000, pg. 11-12 (September 2012).

\(^2\) GBI Evaluation of Breath Alcohol Testing Instruments to Replace the Intoxilyzer 5000, pg. 64-65 (September 2012).

References


GBI Evaluation of Breath Alcohol Testing Instruments to Replace the Intoxilyzer 5000, (September 2012).

References for Addendums:


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The Intoxilyzer Model 9000

Features at a glance

The Intoxilyzer Model 9000 is an evidentiary breath alcohol instrument that utilizes infrared detection somewhere in the 9-micron wavelength.

Range:
0 - 0.650 grams/210 litres
0 - 650 milligrams/210 litres

Pulsed Infrared Source:
A digitally controlled LED light source produces pulsed signals that are detected by 4 discrete detectors in the 9-micron wavelength. This eliminates the need to break up the signal with a motor and chopper wheel, as in the Model 5000.

Stated Accuracy according to CMI:
± 3% or ± 0.003 grams (3 milligrams) / 210 litres

Operating System:
• Microsoft Windows CE interface with 7” color touchscreen capability
• External keyboard with USB connectivity
• External touch sensitive signature pad with USB connectivity

Calibration Checks:
The Intoxilyzer 9000 can perform Calibration Checks with each breath test sequence using either Wet Bath or Dry Gas calibration.

Calibration Adjustments:
The unit is capable of performing multi-point Calibration Adjustments in the field.

Printer Capability:
On board internal Thermal Line Printer
External USB PCL LaserJet compatibility

Memory:
On board 128 Mb Random Access Memory (RAM) with 512 Mb of Nand Flash Memory (Nand flash memory is non-volatile storage that doesn’t require power to retain data). The unit is capable of SD card memory expansion to 32 Gb.

Connectivity:
• RJ-11 Analog Phone Plug
• RJ-45 Ethernet LAN Plug
• RS-232 Serial plug for Simulator
• 2 USB plugs for keyboard/signature pad/card swipe connectivity

Physical Specifications:
Width 14”
Height 6¾” with unit in lowered position
Length 14½” without Gas,
19” with Gas Calibration Module
Weight 10 lbs without Gas
12 lbs with Gas Calibration Module
Power 110 Volts AC
12 Volts DC Power Source

Temperature Range:
32-104°F or 0-40°C

Display:
The 7” color touchscreen is capable of displaying a real time graph of the subject’s exhalation profile. See the topic What is a Histogram? on Page 36.

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The Absorption of Ethanol

Trial lawyers are often faced with issues surrounding the movement of alcohol through the human body. This article will address the absorption of alcohol, and discuss some of the issues surrounding the first stage of movement in the “alcohol consumption system.”

By Jan Semenoff

In Defense of Standardized Field Sobriety Testing
A Review of their Logic & History

This is the first of two articles from one of the researchers involved in developing and validating Standardized Field Sobriety Tests. This paper provides some background on the logic and history of the “Fields.”

By Dary Fiorentino, Ph. D.

The Intoxilyzer 9000

An overview of one of the latest evidentiary breath alcohol testing devices recently introduced to North America.

By Mark Ryan Thiessen

Police Body Cameras

More and more, public watch groups are calling for the full scale implementation of police body cameras. This article will look at the capabilities of the current cameras available, and discuss some of the policy and implementation criteria.

By Jan Semenoff
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Final Thoughts

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In the Winter 2016 (Volume 1, Issue 2) issue of Counterpoint we are scheduling¹:

- An explanation of how infrared spectroscopy is used in evidentiary breath alcohol devices
- Part 2 on the DUI investigations article
- Part 2 of ADME - an introduction to the distribution and elimination of ethanol in the human body, and a discussion of elimination rates
- An introduction to blood to breath ratios
- Part 2 of Dary Fiorentino’s discussion on the SFSTs
- A look at what the average juror understands about science, and how we confuse juries as a result.
- A look at roadside screening devices, and how they are affected by ambient temperatures during operation
- A review of those little mini-keychain breath test devices, and what to tell your client if they used one...

Until then, enjoy the holidays. I look forward to receiving your comments on this FIRST issue. Take care...

Jan Semenoff
Editor-in-Chief

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¹ We may make article substitutions and revisions based on availability at release time.