An Introduction to the

Intensive

Breath Alcohol Testing Workshop

Module 1

Intoxilyzer® 9000 & Intoximeter® DMT Dual Analytical

The DUIDLA Fall Seminar 2017

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Forensic Criminalist
Editor – Counterpoint Journal
THE INTENSIVE BREATH TESTING WORKSHOP
AN INTRODUCTION TO MODULE 1

Focusing on the Intoxilyzer® 9000 and Intoximeter® DMT Dual-Analytical Breath Test Devices

THE DUIDLA FALL SEMINAR, September 2017
CHARLESTON, SOUTH CAROLINA

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The Intensive Breath Test Workshop

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Part 1: Introduction to Breath Testing

Critical science you need to know about Breath Alcohol Testing

Recommended Reference Materials:

**Articles:**
- Understanding Infrared Spectroscopy
- The Intoxilyzer 9000
- The Intoxilyzer 9000 & the Unknown
- The Calibration of Breath Alcohol Testing Devices

**NEW:**
- The Intoxilyzer 9000 – RADS
- The Intoxilyzer 9000 – Specificity
- The Intoxilyzer 9000 – RFI

**Counterpoint Issue:**
- Free Issue, Page 19
- Volume 1, Issue 1, Page 31
- Volume 1, Issue 3, Page 196
- Volume 2, Issue 1, Article 3
- Volume 2, Issue 2, Article 3
- Volume 2, Issue 3, Article 4
- Volume 2, Issue 2, Article 5

Infrared Spectrophotometry

*Beer’s Law? … Yes, it really is called “Beer’s Law”*

**Beer Law # 1** – Beer before liquor… get drunk quicker.
**Beer Law # 2** – Beauty is in the eye of the beer-holder.
**Beer Law # 3** – One beer, two beer, three beer, four;
Five beer, six beer, seven beer - floor

**Beer’s Law** - The Beer-Lambert law (or Beer's Law, is the nearly linear relationship between absorbance and concentration of an absorbing substance). In other words, increasing the amount of a substance put inside a test cylinder will increase the amount of radiation absorbed by the substance. An increase in the alcohol concentration inside the test cylinder will increase the amount of EM radiation absorbed by the alcohol, and decrease the amount of EM transmission through the alcohol.

While although beer laws # 1, 2 and 3 are undeniably true, it is in fact the *Beer-Lambert Law* (referred to simply as *Beer’s Law*) that has a direct implication in the operation of the Intoxilyzer Model 9000 and the infrared component of the Intoximeter DMT. We need to first look at the nature of electromagnetic radiation and infrared spectrometry to understand Beer’s Law.

One form of energy is electromagnetic (EM) radiation. The light bouncing off this page and into your eyeball is an example of EM radiation at work. Look towards a light source in the room. You are again experiencing EM radiation in the form of visible light hitting your eye. Look at that light bulb for too long, and you will be left with the residual signature of the EM radiation, as it only temporarily burns into the back of your eyeball, leaving a ghost image.

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1 This law also applies to liquids, and is used indirectly in the color change determination used in the Breathalyzer.
Electromagnetic Radiation and the Electromagnetic Spectrum

EM energy can be found in many forms. Your car radio is an AM-FM EM detector. *(Sorry, I couldn’t resist).* The microwave oven in your kitchen is a generator of microwave EM radiation. X-Rays are a form of EM radiation. Infrared is another form of EM radiation. You get the picture. *See Figure 1 below.*

Obviously, there is considerable energy transfer with most forms of EM energy. Energy at the short wavelength end of the spectrum, being higher in frequency, can do a lot of damage. Gamma radiation is quite deadly and most people prefer to limit the number of x-rays they receive. Even the amount of ultraviolet radiation you receive is subject to control measures, at least in the Occupational Health & Safety setting, where employers are required to provide UV protection for outside workers.

In the visible light spectrum, energy transfer is still considerable. Most people have experienced sunburn, or the shock of flicking on the bathroom light in the middle of the night. Once you move into the infrared spectrum, energy transfer is still apparent. If you’ve ever had a filling cured by the dentist using that light probe stuck in your mouth, you’ve experienced first-hand the transfer of ultraviolet energy. There are radio waves, including radar and microwaves. Microwave energy transfer occurs in many kitchens every day. Radar waves have been known to burn out delicate electronic equipment, and there is debate about the apparently higher incidence of testicular cancer amongst police radar operators, who often leave their radar “guns” lying on their laps in standby mode while running radar.

In this diagram, it is important to know that there is no set delineation point between one type of EM energy and the next. Ranges overlap, and some energies can be considered to have characteristics of both. Some infrared sources also emit radio waves, and some UV rays have properties of x-rays. The divisions are for the convenience of humans, who tend to like to compartmentalize intangible ideas.

![The Electro Magnetic (EM) Spectrum](image)

*Figure 1 - A Representative Diagram of the Electro-Magnetic Radiation Spectrum*
Beer’s Law, the EM Spectrum, and Alcohol Testing

Imagine being at a movie, a much-anticipated sequel. As the movie starts, people start to get up in front of you. Some go for popcorn; some go to the bathroom. Some change seats. One guy just walks back and forth in front of your seat. Your ability to see what happens to your beloved lead character is being severely compromised by the people passing in front of you. In scientific terms, their opaque bodies are absorbing the EM radiation (the visible light spectrum) bouncing off the screen, and into your eyes – your EM detector in this example. As more people walk in front of you, their absorbance of the EM radiation from the screen increases. You see less. In other words, your eyes (your EM detectors) absorb less EM radiation. Frustrated, you leave the theatre and wait for the movie to come out on Netflix™.

It is that perceived drop in strength of the infrared light passing through the test chamber that is used to calculate the concentration of ethanol molecules in the breath sample. A higher amount of ethanol in the sample means less infrared energy can pass through the sample. As long as the unit is calibrated, the sample concentration can be quantified.

How the Intoxilyzer 9000 calculates a Breath Alcohol Concentration

The Intoxilyzer Model 5000 used five-points in the 3 - 4 micron (µ) range to calculate the BrAC of a test subject, while the Model 8000 uses only two points at 3 & 9µ. The latest Intoxilyzer Model 9000 uses four points somewhere in the $\geq 8\mu$ - $\leq 9\mu$ range to make these calculations. *The Beer-Lambert equation is used to calculate the concentration of ethanol in a breath sample.*

In a given sample, the four wavelengths will produce four discrete voltage signals at the infrared detector. The unit is programmed to detect a change in the relative BAC measurements at each wavelength. Any value OTHER than what is expected will trigger the INTERFERENT DETECT algorithm.

![Figure 2: The infrared signature of ethanol at the $\geq 8\mu$ - $\leq 9\mu$ ranges.](image)
The Sample Chamber and Optical Bench

The optical system is comprised of three parts:
1. The pulsing infrared (IR) source
2. The sample chamber
3. The IR detector with four single-wavelength detectors

The spinning filter wheel, “chopper” motor and infrared filters of the Model 5000 are gone. Instead, the IR source “pulses” by flickering on and off at a frequency of 10 cycles per second (10-Hz). It produces radiation between 8 and 9 microns. Think of the source as more of a flashing light than a continuous light bulb, and you’ll get the picture on how it works. It should last longer, and will draw less power. However, it can’t pulse as quickly as with the spinning filter wheel, with light passing through and broken up by the “chopper wheel”. As a consequence, the ability of the unit to determine false positive mouth alcohol bias may be affected.

The sample chamber is also different than on the Model 5000, and perhaps the 8000. We don’t know the actual design of the sample chamber – whether it is a single chamber or uses a pre-chamber design as in the Intoxilyzer 8000. We think that the chamber is a flow through design, and does not incorporate a folded-path for the optical component. The temperature of the chamber is heated to 47°C, +/- 0.2°C.

With the use of four IR detectors, one of the weaknesses of the 5000 is replaced. The detectors absorb between 8 and 9 microns, and convert the IR signals to an electrical signal that can be processed by the CPU of the unit.

Figure 3 – The sample chamber and four infrared detectors of the Intoxilyzer 9000
How the Intoximeter DMT calculates the Breath Alcohol Concentration

The Intoximeter DMT uses infrared technology, and applies the Beer-Lambert Equation, in the same manner as the Intoxilyzer 9000. We know the DMT uses infrared filtration in the 3-micron range, using three discrete narrow band filters. The DMT Dual Analytical unit adds another dimension – a fuel cell – to determine the presence and concentration of ethanol in the test chamber.

![Image](data-master-dmt.png)

Figure 4 - Three points are used by the DMT to measure ethanol using an infrared detector.

Fuel Cell Sensors

Recommended Reference Materials:

**Articles:**
- *Fuel Cell Basics*
- *An Introduction to Roadside Testers*

**Counterpoint Issue:**
- Free Sample, Page 38
- Free Sample, Page 60

Fuel cell sensors are true electrochemical devices. They oxidize the substance to be analyzed, in this case ethanol, on a catalytic surface – a platinum electrode. The platinum electrode forms the anode of the fuel cell. The other side of the cell reduces atmospheric oxygen at the platinum cathode – the counter electrode in the cell.

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2 To oxidize in this case is to remove one or more electrons from the compound in question.
3 The anode is the positive electrode of the device, the point of departure for the electrical energy from the fuel cell. Think of it as the “+” pole of a battery.
4 The cathode is the negative electrode of the device, the point of entry of electrons into the fuel cell. Conversely, this is the “-“ pole of a battery.
The two platinum electrodes are separated and supported by a thin porous ceramic disc that is impregnated with a reagent - an acidic electrolyte solution. The fuel cell oxidizes ethanol into acetic acid (in comparison, vinegar is roughly 5% acetic acid by volume). The fuel cell is designed to produce a self-sustaining oxidation of ethanol at the cell’s negative pole, initiating electron flow and therefore current generation to the cell’s positive side. Basically, it becomes a battery producing an electrical current.

Quantifiable fuel volume produces a measurable reading

The only variables we have are the volume of sample introduced, and the concentration of ethanol in the sample. Ultimately, the breath testing device will control the breath sample through the volume of its sample chamber. (See “The Breath Sampling System” in the article on Roadside Screening Devices in the free sample issue of Counterpoint). This leaves only the ethanol concentration as a variable. More ethanol ultimately produces more electrical current. Therefore, the unit must be calibrated to know that a specific concentration of ethanol produces a specific electrical current. This electrical current is equivalent to a specific Blood Alcohol Concentration (BAC) reading.

**Activity #1**

At your table, record any questions you have about the operations of a breath testing device such as the Intoxilyzer 9000 and the Intoximeter DMT (15 minutes).

We will collect the questions and address them now (15 minutes)
Notes:
Operational & Procedural Foundations

What scientific and procedural foundations are necessary for an accurate and reliable breath test? What are some specific issues?

Reference Materials:

**Articles:**
- An introduction to DUI Investigations
- Accuracy, Precision & Reliability

**Counterpoint Issue:**
- Free issue, Page 29
- Volume 1, Issue 1, Page 52

Accuracy, Precision & Reliability

Close Only Counts in Horseshoes and Hand Grenades

In order to have any perceived value as a breath testing instrument, we need to establish that the readings obtained are true indicators of the blood alcohol concentration of the subject. This leads us to four important concepts:

- **Accuracy**
- **Precision**
- **Reliability**
- **Specificity towards ethanol**

**Accuracy**

In order to be considered accurate, an instrument must provide a reading that is true and correct. In breath testing, accuracy refers to the ability of the instrument to provide a breath sample reading that is highly correlated to the “true” blood sample concentration. We could express that concept as:

\[ [B_{rAC}] \equiv [BAC] \]

or

[Breath Alcohol Concentration] is exactly equal to [Blood Alcohol Concentration]

Much of the accuracy of breath alcohol testing instruments are tied to the fundamental hypotheses and working models of their design. The *Partition Ratio*, discussed later in this workbook, sets the working ratio between BrACs and BACs. If indeed 2300:1 is a more correct average partition ratio, then no, breath alcohol testers that use a 2100:1 value are NOT accurate. Their readings are only 91.3% accurate.

**Precision**

*Precision means reproducibility*. It is the ability of an instrument to provide the same readings, or nearly the same readings, as we measure the same sample repeatedly. You may know this as “standard deviation.”
You are the judge of an Olympic competition. Don’t worry if you don’t have the qualifications; recent events seem to indicate qualifications are not necessary. You will be judging the ability of an archer to hit the bull’s-eye on a target. You can stand close, but not too close, to the target and watch each arrow strike the target. Fifty shots, and the competitor you are scoring strikes 50/50 in the bull’s-eye, all within mere inches of each other, an amazing feat. You grade the competitor accordingly, and she gets the silver medal because the fix is in with the judge from…never mind.

![Accuracy versus Precision](image)

Your competitor was accurate. She was able to place her arrows in the bull’s-eye within a few inches of one another, and the average of all her shots was the center of the bull’s-eye. In the second round of shots, your competitor was also precise, as she was able to place all 50 arrows in that bull’s-eye with reproducible ease – but she kept missing the center of the bull’s-eye. In the final round, she got both accurate and precise, hitting the center of the target with precision, time and again.

We have a situation where you can judge based on the qualitative assessment of your eyes, and provide a quantitative assessment using your little Olympic-judge issued ruler. That would be fine if you knew a test subject’s true BAC.

Reliability

Reliability is a systems concept. See the article in Counterpoint, Vol. 1, Iss. 1, page 52 for more information on reliability.

Activity #2

At your table, co-construct a series of questions for instrument operators based on these 5 foundational precepts for breath test admissibility (15 minutes).

We will collect the questions and discuss (15 minutes)
Part 2: Breath Testing Errors – Machine & Human Factors

Are there systemic errors in Breath Alcohol Testing?

Reference Materials:

**Articles:**
- Blood to Breath Ratios in Breath Alcohol Testing
- The Bell Curve & Standard Deviation

**Counterpoint Issue:**
- Volume 1, Issue 2, Page 136
- Volume 1, Issue 3, Page 169

Partition Ratios – The Blood to Breath Ratio

What is old is new again. With the July 2009 California decision in the *People v. McNeal*, the issue of partition ratios is more relevant than ever. The *Partition Ratio* is the ratio between the alcohol *dissolved in the blood* to the alcohol *exhaled in the breath* \(^5\) at a given point in time. The currently used blood/breath ratio assumes that 2100 parts of breath contain the same quantity of alcohol as 1 part of blood. This is sometimes referred to as the *partition ratio*. Remember, as respiration occurs, the ethanol and carbon dioxide molecules must migrate across the permeable partition of the blood vessel walls, and into the alveolar sacs of the lungs, where they are exhaled.

The first serious attempt at establishing the Partition Ratio began in 1930 when Liljestrand & Linde established a ratio of 2000:1. Harger and Borkenstein the inventors of the Drunkometer, also used the 2000:1 ratio, based on the previous work. But, between 1930 and 1953, debate ensued over the true ratio, with some postulating ratios as low as 1300:1, and others arguing for ratios of 2100:1 and beyond. The debate was quelled somewhat in 1953 when a special committee appointed by the U.S. National Safety Council concluded that the ratio was approximately 2100:1. This became the de facto standard in North America, and much of the world.

Since its inception in 1954, the Breathalyzer used the 2100:1 ratio, and that ratio has since become the accepted standard by government agencies and breath alcohol testing committees when determining instrument certification for approved screeners and evidentiary instruments. This ratio is used by the testers produced by all manufacturers for the North American market.

Numerous average values and ranges have been reported in refereed medical journals, scientific journals and non-scientific websites. For many years, the value of 2100:1 was accepted as the population average. While values in the scientific literature\(^6\) for this ratio range from 1300:1 to 2700:1 (with some research as low as 1100:1, and as high at 3400:1), the currently accepted value used in North America\(^7\) for the partition ratio is 2100:1. However, the debate continues to this day. *Think of the ratio more as a compromise that we inherit from the 1950’s, rather than an absolute number.*

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\(^5\) I point out in passing that if the law in your jurisdiction expresses the legal limit for driving as 0.08 grams alcohol per 210 litres of breath, this particular debate is moot. In the United Kingdom, the Road Traffic Act stipulates legal limits based on the amount of alcohol in the blood, or the amount of alcohol in the breath, or the amount of alcohol in the urine. Conversion factors do not apply.


\(^7\) In Great Britain and Holland, a partition ratio of 2300:1 is used. In Australia, Canada, Norway, Sweden and the US, 2100:1. Austria has chosen 2000:1.
However, 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 - too many people for a comfortable margin of error. That ultimately means that 20% of persons charged at or just over the statutory limit were in fact below that value, according to a true representation of their blood alcohol concentration. *Is +20% error an acceptable margin for borderline cases?* I certainly hope not. I hope a +20% error rate does not hold true for the rest of the criminal justice system. The +20% value is also disputed, with some researchers saying that the 2100:1 ratio probably overestimates roughly only 5-10% of the population.

In order to provide a level of confidence in the partition ratio of 99.7% of the population, we would need to use a 1555:1 partition ratio. This would provide BACs of approximately 75% of the 2100:1 readings. Therefore, a true Blood Alcohol Concentration of 0.100 would be reported as a Breath Alcohol Concentration of 0.075. The vast majority of drivers that I observed as a Qualified Technician had BACs around 0.160 - 0.180. Even if we adopted this seemingly low 1555:1 ratio, these drivers would still have breath test results at 0.120 - 0.135. The net effect by adopting a lower partition ratio would be to achieve a confidence level in 99.7% of the population, and eliminate criminal charges for borderline of marginal cases, where as many as 20% of the population may be unfairly criminalized.

Dr. Kurt Dubowski has proposed that in order to correct for partition rate variables, it would be appropriate to subtract 0.025 g from all breath results. Dr. A.W. Jones measured the low-end of the ratio at 1756:1 (in 1983) and 1663:1 (in 1992), and this leads to an over-reporting of the partition ratio by 20%. Keep in mind, breath alcohol analysis is an indirect measure of blood alcohol concentrations.

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Fresh Mouth Alcohol, Residual Alcohol Detection, and Wait Periods

Can breath test operators make errors that affect test results? What should you look for?

Reference Materials:

**Article:**

*Breath Sampling Criteria*
*Establishing Reliability*

**Counterpoint Issue:**

Volume 1, Issue 4, Page 302
Volume 1, Issue 4, Page 309

The slope detector plays an important role in determining the presence of fresh-mouth alcohol. A subject who may have recently introduced alcohol into their mouth and respiratory tract by:

- Vomiting
- Burping
- A condition such as *Acid Reflux Disease, or GERD*

will have an initial rapid rise in BAC that also falls off sharply as the false-high alcohol reading dissipates and is replaced by a “true” near-level slope. Let’s pretend that the subject above has “micro-burped” immediately prior to or while providing a sample, as shown in red:

![Figure 8 – Sample slope caused by the introduction of fresh mouth alcohol.](image)

The Intoxilyzer 9000 has different requirements in determining a suitable sample. First, there is a minimum flow rate requirement of 0.15 litres per second, with a minimum breath time of five seconds. The sample must be a minimum of 1.1 litres in volume. The IR source on the Intoxilyzer 9000 pulses at only 10 cycles per second (Hz). With four filters, a reading is obtained every 1/10 of a second (100 milliseconds). As the pulses are analyzed, consecutive BAC readings that do not differ by more than 3 percent will indicate a level slope. Once the four criteria (flow rate, time, volume and slope) are met, a Zero will appear in front of the preliminary breath test results.

The forensically acceptable standard of obtaining two readings within 0.02 grams/100ml of each another, coupled with the observation period between the two readings *assists* in obtaining suitable samples. The slope detector system adds only a certain degree of validity to our testing process.
Many jurisdictions around the world do not obtain two readings, so the slope detector becomes even more valuable to them.

However, it has been my experience that the slope detector can, and often is, fooled under a variety of circumstances, most notably, recent consumption of an amount of alcohol, similar to what would occur during a burp or “micro-burp”. Listerine PocketPaks® also give a minor but perceptible false positive reading. This circumstance is precisely what the slope detector was designed to detect. I have routinely observed the slope detector fail to register mouth alcohol that is a few minutes old, often allowing the unit to register an abnormally high reading given a simple swish of alcohol. I can only conclude that the slope detector is merely an investigative aid, and is a highly inaccurate detector of mouth alcohol. More alarming is the apparent inability of the Intoxilyzer 9000 to accurately determine this contamination. My data shows that the 9000 routinely gave false positive readings with a minimum mouth alcohol contamination, often well beyond the legal or per se limit. Simply put, Slope Detectors don’t work…

Obtaining Proper Samples & Operational Implications

Relying upon the pressure / time / slope detector to automatically determine the suitability of the sample is insufficient. It must still be the responsibility of the qualified technician to ensure that a suitable sample is properly obtained. Some subjects will be able to provide a breath sample that far exceeds the minimum 5-second requirement of the pressure-time circuit. The Model 5000, 8000 or 9000 sets minimum standards for a suitable sample, based on an average subject. The qualified operator is the one who must ensure that a given subject has provided their own unique suitable sample.

There is no manual override on the Model 5000, 8000 or 9000 as there are on some roadside screeners that are capable of automatically drawing a breath sample into the test chamber. The Model 5000, 8000 and 9000 will continue to receive the sample as long as its parameters don’t fall outside the slope detection system’s threshold values. As long as the subject continues to provide air sufficient to keep the pressure transducer open, the sample will be analyzed either 4, 10 or 30 times per second. This, coupled with an observation period of a reasonable length of time, should provide a degree of credibility in the breath testing results. But remember, an observation period is exactly that – observation. The operator should be paying attention with their eyes, ears, and in some cases their noses to detect the smell of the fresh burp, or unnoticed “micro-burp”.

Activity #3
At your table, co-construct a series of questions for instrument operators based on the issue of fresh mouth alcohol, and deprivation and wait periods for breath test reliability (15 minutes).

We will collect the questions and discuss (15 minutes)
Operator Malfeasance: Is this even possible?

*Can an operator affect the outcome of an evidentiary Breath Alcohol Test?*

**Activity #4**

*At your table, discuss the issues of instrument operators willfully interfering with suitable test procedures to obtain improper results. Is this even possible? Have you experienced this situation, or suspected it has occurred to your client? How do you address the situation in court? (15 minutes).*

*We will discuss the issue as a group (15 minutes)*

Notes:
Standard Acts, Practices & Conditions

How to incorporate these fundamental concepts into your case...

Reference Materials:


Counterpoint Issue: Volume 1, Issue 4, Page 309

<table>
<thead>
<tr>
<th>INHERENTLY RELIABLE</th>
<th>INHERENTLY UNRELIABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>STANDARD PRACTICE</td>
<td>SUB-STANDARD PRACTICE</td>
</tr>
<tr>
<td>Routine maintenance procedures performed annually according to the jurisdiction’s or manufacturer’s instructions or recommendations</td>
<td>Maintenance not performed at required intervals, not performed altogether, or not performed according to the jurisdiction’s or manufacturer’s instructions or recommendations</td>
</tr>
<tr>
<td>Simulator solution changed according to requirements, using traceable standard</td>
<td>Simulator solution not changed in a timely manner, or not performed using traceable standard</td>
</tr>
<tr>
<td>STANDARD ACT</td>
<td>SUB-STANDARD ACT</td>
</tr>
<tr>
<td>Instrument diagnostics performed and passed at routine intervals</td>
<td>Instrument diagnostics not performed, or performed at sub-standard intervals, or instrument does not pass but left in service</td>
</tr>
<tr>
<td>Calibration and maintenance records retained for external review</td>
<td>Calibration and maintenance records not retained, or not available for external review</td>
</tr>
<tr>
<td>STANDARD CONDITION</td>
<td>SUB-STANDARD CONDITION</td>
</tr>
<tr>
<td>Test subject free from medical conditions that make them unsuitable candidates for testing</td>
<td>Test subject has medical conditions that make them unsuitable candidates for testing</td>
</tr>
<tr>
<td>Testing environment free from contaminants or sub-standard conditions</td>
<td>Testing environment that contains contaminants or sub-standard testing conditions</td>
</tr>
</tbody>
</table>

Table 1 – Examples of standard acts, practices and conditions, and their counterparts; Sub-standard acts, practices and conditions

Practice Takeaway

* A practice, action or condition that is inherently sub-standard is by definition unreliable. An inherently unreliable practice, action or condition yields, by definition, an unreliable result. Therefore, an unreliable result cannot be accepted beyond a reasonable doubt.

* It holds that the inherently unreliable result gives rise to a reasonable doubt.
## Communication Messages on the Intoxilyzer 9000

<table>
<thead>
<tr>
<th>Message</th>
<th>Description</th>
<th>Common Causes</th>
<th>Recommended Actions</th>
</tr>
</thead>
</table>
| Invalid Sample        | The instrument has detected a drop in the BrAC during the exhalation profile | • Residual or Mouth Alcohol                                                                                                                  | • Initiate a new 20-minute deprivation period and then retest the subject.  
  • Request a blood test if necessary. |
| Insufficient Sample   | The subject did not provide a breath sample that meets the requirements for flow, volume, and level slope. | • Medical or physical limitation in providing a sufficient sample  
  • Intentional non-compliance with the operator’s instructions. | • Re-instruct the subject and request a second test.  
  • Inquire of the subject if they possess any medical conditions that would prevent them from providing a good sample.  
  • Assess the stature of the subject. |
| Diagnostic Fail       | One of the instrument’s internal checks is out of tolerance.                | • The instrument did not sufficiently warm up before running the self-diagnostic  
  • RFI detected during diagnostic.  
  • Depending on the nature and frequency, maintenance may be needed | • Allow the instrument to warm up for an additional 10 to 20 minutes.  
  • If the problem occurs again after the additional warm up time and the cause can’t be identified, put an out of service sign on the instrument and contact your local area supervisor. |
| Out of Tolerance      | The measurement from the ethanol gas standard is not within 5% or 0.005 g/210L of the target value.  
  (Note: Failure of the ITP part of the diagnostic will produce a similar warning on some software revisions. If the warning is Diagnostic related see the Diagnostic Fail) | • Low tank pressure  
  • Improper tank installation/ Leak in gas pathway  
  • Dry gas pathway obstructed  
  • Improper ventilation during air blank / mouth piece not removed after subject sample.  
  • Low level ambient alcohol  
  • Instrument is in need of calibration.  
  • ITP failure during diagnostic. | • Verify environmental conditions.  
  • Check tank pressure and installation and if necessary change tank. Force the instrument to initiate another dry gas check from the tank installation screen and if it passes attempt an-other test.  
  (Note: The I9000 will remain locked until this is done)  
  • If a second consecutive warning is obtained, change tanks. If the same warning is then obtained from a different tank put an out of service sign on the instrument and contact your local area supervisor for instructions. |
| Ambient Fail / Purge Fail | The sample chamber cannot be sufficiently purged of air containing alcohol or various other volatile chemicals. | • The area around the instrument contains some source of alcohol or volatile chemicals such as cleaners.  
  • The breath sample pathway is obstructed.  
  • Improper ventilation / mouth piece not removed promptly | • Ventilate the area and retest the subject.  
  • If the conditions persists and cannot be corrected, put an out of service sign on the instrument and contact your local area supervisor. |
| RFI Detected          | A strong source of radio frequency was detected by the instrument.          | • Police radio transmission.  
  • Intermittent transmissions from cell phones or wireless recording devices | • Locate the source of the RF, eliminate it and retest the subject.  
  • Turn off all cell phones and wireless devices. |
| Interferent Detected  | There is a significant quantity of a volatile organic chemical in the subject’s breath producing a response at the instrument’s detector. | • Volatile or inhalant abuse  
  • Metabolic or Diabetic ketosis  
  • Foreign object in the subject’s mouth | • Assess the subject, re-read implied consent and request a blood test. |

Table 2 – Communication messages for the Intoxilyzer 9000
## Communication Messages on the DataMaster DMT

<table>
<thead>
<tr>
<th>Status Message</th>
<th>How to fix the problem:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ambient Fail</strong></td>
<td>1. Remove the subject from vicinity of the DataMaster (try test again)</td>
</tr>
<tr>
<td></td>
<td>2. Ventilate the room</td>
</tr>
<tr>
<td></td>
<td>3. Purge the sample chamber</td>
</tr>
<tr>
<td></td>
<td>4. Perform a non-drinking subject test</td>
</tr>
<tr>
<td></td>
<td>5. If ambient fail persists contact crime lab</td>
</tr>
<tr>
<td><strong>Blank Error</strong></td>
<td>1. Remove the subject from vicinity of DataMaster</td>
</tr>
<tr>
<td></td>
<td>2. Ventilate the room</td>
</tr>
<tr>
<td></td>
<td>3. Purge the sample chamber</td>
</tr>
<tr>
<td></td>
<td>4. Perform a non-drinking subject test</td>
</tr>
<tr>
<td></td>
<td>5. If blank error persists contact crime lab</td>
</tr>
<tr>
<td><strong>Breath Tube Temperature Check</strong></td>
<td>1. Ensure breath tube is connected properly</td>
</tr>
<tr>
<td></td>
<td>2. Run diagnostic to find breath hose temperature</td>
</tr>
<tr>
<td></td>
<td>3. Remove the breath hose from the cover if it is too hot</td>
</tr>
<tr>
<td></td>
<td>4. If the message persists contact crime lab</td>
</tr>
<tr>
<td><strong>Detector Overflow</strong></td>
<td>1. If the status message occurs during a subject test attempt a second test. If the sample was taken properly and no instrumental problem is suspected, take subject to hospital, their breath alcohol may be greater than 0.80.</td>
</tr>
<tr>
<td></td>
<td>2. If the status message occurs at a time when a subject is not being tested, contact the crime lab</td>
</tr>
<tr>
<td><strong>Filter Wheel Error</strong></td>
<td>1. Attempt to run a filter test (under functions) and see if the filter will realign itself.</td>
</tr>
<tr>
<td></td>
<td>2. Reboot instrument</td>
</tr>
<tr>
<td></td>
<td>3. If message persists contact the crime lab</td>
</tr>
<tr>
<td><strong>Filter Wheel 1,2 or 3 Won’t Zero</strong></td>
<td>1. Reboot instrument</td>
</tr>
<tr>
<td></td>
<td>2. If status message persists contact crime lab</td>
</tr>
<tr>
<td><strong>Heated Simulator Tube Temperature Check</strong></td>
<td>1. Contact the crime lab.</td>
</tr>
<tr>
<td><strong>Incomplete Breath Test</strong></td>
<td>1. Restart test and instruct subject to blow until they are out of air.</td>
</tr>
<tr>
<td></td>
<td>2. If subject seems to be attempting to provide a sample and is having difficulty, attempt a non-drinking subject test to determine the ability of the instrument to accept a sample.</td>
</tr>
<tr>
<td></td>
<td>3. Contact the crime lab if there seems to be a problem with the instrument sample acceptance</td>
</tr>
<tr>
<td><strong>Interference Detected</strong></td>
<td>1. Restart test, direct subject to provide a sample steadily.</td>
</tr>
<tr>
<td></td>
<td>2. If Interference Detected status message occurs twice in a row on the same subject, who appears to be blowing properly, get a search warrant for blood.</td>
</tr>
<tr>
<td></td>
<td>3. If Interference Detected status message occurs with unusual frequency, contact crime lab (breath test supervisors)</td>
</tr>
<tr>
<td><strong>Internal Standard Error</strong></td>
<td>1. Reboot instrument</td>
</tr>
<tr>
<td></td>
<td>2. Contact the crime lab if the message persists.</td>
</tr>
<tr>
<td><strong>Invalid Sample</strong></td>
<td>1. Restart test, direct subject to provide a sample steadily. Watch for inappropriate blowing behavior such as: blowing around the mouth piece, blocking mouth piece with tongue, etc.</td>
</tr>
<tr>
<td></td>
<td>2. If Invalid Sample status message occurs with unusual frequency, contact crime lab (breath test supervisors)</td>
</tr>
<tr>
<td><strong>Pump Error</strong></td>
<td>1. Check mouthpiece, check valve and breath hose screen for blockage.</td>
</tr>
<tr>
<td></td>
<td>2. Remove breath hose from instrument and blow through it. 5. If Pump Error persists, contact crime lab</td>
</tr>
<tr>
<td>Status Message</td>
<td>How to fix the problem:</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>------------------------</td>
</tr>
</tbody>
</table>
| Radio Frequency Detected             | 1. Locate the source of the RF interference (radio in operation in vicinity of DataMaster) and remove from vicinity. Restart test.  
                                          2. If Radio Frequency Detected persists, contact the crime lab |
| Sample Chamber Temperature Check     | 1. Reboot the instrument.  
                                          2. If the message persists contact the crime lab. |
| Simulator Time Out                   | 1. Restart test.  
                                          2. If message persists contact the crime lab. |
| Standard Deviation Error             | 1. Contact the crime lab. |
| Standard Out of Range                | 1. Ensure there is sufficient pressure in the external standard tank  
                                          2. Check the barometer reading with the barometric pressure for your area, if barometer is out of range call the crime lab 6. If Standard Out of Range status message persists, contact the crime lab |
| Suck Back Error                      | 1. Restart test and instruct subject not to suck back air thru the mouthpiece.  
                                          2. If message persists and subject appears to be blowing properly contact the crime lab. |

Table 3 – Communication messages for the DataMaster DMT

Notes:
A Video Scenario

With the notion of standardized acts, practices and conditions in mind, watch this video. Do you see any operator errors, or issues of malfeasance? Discuss:

Activity #5
At your table, discuss the video. What issues have you discovered? What Motions would you make pre-trial, if any? What questions would you ask the operator in court? (15 minutes).

We will discuss the issue as a group (15 minutes) after the break

Notes:
Part 3: Medical Issues that Can Affect a Breath Test

Does your client have a pre-existing medical issue? Can these affect the outcome of a Breath Alcohol Test? What do you need to know? What do you need to learn from your client?

Reference Materials:

**Articles:**
- Diabetes
- Acid Reflux, GERD & LPRD
- COPD
- Window on a Molecule:
  - Occupational Exposure to Hydrocarbons

**Counterpoint Issues:**
- Diabetes Volume 2, Issue 1;
- Acid Reflux, GERD & LPRD Volume 2, upcoming Issue
- COPD Volume 2, Issue 1; Article 2
- Window on a Molecule:
  - Occupational Exposure to Hydrocarbons Volume 2, upcoming Issue

Diabetes

Research since the 1960’s indicates that more than 250 Volatile Organic Compounds (VOC’s) can be measured on the human breath. Ketoacidosis can be smelled on a person’s breath, and is commonly dismissed as alcohol consumption. The levels of exhaled ketones and acetone rise appreciably. It is this exhaled acetone that is designed to be detected by the acetone detectors in modern breath alcohol testing instruments. However, the level at which each detector system is set to trigger vary from jurisdiction to jurisdiction.

Acetone in and of itself is not very toxic to humans. For this reason, the levels of the detector are often set quite high. Many jurisdictions use a concentration of 1 milliliter of acetone in 100 milliliters of water as the threshold level. This may be higher than the level experienced by most uncontrolled diabetics experiencing an episode of severe diabetic ketoacidosis, and may therefore have little use in an evidentiary breath alcohol instrument. Also remember that acetone is only produced by the diabetic at the later stages of metabolism. It has also been demonstrated that the acetone is not a total waste product, being then converted into isopropanol by the diabetic. This is also an important step to consider.

Figure 6 - The infrared overlap of ethanol with \( \beta \)-hydroxybutyrate read in the ranges by the Intoxilyzer Models 5000 and 8000 (Red). Note the lack of overlap in the 8-9 micron range read by the Intoxilyzer 9000 (Green).
Newer instruments such as the Intoxilyzer 8000 and 9000 advertise, and this has been supported in various state training manuals, the notion that the 9.5-micron range is better suited in reading ethanol levels. Florida’s state training manual says, as an example, that the 3.3 – 3.8 µ range (the range used in the older Intoxilyzer 5000EN to determine the presence and concentration of ethanol) is better suited to determine the presence of Interferents. The overlap of acetone, and its metabolite isopropanol, mimic that of ethanol in the 3.3 – 3.8 µ range.

An alarming finding:

I have observed that, when confronted with a variety of potential interferents, the Intoxilyzer 5000EN and 8000 will report exaggerated BAC readings. The Intoxilyzer 5000, even the enhanced EN version, is just not sophisticated enough to discern the overlapping infrared signatures, and separate them from ethanol. I performed a series of simulations on an Intoxilyzer 5000 66-series and had a “true” ethanol level of 0.035 grams in a simulator elevated to an average of 0.072 grams with the inclusion of less than 1.0 ml of isopropanol and less than 1.0 ml of acetone (the expected metabolite of isopropanol). However, the unit only reported an interferent in 7 out of 15 samples. When the same 0.035 grams ethanol solution vapor was introduced into an Intoxilyzer 5000EN 68-series, the average reported BAC was inflated to .117 grams, yet the interferent detect circuitry only reported the interferent on 8 out of 15 occasions.

What is more alarming is the tendency of the units to report the BAC as a subtracted, or corrected, value on the occasions when the units did discover the interferent. In the simulations described above, during those times that the Intoxilyzer 5000 or 5000EN did determine the presence of the interferent isopropanol, they reported the inflated BAC value as being a corrected value, and apparently the product of subtraction of the false interferent value. However, these BAC values reported were still over-represented, often more than threefold.

See Table 3 for these test results:

<table>
<thead>
<tr>
<th>Test</th>
<th>Instrument</th>
<th>True BAC Ethanol</th>
<th>Average of 15 Tests with Isopropanol &amp; Acetone</th>
</tr>
</thead>
</table>
| 1    | Intoxilyzer 5000EN Minnesota version & DOT version | .035 grams | .117 grams
|      |            |                  | Interferent detected (8/15) but falsely reported as subtracted. |
| 2    | Intoxilyzer 5000 66 Series | .035 grams | .072 grams
|      |            |                  | Interferent detected (7/15) but falsely reported as subtracted. |

Table 3– Test results using 1.0 ml isopropanol and 1.0 ml acetone in 500 ml water

**NOTE:** My recent examination of the Intoxilyzer 9000 indicated that the unit correctly identified and aborted the breath test sequence each time ethanol was tested with BOTH isopropanol and Acetone, and each interferent separately. Although the preliminary display often indicated a falsely-elevated reading, the final printout always indicated the error message INTERFERENT DETECTED.
Diabetic response to fuel cell devices

Methodology & Results:

Using a GUTH Model 34C simulator, I created an Alcohol Standard Solution using 500 mL of distilled water and added about 0.5 mL of 40% ethanol. After allowing the solution to come to equilibrium, I tested the resulting vapors which produced on a recently calibrated Intoximeter FST. My result was as expected, and was reported at 24 mg/100 mL. This became my baseline solution.

To this solution, I added 0.5 mL of lab grade Isopropanol. Again, after allowing the mixture to come to equilibrium, the vapor was introduced into the same Intoximeter FST. The reading generated by a combination of both the Isopropanol and Ethanol was 71 mg/100 mL.

To this solution, I added 0.5 mL of lab grade Acetone. The same equilibrium wait time was completed, and the vapor introduced directly into the Intoximeter FST. The reading generated by the mixture of all three chemicals (Acetone, Isopropanol and Ethanol) was 77 mg/100 mL. For interest’s sake, I increased the amount of Isopropanol by another 0.5 mL, for a total of 1.0 mL Isopropanol, 0.5 mL Acetone and 0.5 mL Ethanol. The usual equilibrium time was allowed, and the vapor also introduced into the Intoximeter FST. The reading generated was 124 mg/100 mL. This is exactly 100 mg/100 mL HIGHER as a false positive reading.

A chart might better summarize my findings:

<table>
<thead>
<tr>
<th>Chemicals in Simulator, introduce in vapor form to Intoximeter FST:</th>
<th>Readings obtained on Intoximeter FST (Expressed in grams per 100mL):</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5mL Ethanol in 500 mL Distilled Water</td>
<td>0.024 g/100 mL (BASELINE BrAC READING)</td>
</tr>
<tr>
<td>ADD 0.5 mL Isopropanol</td>
<td>0.071 g/100 mL</td>
</tr>
<tr>
<td>ADD 0.5 mL Acetone</td>
<td>0.077 g/100 mL</td>
</tr>
<tr>
<td>ADD 2nd - 0.5 mL Isopropanol (1.0 mL total)</td>
<td>0.124 mg/100 mL</td>
</tr>
</tbody>
</table>

Table 4 – Test results on interferent effects with Intoximeter FST

I am left to reasonably conclude, as have other researchers, that a combination of infrared absorbing substances in the test chamber with levels of ethanol may falsely over-report the true BAC level, and may do so without triggering the interferent detector algorithm. The reported incidence of an interferent may vary among jurisdictions depending upon the threshold levels set in the acetone detect or subtract algorithms. As such, persons routinely displaying symptoms caused by uncontrolled blood ketone or blood glucose levels are extremely poor candidates for breath alcohol testing, using previous-generation designed breath alcohol testing units.

IMPORTANT NOTE: I have conducted a series of Interferent Detect controlled experiments on the Intoxilyzer 9000 and the DataMaster DMT. They BOTH correctly identified interferent chemicals on each and every test performed. The interferent detect algorithms seem to work on the devices as planned and designed!
Reference Material

Bailey, D., Detection of Isopropanol in Acetonemic Patients Not Exposed to Isopropanol, Clinical Toxicology, 28(4), 1990, Pages 459-466.


Friel, P.N., Bear, J.S. and Logan, B.K., Variability of Ethanol Absorption and Breath Concentrations During a Large-Scale Alcohol Administration Study, Alcoholism: Clinical and Experimental Research, Volume 19, Number 4, August 1995, Pages 1055-1060.


Simpson, G., Accuracy and Precision of Breath Alcohol Measurements for Subjects in the Absorptive State, Clinical Chemistry Volume 33, 1987, pages 753-75