COUNTERPOINT
The Journal of Science and the Law

Reflections on DUI Defenses

Breathe Easy: Breath Testing in Court

Friday June 4, 2021

Please see the SEMINAR BONUS MATERIAL AT: Counterpoint-Journal.com/MCLE2021

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Introduction

I've been using roadside and evidentiary breath testing devices for about 35 years, first as a police officer, and later, conducting forensic breath alcohol testing for the defense. I've been factory certified as an instructor, technician, or calibration technician by all the major breath test manufacturers. I've performed more than 5000 breath tests for court, and for teaching purposes. I've written about 150 articles on breath testing, and have presented at about 100 local, regional and national conferences in North America. I've been qualified as an expert after *Voir Dire* in more than 150 bench and jury trials across the United States and Canada.

Here are some musings on common DUI defenses, and my random thoughts on their efficacy.

I've divided the various defenses up into three broad categories: *Instrumentation* issues, *Administrative* issues, and *Medical* issues. Some are systemic issues that will probably not change. Partition ratios come to mind in that category as an overall instrumentational concern. Others, such as operational error, must be addressed on a case-by-case basis, and are beyond what we can accomplish today. Administrative issues include such items as incomplete or improper observation periods, calibration and maintenance issues, and record keeping. Medical issues, such as testing someone who has GERD or Diabetes, presents their own set of challenges.

Due to the time constraints of my *Breathe Easy: Breath Testing in Court 2021* presentation, I will examine two specific issues.

1. First, the basic premise of establishing reliability in breath testing will form a framework in examining the overall trustworthiness in reported results. This is a broad-based approach that you may find helpful.
2. Next, I'll look at one of the most misunderstood areas of medical defenses in DUI investigation, GERD, or Gastro-Esophageal Reflux Disorder. Although I believe it can cause false-positive readings, we must examine the merits and weaknesses of this specific defense.

There are certainly many other defenses in DUI cases, and I will refer you back to the numerous Counterpoint articles that examine these issues in great detail.

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Establishing Reliability

Substandard Acts, Practices & Conditions

This section is more than a purely academic exercise. Using the framework presented, you will be able to identify and establish whether or not a reading presented is reliable, whatever that reading may be – breath test, blood test, forensic evidence, ballistic evidence, etc. Conversely, you will be able to raise doubts concerning the reliability of a result when one has been appropriately identified…

What is Reliability?

I want to deal with the concept of reliability using a different framework. This approach may be more accessible to many of you. In Volume 1, Issue 1 of Counterpoint, we introduced the notions of *Accuracy, Precision and Reliability* in the article of the same name. In another Counterpoint article, we discussed issues with Specificity in the article *Window on a Molecule*. These are all scientific concepts that are not only useful, but critical to understand.

When we say something is *reliable*, what do we mean? The other articles referenced above talk about reliability as hitting the right target, on the bull's eye, time and again with consistent and repeated results. The concept of reliability refers to a *system that produces consistent results under similar conditions*. Reliability is a *systems* concept. In other words, it is the *system itself* that is reliable, not necessarily the individual measurements produced. Think of reliability as the degree to which an assessment tool produces stable and consistent results, repeatedly.

Establishing Reliability

Remember that reliability refers to a *system of measurement*. If you need to establish that a forensic result is reliable, you need to examine the system that produced the result. In other words, you need to examine the way the result was produced, and under what conditions the result was produced. Enter the concept of *Acts, Practices* and *Conditions*.

A system is used to produce a result – any result, no matter what it is. The system consists of two broad components: The infrastructure and policies surrounding the system (or the way the measurement was produced by the system – the individual *acts* and established *practices*), and the *conditions* under which the reading was obtained.

I focus professionally as a breath alcohol specialist, so I will use that system as an example. A Breath Alcohol Concentration (BrAC) reading is produced in a sample jurisdiction using breath test device X. We need to examine that BrAC reading to determine whether or not it is reliable. We do that by looking at by looking in three main areas: Acts, Practices and Conditions

Standard Acts, Practices and Conditions

Infrastructure, Policies, Acts and Practices

The system, in this a case a *Breath Alcohol System*, is used to produce a BrAC reading. It is helpful to look at the system as a whole to establish reliability. This brings us to our first issue – Infrastructure.

Infrastructure in breath alcohol testing refers to the standards and policy surrounding the use of the device. *How are they to be maintained? What training is required to use the device? How often are they to be calibrated? What are the minimum testing requirements? What are the Standard Operating Procedures to be conducted during each test? In short, what are the agency's policies and procedures required in the use of the devices?*

It is helpful to think of these theoretical police requirements as individual ACTS. Instead of looking at the concept of "calibration," take a look at the individual actions that must be accomplished during a device's annual calibration. *Were the acts performed? Was a standard for performance attached to the act? Similarly, what actions must be performed during calibration? During operation?*

These actions can be broken down into two categories: *Practices* that are standardized and required, and individual *acts* – those actions that become the de facto way of operating a device. Sometimes there are compelling reasons why local acts or actions should take precedence over suggested practices. These must be judged on their individual merits and circumstances.

The automated nature of modern breath alcohol testing devices has taken over the control of many acts and practices in breath alcohol testing. Often, Qualified Technicians will testify in court along the lines of, *"I don't know about that. I'm trained to push the start button…."* regarding a specific operation of the device.

But there are certain procedures (practices) that are established in your local breath alcohol testing protocols. As an example, disposable mouthpieces may be required to be changed for each test. The Qualified Technician might be required to inspect each mouthpiece prior to use. Certain jurisdictions may require mouthpieces to be seized in the case of a refusal to provide a breath sample, to prove that there were no obstructions in the mouthpiece that created an inability to provide a breath sample. If these practices were carried out properly, the reliability of a reading is enhanced. If these practices were NOT carried out, or carried out improperly, the reliability of the reading obtained is in doubt.

Similarly, in many jurisdictions, *Calibration Checks* must be performed. In some jurisdictions, these checks are performed with EACH breath test, or breath test sequence. In other jurisdictions, the checks are performed at some period of time – often quite far apart. Some jurisdictions do not perform Calibration Checks at all and rely upon the annual maintenance

of the breath testing device to discern any discrepancies in testing (*by then, of course, it is too late*.)

Again, if these practices were carried out properly, the reliability of a reading is enhanced. If these practices were NOT carried out, or carried out improperly, the reliability of the reading obtained is in doubt. A Qualified Technician minimally trained only to "push the start button" may not identify and recognize that sub-standard acts and practices exist or have occurred.

Testing Conditions

One thing to keep in mind with breath alcohol testing is that the breath test system assumes that certain conditions will be present for testing to occur. As an example, the ambient temperature of the testing room cannot be too hot or too cold. There cannot be fumes in the room emanating from a recent paint job, or from the use of harsh cleansers or fumigants. There cannot be radio frequency interference from police radios or cellular phones, including transmitter arrays for the communications system. Electrical outlets should be dedicated, grounded and isolated. *The list goes on and on*.

Then there are issues with the test subject's themselves. Certain assumptions are made about people, as a whole, that individuals must meet, in order for testing to be correct. The blood to breath ratio of the person must be 2100:1 for reliable readings. The person's exhaled breath temperature is expected to be a certain temperature (34.0°C) for reliable readings. The test subject cannot have endogenous[1] Volatile Organic Compounds (VOCs) on their breath for reliable readings. The test subject must have a minimal lung volume and be free from any medical conditions that make them a poor candidate for breath alcohol testing.

As with acts and practices, when these conditions are met, the reliability of the reading is enhanced. If these conditions are *not met*, the reliability of a reading is in doubt. Sub-standard conditions can and do affect breath test results. Again, a Qualified Technician, trained only to "push the start button" may not identify and recognize that sub-standard conditions exist or have occurred.

The Concept of Measurable Standards

When looking at overall reliability, it is helpful to look at the standards required for the testing process. What acts, practices and conditions are required, and under what standards are they measured? We can't really look at results of a breath test and say for certain that they are reliable or unreliable without looking at the acts, practices and conditions under which the testing occurred.

[1] Endogenous refers to naturally occurring compounds on a person's breath.

Why a measurable standard? It is difficult, if not impossible, to examine a test and say it was done "correctly" or "incorrectly". *How do we decide upon correct versus incorrect?* We can, on the other hand, attach performance standards, or measurable objectives to individual components of the testing process, then assess whether or not these performance standards or measurable objectives were met. From this notion we get standards such as:

- A minimum exhaled breath volume of 1.1 liters
- A simulator temperature of 34.0°C
- Two sample within 0.02 grams/100mL (20 milligrams/100mL) of one another
- Two samples taken within 3 minutes
- Two samples taken no sooner than 15 minutes apart
- A Calibration Check within +/- 10 milligrams/100mL (+/-0.10 grams/100mL) of the standard solution

If the individual acts, practices and conditions were performed correctly according to the measurable standards, the reliability of a reading can be established. Reliable readings can be considered scientifically valid.

If, on the other hand, the acts, practices and conditions under which a reading was obtained were performed incorrectly, or they did not meet the established measurable standards, then the results must be considered inherently unreliable. Unreliable readings cannot be considered scientifically valid and should be disregarded.

Examples

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

Table 1 – Examples of standardized, and substandard acts, practices and conditions

The Last Word

This has not been intended to be a philosophical discussion about nuance, but rather, an exercise intended to provide you with a valuable assessment tool. Remember, the *reliability* of a reading is based on the examination of the *system* that created the reading to begin with, holistically.

When looking at the reliability of a reading (whatever that reading may be) examine the individual acts, standards and conditions under which the reading came to be. If the examination indicates that the measured standards have been met, then the reliability of the reading is enhanced. Reliable readings are considered scientifically valid.

On the other hand, if sub-standard acts, practices and conditions are identified, then, by definition, the results are also sub-standard. Sub-standard results must be considered inherently unreliable, scientifically invalid, and should be discarded.

Instrumentation Issues

Accuracy & Reliability Issues

The Partition Ratio

One of the greatest sources of error in BAC readings concerns the *Partition Ratios* programmed into the devices. This is the ratio between the alcohol *dissolved in the blood* to the alcohol *exhaled in the breath* 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. 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. It should be noted that this is a fairly simplistic description of human respiration.

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.

A synopsis of measure partition ratios as reported in the scientific literature is itemized in Table 2 on the next page:

Year	Researchers	Measured Ratio
1930	Liljestrand & Linde	2000:1
1935	Butler et al	1900:1
1960	Timmermans	1600:1
1963	Burnett	2200:1
1969	Schaefer & Daubert	1500:1
1973	Rohrschneider	2300:1
1983	Jones	1750:1
1984	Gaffney and Senum	2000:1
1985	Snider & Dawson	1900:1
1991	Meylan & Howard	2000:1
1992	Yaws & Yang	1200:1
2002	Jones & Andersson	2450:1
2007	Lindberg et al (Jones)	2250:1
2020	Jones & Cowan	2380:1
	Median (& Average)	*1960:1*

Table 2 – Measured *Partition Ratios* as reported in peer-reviewed works

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*. However, if we are to take the median value for the reported ranges in the peer-reviewed scientific literature, the partition ratio would be 1804:1. While values in the scientific literature for this ratio range from 1200:1 to 2700:1 (with some published research as low as 900:1, and as high at 4200:1), the currently accepted value used in North America for the partition ratio remains 2100:1. It is perhaps helpful to think of the ratio more as a compromise that we inherit from the 1950's, rather than an absolute number derived from science.

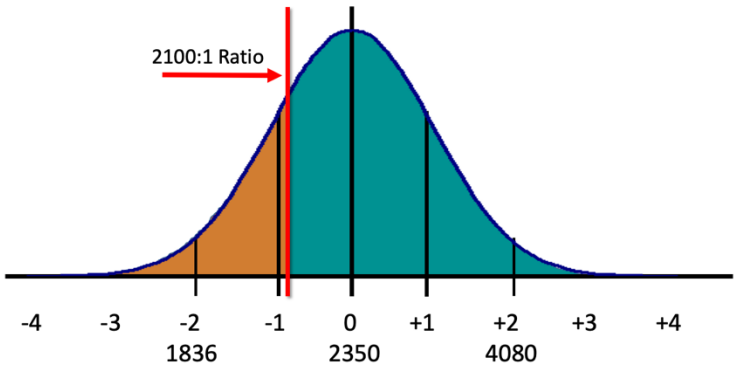

Figure 1 - The Partition Ratio

Even if we accept 2100:1 (indicated above as the vertical red line) as an acceptable partition ratio, with the mean value at 2350:1, a distribution bell curve would show that this ratio *overestimates* the BAC in approximately 30% of the population[2], shown in the brown portion on the left side of the distribution curve. That ultimately means that about 30% 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. Conversely, it may be considered that 30 percent of all people tested will have their reported BAC levels inflated from 0-40%, depending upon where they fall on that distributive curve.

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 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 30% 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 – 0.055 g from all breath results. Dr. A.W. Jones postulates that it would be appropriate to subtract 0.015 from all breath test results to achieve a 99.9% degree of certainty[3]. Jones originally measured the ratio[4] at 1756:1 (in 1983), and stated that this lead to an over-reporting of the BAC results by 20%, but by 2020 had revised the ratio to about 2380:1. Keep in mind, *breath* alcohol analysis is an indirect measure of *blood* alcohol concentrations.

The notion of respiratory variables is not unique. As an example, I have observed virtually identical SCUBA divers in the water, matched in terms of their age and physical fitness levels use radically different air consumption when following the same dive profile. Variations exist

[2] Kurt M. Dubowski, *"Absorption, Distribution and Elimination of Alcohol: Highway Safety Aspects"*, J. Stud. Alcohol (Suppl. 10) 1985, p. 95-106.

[3] Jones, A.W., "Physiological Aspects of Breath Alcohol Measurement", Alcohol, Drugs and Driving, Volume 6, Number 2,

[4] Jones, A.W., *"Determination of Liquid/Air Partition Coefficients for Dilute Solutions of Ethanol in Water, Whole Blood, and Plasma"*, 7: 193-197, 1983. Journal of Analytical Toxicology.

in human physiology, reflected in these different air consumptions. As a Master Scuba Diver Instructor, it was my obligation to observe and respect those physiological differences as a means of ensuring the safety of my students. As a qualified instructor of breath test operators, I must equally acknowledge the variations in respiratory physiology.

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Measurement Uncertainty

The results of any scientific test are subject to variables and should be reported with an associated certainty value attached. Breath alcohol test results typically do not conform to this generally accepted scientific principle. Different researchers have identified some of the variables associated with the breath test process and have discussed a tolerance with which breath test results should be reported. You will note that many of these sources of measurement uncertainty are additive.

In general, the categories that offer variability in the test results include variations in the physiology of the tested individuals, sampling errors, instrumentation margins of error, and calibration (or partition) errors. In my view, the greatest source of error in the breath test process itself is that of the ratio between alcohol dissolved in the blood versus alcohol which escapes through the breath – the so-called partition ratio. Various researchers have estimated that this single source of error may be responsible for over-estimating the reported *Breath* Alcohol Concentration (BrAC) between as much as 23-31% of the population as much as 0-50% beyond their true Blood Alcohol Concentration (BAC).

As such, there is a concern raised among certain researchers that the breath test results should be reported with a certainty value attached. Simpson (2003) calculates the total uncertainty at +/- 15%. Gullberg (2003) place the certainty value at +/- 7% just for measurement variables alone, without taking the underlying physiology into account. Simpson quotes Dr. K. Dubowski at +/- 19%. Dr. A. W. Jones has opined that the certainty value may be as high as +/- 26%. This is all in stark contrast to the breath instrument manufacturers who often establish the accuracy at +/- 3-5%. However, in fairness, their computations may be an analytical one using simulators, and not reflective of data collected under clinical or laboratory findings, and certainly may not reflect testing done on dosed subjects.

The nature of the breath test process is not as exact as perhaps portrayed. Capturing a single suitable sample that ideally reflects the true nature of a test subjects BAC is at best an educated guess. It must be noted that I have conducted in excess of 5000 breath tests for evidentiary, roadside and instructional or demonstrational purposes with live and dosed subjects. One never really truly knows when an appropriate sample has been provided, whether or not this sample is free of contamination or false-positive bias (there is as much as a 37-48% failure of the fresh-mouth alcohol detectors), and if the results are therefore truly indicative of the actual BAC at the time the sample is provided.

Additionally, a single sample is scientifically imprecise, and is not considered best or standard practice in most jurisdictions, where duplicate testing is required, and has been performed for more than 30 years now, to be the most effective way of confirming the reliability of breath test results.

The calibration and duplication of results of an individual breath alcohol testing device must also be taken into account. The majority of the calibration checks performed on any breath testing device are typically +/- 0.010 grams of a target value. This demonstrates the inherent uncertainty of measurement that ANY breath alcohol device delivers, both under controlled circumstances - as in a calibration check, and uncontrolled circumstances during an actual breath alcohol reading.

It is for these reasons that readings at or near the legal limit, indeed at any threshold of measure, must be held as questionable as a result of this uncertainty. Perhaps they should be stated in terms of a range of probable values. Mr. R. Gullberg, former Technical Supervisor for the Washington State Patrol's breath test program, writes in response to legal challenges to readings near critical limits:

> *Measurement uncertainty near the critical limits is a fair and relevant argument. Breath alcohol analysis results, like all measurements, possess uncertainty. Forensic scientists must be prepared to acknowledge this and compute appropriate estimates… The reality of measurement must be acknowledged. (Gullberg, 2004)*

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Machine Errors

Radio Frequency Interference

Radio Frequency Interference (RFI) has been identified as electromagnetic radiation emitted by electrical circuits that causes unwanted signals, culminating as interference or noise that is induced in other external circuits. The RFI may interrupt, obstruct, degrade or otherwise limit the effective performance of the secondary devices.

The problem with assessing the impact of RFI is that it is generated in an intermittent fashion, producing random and potentially irreproducible errors. Indeed, the simple act of detecting the presence of RFI is a considerable challenge. As such, it has been frequently suggested that the prudent course of action is to limit exposure of RFI to devices that must deliver precise measurements with a high degree of reliability, or in critical-application situations.

It should be noted that the RFI detectors built into most breath alcohol testing devices are based on technology of circa 1990. Although the breath alcohol testing devices have undergone various upgrades in their capabilities, the RFI detector circuitries they employ has remained essentially the same since their creation more than thirty years ago. They were designed to detect the presence of radio frequencies in the 10-600 Megahertz (MHz) range, as was commonly found in police radios of that era. Due to their poor performance, and changes towards modern communication technologies, most of these old-style radio devices have long been abandoned.

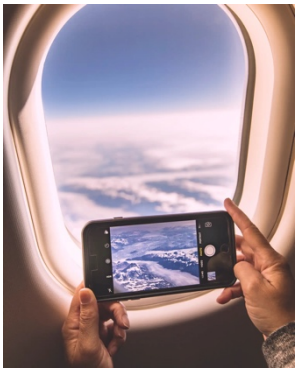
Unfortunately, the detectors in most modern breath alcohol testing devices do not recognize the presence of either upper-band analog, or more modern digital burst transmissions, that may be present and interfering with the internal circuitry of modern devices. As well, the type of plugs used to connect the rudimentary antennas of the breath alcohol testing devices are only suitable for detecting radio frequencies in the much lower 5-6 MHz range. Simply put, the detectors utilized by modern breath alcohol testing devices are "blind" to modern portable transceivers, used by both civilians and police agencies. Modern digital transmission cellular smartphones, wireless and Bluetooth™ devices and police *Body Worn Cameras* have only exacerbated the situation.

Modern police radios commonly transmit and receive within frequencies between 900 MHz to 3 Gigahertz (GHz). Cellular telephone voice and data technology used in the United States and Canada utilizes radio frequencies in the 800 MHz through 1.9 GHz range. Additionally, voice and data transceivers utilizing technology commonly known as "Bluetooth devices" operate in the 2.4 GHz range. Modern commercially available "walkie-talkies" operating in the FCC Licensed Family Radio Service bands operate in the 462-467 MHz range.

The effect of these radio frequencies on the internal operation of breath test devices that use electronic circuitry similar to that of early computers is in debate. Accordingly, standard police procedures have been established in most jurisdictions in North America and Europe that prohibit the presence of active police radios, cellular telephones, and similar devices in breath test facilities.

This prohibition amongst police agencies is not unique. Most hospitals have policies prohibiting the use of similar radio or other electronic devices in patient care areas, where critical life-support or patient monitoring equipment is in operation[5]. RFI interference to devices such as ventilators, patient monitors, pacemakers, neonatal incubators, motorized wheelchairs, and anesthesia delivery equipment has been reported and documented.

[5] I have served as both a Police Constable and Primary Care Paramedic in my community from 1982-2002. Under both police and ambulance protocols, I was required to turn my portable radio off before entering local emergency departments, as a proactive measure against the unintentional interference with critical patient care equipment.



Additionally, although there has only been one reported case of an air crash where the use of cellular telephones has been alternately purported as responsible[6], Transport Canada and the United States Federal Communication Commission bans the use of transmitting and receiving signals with cellular phones in aircraft entirely. Similar bans are enforced in many other jurisdictions worldwide. It should be noted that newer cellular telephones transmit intermittent digital identification signals, whether a call is in progress or not, so that local cellular transceiver sites recognize the mere presence of the phone for reception of incoming calls. As this function is beyond the control of the operator of the device, deactivating the device to the off position is warranted. Police radios function in the same manner.

Shortly after the introduction of the types of technologies used by early modern breath test devices into general police service, the National Bureau of Standards conducted a study ("*Effects for the Electromagnetic Fields on Evidential Breath Testers"*, 1983) and concluded that the possibility of erroneous Breath Alcohol Concentration (BrAC) readings, influenced by various radio frequencies, was "severe". There are numerous reported, albeit anecdotal, instances where elevated BAC readings have been observed due to the presence of known radio transmissions.

The problem, frankly, in extrapolating from these observed instances, is the unpredictability and lack of reproducibility of the circumstances that apparently gave rise to the elevated BrACs. As such, the cautious and prudent approach is to absolutely eliminate the possibility of RFI altogether.

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[6] Crossair Flight LX498, January 10, 2000 (flight from Switzerland to Germany). The official crash report does not mention cell phone activity as a primary cause of the crash, and instead attributes it to pilot error. However, a separate investigation into the cause of the crash documented that the autopilot system malfunctioned at the same time that a passenger's cell phone on board the plane received an SMS message and another cellular phone received a call. After this information was made public, a number of countries that had previously been reluctant to do so outlawed cell phones on flights. The bans remain in effect to this day.

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An Introduction to Error Messages

A Guide to Error Status or Exception Messages on Breath Test Devices

The ability to interpret a breath alcohol result is important in your day-to-day practice. While you may not see error messages too often, you should be able to interpret their meaning, and the impact they may have on your client's case. Of course, each manufacturer puts their own unique definition to error messages, but overall, they follow a specific trend. This section is an introduction to error messages. Additionally, there are two or three specific status messages that deserve greater exposure than we will give them here, so they additionally will get a more complete treatment in a series of future article.

Shifting Paradigms

The manufacturer's and state agencies have worked hard to change the language of messages issued by the devices. Obviously, they don't want "error" to be part of the lexicon. So, we see that newer devices no longer have "errors". Instead, they report their "status", or perhaps issue "exception" messages. Whatever. At the root of the matter is a condition, potentially substandard, that is being reported by the device in hopes that the operator will take the appropriate corrective action. *Did they?*

There are two rough categories that we can place these error messages into – issues caused by *external* sources, and you guessed it – *internal* issues. You should understand the basic impact each of these may have on your client's reported breath test results – especially if they have been charged with a refusal to provide a sample. This article will deal with the external factors.

An Important Note:

Some of these error, status or exception messages are programmable by the manufacturer in response to client requests. Device X may report a different error message in a different state under the same circumstances. As an example, the Intoxilyzer error messages *Deficient Sample* and *Insufficient Sample* mean exactly the same thing. That same condition will be reported by the DataMaster DMT as an *Incomplete Sample*. Again, you need to understand these messages, and if your jurisdiction uses more than one manufacturer's devices, need to understand their implications across a broader spectrum of devices. *To help, we are compiling cheat sheets that you can download for individual devices…*

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External causes of error:

Ambient Fail / Ambient Detected / Check Ambient Conditions

In *Counterpoint*, Volume 2, Issue 1, "*Best Practice in Breath Alcohol Testing – Part One Environmental Conditions*" we discussed the notion of Floating Air Blanks and ambient conditions. You may wish to review that article. In essence, an Ambient Fail error message occurs when an Air Blank delivers a measurable BrAC reading above a programmed threshold when performing an Air Blank. The reading is obtained from the room air. Something in the air, in the room environment, is influencing the breath test device. It could be fumes from a cleaning product or disinfectant. It could be paint fumes passing through the ventilation system. It could be, and most probably will be blamed on, alcohol fumes emanating from the test subject. Sometimes, breath alcohol test subjects are "hygienically challenged".

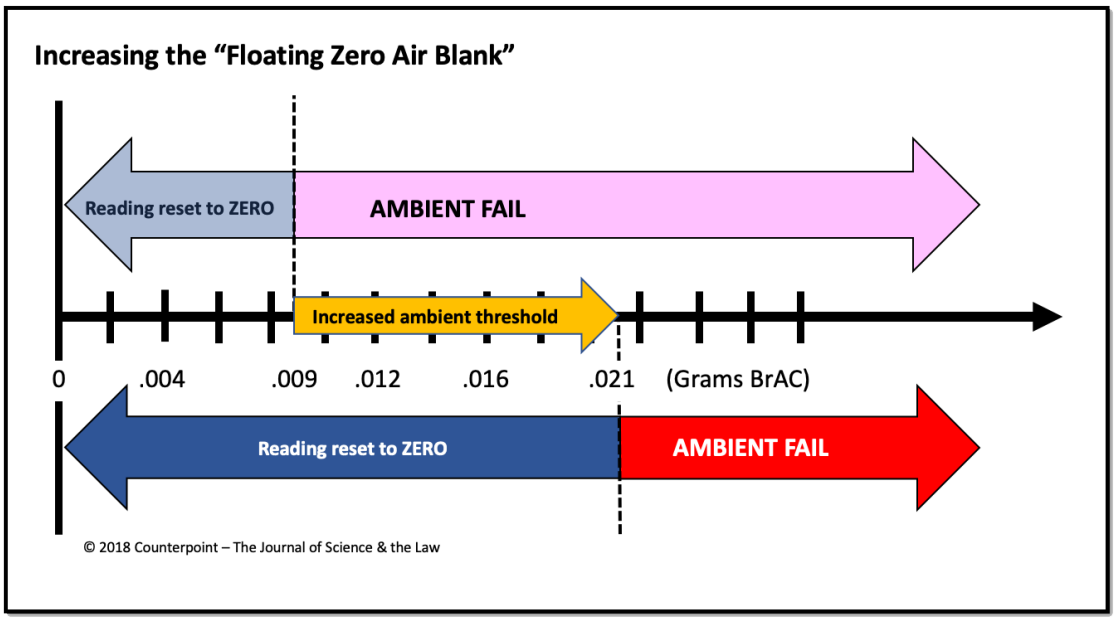

Figure 2 - The Floating Zero Air Blank and its implication in detecting sources of localized ambient contamination.

Whatever the cause, the remedy should be to determine and remove the cause of the failure as described in the article referenced above.

Again, that article pointed out what should NOT occur, as in the Case Study presented where the state agency requested that the manufacturer issue a software update, raising the threshold from 0.009 grams to 0.021 grams before the error was reported. This merely hides the contamination and does nothing to identify its source and subsequent removal. This is, in my opinion, a sub-standard practice in dealing with this sort of error condition.

Invalid Sample / Mouth Alcohol Detected / Residual Alcohol Present

The cryptic *Invalid Sample* error message may have been superseded by the more descriptive *Mouth Alcohol Detected* or *Residual Alcohol Present* error messages. *Residual Alcohol Detection Systems* deserve a number of articles to understand the depth of issues they present. Suffice to say, for now, that it is extraordinarily difficult for manufacturers to create an algorithm that reliably identifies mouth alcohol contamination. These so called "slope-detectors" have a fairly high failure rate (unless you buy into some of the latest revisionist articles out there that tout these detectors as nearly infallible).

Errors of this sort are dealt with by having a *Deprivation* or *Observation* period before taking samples that helps to ensure that no contamination has occurred. If an error of this type is generated, the Deprivation or Observation period MUST occur again before any attempt has been made to receive samples for analysis. It is a sub-standard act to wait a minute or two, and simply push the Start Test button again and continue on. Regardless of the cause, the only remedy is the normal dissipation of ethanol over time.

There are a number of issues that we need to discuss in the future regarding this error message, of which the following immediately come to mind:

- Chewing tobacco in the mouth of the test subject
- Gastro Esophageal Reflux Disorder, or GERD
- The typical time between breath tests
- The need for two breath tests as standard or best practice
- Failures of Residual Alcohol Detection Systems

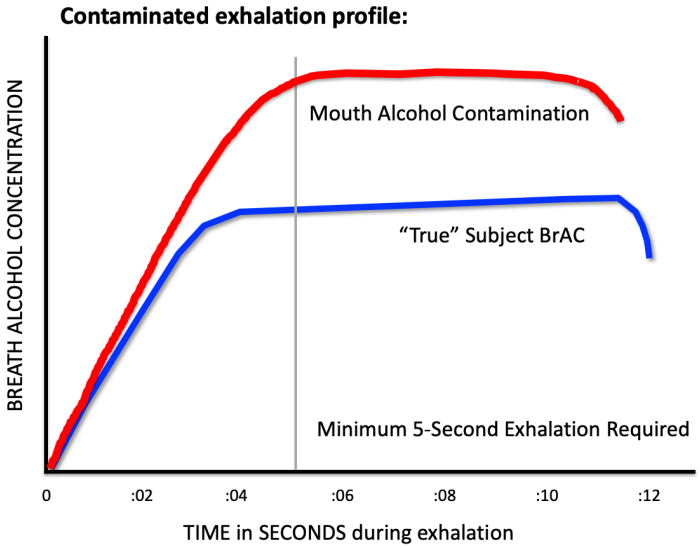

Figure 3 - A contaminated breath sample in red, compared to an uncontaminated breath sample in blue.

No .02 Agreement / Subject Sample Correlation Fail

In most jurisdictions, two breath samples are received that have to correlate to one another before the lowest of the two values is reported as the measured BrAC. For some reason that has never been completely explained to me, the typical correlation is a value of 0.02 grams agreement. That means that the two samples must be within 0.02 grams of one another to be considered reliable. As an example, if the first test generated a result of .100 grams, then the acceptable range for the second test result is between .080 and .120 grams. This means that any readings between 0.080 and 0.100 are acceptable, or conversely any reading between 0.100 and 0.120 are within the acceptable range.

What is interesting is how different jurisdictions deal with *truncation* and agreement. Truncation in the scientific practice of reporting to only a certain number of decimal places, and the rounding DOWN in that reported figure. As an example, a BrAC reading of 0.089 grams would be rounded down to 0.080, or simply 0.08 grams as a reported concentration. If that specific jurisdiction had a legal limit that read *over* or *exceeding* 0.080 grams, then the act of truncation would actually negate the charge (0.080 is not *over* or *exceeding* 0.080 – it is *equal to* 0.080). So, if the actual readings were 0.029 apart, but each reading was reported as a truncated value, then the readings would be considered 0.02 apart – within the acceptable range from a legal point of view, but scientifically outside the acceptable margin of error.

There are a number of reasons why there is not a .02 agreement between samples, the principal of which is the presence of mouth alcohol contamination, whether by a burp, regurgitation, GERD, recent consumption, etc. Since it is essentially a fresh mouth alcohol issue, the only remedy is to wait the complete time for another Deprivation or Observation period and conduct a third test. Hopefully, the results of either test 1 and 3, or test 2 and 3 will be in agreement… If not, conduct an additional test. The most I've ever seen done is 5 tests, but by then, agreement between 2 of 5 samples is not so much based on scientific reliability for ANY reading obtained than it is random dumb luck…

Interferent / Interferent Detected

I've addressed the issue of specificity and Interference already in the *Counterpoint* article, *"Window on a Molecule"* (Volume 1, Issue 4). This is one of my areas of interest. I have looked at the response of many breath test devices to a wide variety of potentially interfering chemicals – mostly Volatile Organic Compounds, and typically those used in occupational settings. And, as with RFI, the same two issues arise. The Interferent chemicals are present and creating a false reading without being identified by the device, or present and causing unreliable readings with the device identifying their presence.

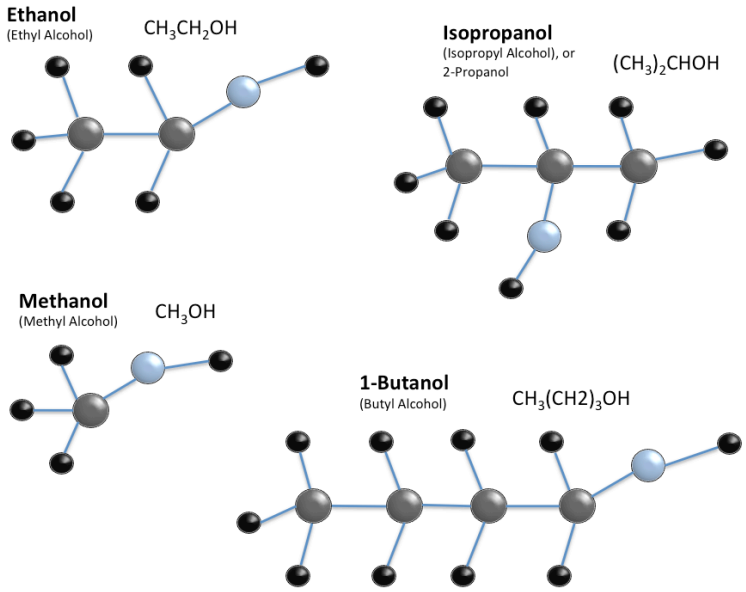

Figure 4 - The "Alcohol" family. Humans drink Ethanol, rub Isopropanol on their skin, and burn Methanol in camping stoves and cars. Don't confuse those...

I'm going to ask you the same question I've been asking seminar audiences for about a decade now. Think back to the last year of your practice. *Have you had a person in your office maintaining that they only consumed one or two drinks, yet provided a sample that was perhaps quite high? Was that person a hairdresser, gel nail technician or a plumber? A furniture refinisher or an auto-body technician or painter? Someone whose occupation has them use harsh or volatile chemicals on a day in day out basis?* If so, I hazard a guess that the reading was potentially inflated by the breath test device.

When the actual Interferent is detected, best practice should have the officer re-initiate a test sequence. If the problem persists, medical intervention should be sought.

Internal Causes of Error:

Invalid Test

Be cautious of this error message – particularly when your client is charged with refusal to provide a breath sample. In the Intoxilyzer lineup of evidentiary instruments (the 5000, 5000EN, 8000 and 9000) the Invalid Test error message means that one of three conditions have occurred:

- The START button was pushed at the wrong time (5000, some 8000, some 9000)
- The evidence card was pulled from the printer
- Inadequate purge of sample chamber by instrument's pump

This error message does NOT mean your client was not providing a suitable sample. I've seen tests aborted by the operator, this error message printed, and the officer testify in court,

under oath, that the test subject was, in essence, refusing. I have one specific breath room video from years ago where a test subject is seen providing a sample, blowing for about 13 seconds (the minimum required by that device is 5 seconds). The operator is able to observe the BrAC results displayed on the Intoxilyzer 5000 screen (some jurisdictions allow preliminary results to be displayed). Not liking what he sees on the screen, the officer pushes the green Start button, invalidating the test. We can clearly see him doing so, and hear the audible tone emitted by the 5000. The printout then only shows the words INVALID TEST, and not the numerical results generated by the test. This officer then charged the person with refusal and lied under oath that the test subject did not provide a sample suitable for analysis.

In some of the newer Intoxilyzer 8000 and 9000 devices, the ability to abort the test using the Start button has been disabled. Some will issue the error message "Sequence Aborted" under these circumstances – certainly a more descriptive message that should prevent the conduct of the Qualified Technician described above.

Figure 5 - You are going to see a criminal act performed by one of the individuals in this video.

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Communication Messages on the Intoxilyzer 8000

Gone are "error" messages, now replaced with two types of messages – "Status" and "Exception." A status message provides information on the operational status of the device. Exception messages alert the Qualified Technician to "unusual situations during testing."

MESSAGE	MEANING
STATUS MESSAGES	
Suitable Sample?	At the end of the breath test, the 8000 asks the operator to qualify the sample, at their discretion, as to its apparent suitability. If "Y" is entered, the sample will be reported. If "N" is entered, the test subject will be re-tested.
EXCEPTION MESSAGES	
Ambient Fail	The difference between the air in the sample chamber at the start of the test, and at the end of the purge pump draw is more than 10 mg/100ml. QT's are advised to relocate the test subject away from the instrument, ventilate the room, and re-test the subject.
Diagnostic Fail	The self-diagnostic performed as a component of the breath test sequence has failed. The unit should be re-booted. If it does not report a subsequent diagnostic failure, the unit can be used. If a diagnostic fail again occurs, the unit must be taken out of service
RFI Detect	The 8000 is sensitive to radio detection, but the manufacturer claims it is not affected by radio frequency interference. Cease radio or cell phone transmissions and re-test.
Interferent Detect	The relative IR absorption between the 3.4 and 9.4 channels has been upset greater than 5%. 0-40 mg/100ml - +/- 8 mg/100ml 41-260 mg/100ml - +/- 5% 261-600 mg/100ml - +/- 13 mg/100ml The test subject should be re-tested. If the message persists, they should be taken for medical evaluation.
Purge fail	The instrument could not clear the sample chamber to within 10 mg/100ml of the first air blank. Re-locate the test subject, ventilate the room, and retest.
Sequence aborted	START button pushed, invalidating the test sequence.
Range exceeded	BrAC > 650 mg/100ml. Wait 15-minutes, re-test and "consider medical evaluation"
No sample given	No sample is attempted during the 5-minute period
Invalid Sample	A sudden drop of the breath sample from peak to end-expiration has occurred. The criteria for this message are dependant upon the measured BAC reading: ≤ 30 mg/100ml - 2 BrAC > 3mg/100 ml lower than peak 31-60 mg/100ml - 2 BrAC > 10% lower than peak ≥ 61 mg/100ml - 2 BrAC > 6 mg/100ml lower than peak If the QT feels the sample is not contaminated by mouth alcohol, they may re-test. If they feel the sample may be affected by mouth alcohol, wait 150minutes, then re-test.
Insufficient sample	The four breath sample criteria (Flow rate, time, volume and slope) have not been met during the 5-minute wait period. DEFICIENT SAMPLE is printed on the test record.
Unstable signal	The detector signals are outside of predetermined limits. Re-boot and perform a diagnostic.
Correlation failed	After five breath tests, if no 20 mg/100 ml agreement is obtained, perform additional tests
No 02 agreement	The truncated results are not within 20mg/100ml. Perform an additional breath test
Improper sample	Subject blew into mouthpiece at wrong time. Re-test.
Disabled Mode Sample Expired	More than 50 tests or 15 days has elapsed since the last standard change, and the unit needs to be re-configured.
Control outside tolerance	The Calibration check is outside the 90-110 mg/100ml range.

Table 3 – Communication messages for the Intoxilyzer 8000C

Communication Messages on the Intoxilyzer 9000

Message	Description	Common Causes	Recommended Actions
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 Di-agnostic 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 4 – Communication messages for the Intoxilyzer 9000

Communication Messages on the DataMaster DMT

Status Message	How to fix the problem:
Ambient Fail	1. Remove the subject from vicinity of the DataMaster (try test again) 2. Ventilate the room 3. Purge the sample chamber 4. Perform a non-drinking subject test 5. If ambient fail persists, contact crime lab
Blank Error	1. Remove the subject from vicinity of DataMaster 2. Ventilate the room. 3. Purge the sample chamber 4. Perform a non-drinking subject test 5. If blank error persists, contact crime lab
Breath Tube Temperature Check	1. Ensure breath tube is connected properly 2. Run diagnostic to find breath hose temperature 3. Remove the breath hose from the cover if it is too hot 4. If the message persists contact the crime lab
Detector Overflow	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. 2. If the status message occurs at a time when a subject is not being tested, contact the crime lab
Filter Wheel Error	1. Attempt to run a filter test (under functions) and see if the filter will realign itself. 2. Reboot instrument. 3. If message persists, contact the crime lab.
Filter Wheel 1,2 or 3 Won't Zero	1. Reboot instrument 2. If status message persists, contact crime lab.
Heated Simulator Tube Temperature Check	1. Contact the crime lab.
Incomplete Breath Test	1. Restart test and instruct subject to blow until they are out of air. 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. 3. Contact the crime lab if there seems to be a problem with the instrument sample acceptance
Interference Detected	1. Restart test, direct subject to provide a sample steadily. 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. 3. If Interference Detected status message occurs with unusual frequency, contact crime lab (breath test supervisors)
Internal Standard Error	1. Reboot instrument 2. Contact the crime lab if the message persists.
Invalid Sample	1. Restart test, direct subject to provide a sample steadily. Watch for inappropriate blowing behavior such as: blowing around the mouthpiece, blocking mouthpiece with tongue, etc. 2. If Invalid Sample status message occurs with unusual frequency, contact crime lab (breath test supervisors)
Pump Error	1. Check mouthpiece, check valve and breath hose screen for blockage. 2. Remove breath hose from instrument and blow through it. 5. If Pump Error persists, contact crime lab

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 5 – Communication messages for the DataMaster DMT

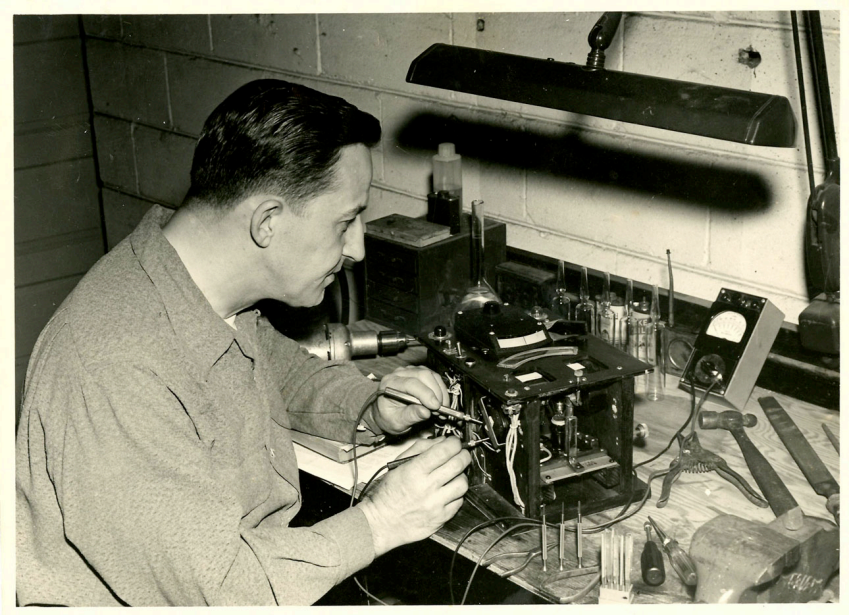

Figure 6 - Robert Borkenstein, a crime lab photographer for the Indiana State Police, at home in his basement, inventing the Breathalyzer, circa 1950. A lieutenant at the time (he had started years earlier as a trooper), Borkenstein went on to receive an honorary doctorate for his invention of the Breathalyzer, and his lifelong dedication to traffic safety.

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Medical Issues

The Absorptive State

Alcohol follows a specific process of absorption, distribution, metabolism and elimination in the human body. These should be considered simultaneous processes that begin with consumption of alcohol. Absorption of alcohol occurs when it enters the body and passes from the stomach and small intestine into the bloodstream. The absorptive phase is defined as the period of time from the beginning of alcohol absorption to the point where alcohol is neither absorbing nor being eliminated by the body. This point is commonly referred to as Peak BAC or Plateau. Alcohol is evenly distributed through the body at this point. Following this high point, the metabolic process of elimination occurs faster than any residual absorption, and the elimination phase begins, marked by a decrease of the BAC over time.

Absorption rates, and the time to peak absorption are not *calculable*. They can be *estimated* based on the time, type and volume of alcohol consumed, the type of food consumed on a full or empty stomach, and the rate of consumption. But, the true point of peak absorption can only be known through empirical testing of the test subject, with repeated readings taken over a long period of time.

Studies have shown that for normal persons, under normal drinking consumption patterns, with an average amount of food in their stomach, that full absorption can occur anywhere between 14 – 138 minutes, with reported ranges of 9-114 minutes, 12-166 minutes and 78-192 minutes (Dubowski, 1985). This is a fairly large spread in time to peak – over three hours in some cases among normal, healthy people. This in in contrast to a 1984 study, where Zink & Reinhardt, as reported by Jones in 1996, found that all of the subjects in one of their elimination rate studies had reached peak BAC after 50 minutes. In another Jones study, 97% of people tested reached their peak BAC within 75 minutes. The time to peak BAC varies widely from individual to individual.

More problematically, other factors can interfere with the rate of absorption. Studies have shown that persons with various medical conditions have slower rates of gastric absorption (Gastroparesis). GERD (Gastro Esophageal Reflux Disorder) and diabetic patients can also have delayed gastric emptying as long as 6-8 hours after consumption ended. Typically, when gastric emptying occurs after four hours or longer, Gastroparesis is confirmed. I was involved in research with Gastroparesis and GERD patients and our preliminary data showed that many patients did not reach peak even after three hours of absorption time.

The issue of over-reporting of *breath* alcohol concentrations versus *blood* alcohol concentrations has been well known for more than thirty years. Dr. Dubowski stated that there may be as much as a 25% overstatement of breath compared to blood when the test subject is in the absorptive state in the 0.10-gram range (Dubowski, 1985). He felt that this was due to a difference in partition ratios, whereby persons in the absorptive state have a lower partition ratio, therefore a higher reported *breath* alcohol concentration compared to *blood*. This is due to the established notion that uniform distribution of alcohol only occurs

in the post-absorptive state. During absorption, there is a higher alcohol concentration in the arterial blood in comparison to the venous blood. This difference in blood concentrations impacts the partition ratios. It is arterial blood surrounding the alveolar sacs in the lungs that supplies the reading for the breath test (Jones, 2003).

Dr. Jones reported that the breath to blood ratio, and therefore the reported breath alcohol concentrations change as a function of time from the end of alcohol consumption as follows:

Time from End Consumption in Minutes	Mean Breath: Blood Ratio (Evidenzer Instrument)	Mean Breath: Blood Ratio (Intoxilyzer 5000)
15	1836 (1314-2099)	1904 (1394-2171)
45	2323 (2031-2724)	2446 (2200-2631)
75	2536 (2268-2962)	2629 (2377-3048)
105	2714 (2479-3460)	2799 (2481-3460)
165	3759 (2481-6119)	3632 (2344-6119)

Of course, breath test instruments in North America are calibrated on a 2100:1 breath to blood ratio. If a person in the absorptive phase has a breath to blood ratio of 1314:1, their *breath* alcohol concentration will be over-reported as 60% higher than their true *blood* alcohol concentration. From this data we see it is demonstrably possible for the test subjects reported breath alcohol concentration to be as much as 60% higher than there true blood alcohol concentration during the absorptive phase. Even the low median value of over-reported BrAC levels is about 20%. Again, this data is from normal, healthy individuals. Persons with other underlying medical conditions may have longer absorption times. The scientific literature on breath to blood ratios reports ratios as low as 1100:1 and 900:1, which would make the measurement error larger.

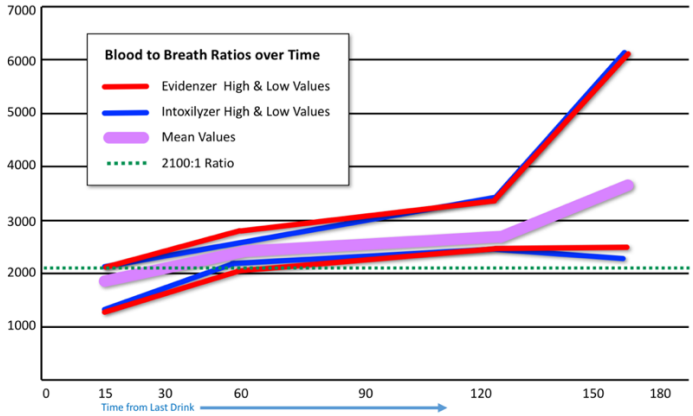

Figure 7 - Partition ratios change over time as the body absorbs and equalizes the ethanol concentration in its system.

Elimination Rate

It should be noted that the elimination rate, typically reported as a single digit value, is perhaps better expressed as a range of rates. Most people will eliminate at a rate between 0.012 – 0.020 grams of alcohol per hour. However, the rates have been reported as low as 0.002 grams to as high as 0.045 grams per hour (Dubowski, 1985). I personally have conducted elimination rate studies with dosed subjects where simultaneous breath and blood samples were obtained. I have witnessed elimination rates between 0.008 grams to as high as 0.028 grams per hour. Most toxicologists use an elimination rate of 0.017-0.018 grams per hour as a median point.

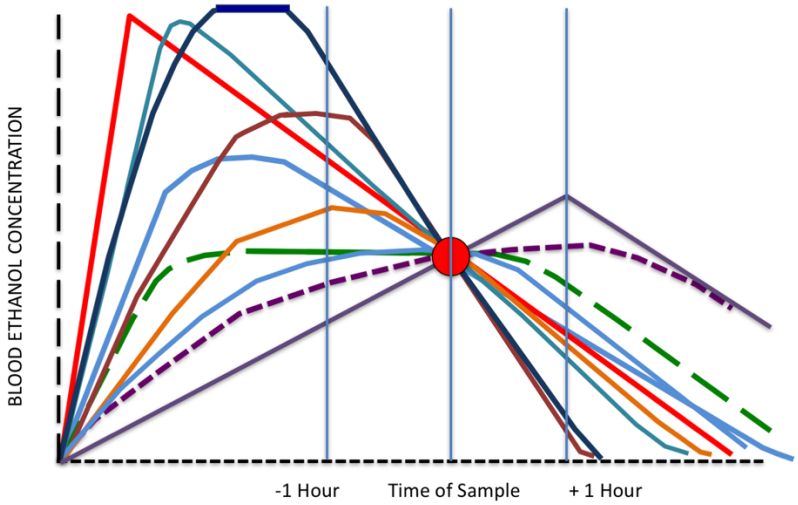

*Figure 8 - The various possibilities of absorption and elimination profiles with a single breath sample obtained (the red dot). Question: What are the possible BAC's that could be reported one-hour **before** the test, or one-hour **after** the test?*

Conclusion

If tested following recent consumption of alcohol, when in the absorptive state of alcohol uptake, the test subject may have breath readings falsely inflated as much as 60% higher, or more, than their true blood alcohol concentration. For a person with a breath alcohol reading at or near the legal limit, this source of error can be considerable. A reported *breath* alcohol concentration of 0.08 grams could conceivably be based on a true *blood* alcohol concentration of 0.48 grams. It has been known for many years that the difference in the breath to blood ratio of persons tested while still in the absorptive state can create this false-positive reading.

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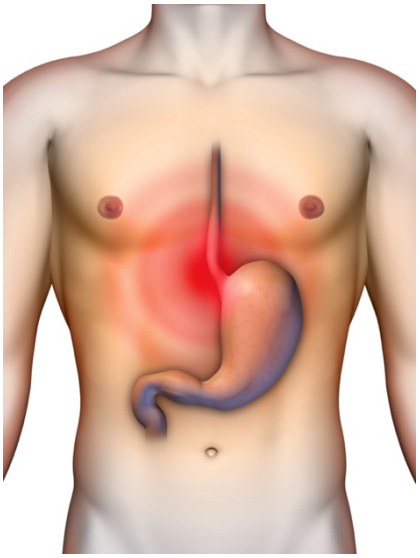
The GERD Defense

Gastroesophageal Reflux Disorder (GERD) and Barrett's Esophagus



Gastro Esophageal Reflux Disorder (GERD) is a chronic condition that is believed to be caused by a partial weakening or failure of the Lower Esophageal Valve (LEV). This is a valve that separates the Esophagus from the Stomach. When stimulated, the LEV will open momentarily, allowing liquid consisting of acidic stomach contents to partially regurgitate, or reflux, back into the esophagus. This creates an uncomfortable burning sensation, often likened as severe heartburn.

About 7-20% of adults in the USA suffer from GERD, with the majority requiring some sort of medical intervention in its management. These rates seem to be increasing (Kahrilas, 2008).

Barrett's Esophagus is thought to be a major complication of GERD. The patient will experience cellular damage and change in the lower esophagus resulting from the chronic acid and inflammation caused by the GERD. Persons with this syndrome will have frequent and long-standing heartburn, and often experience trouble in swallowing, and keeping their stomach contents intact. They often experience frequent chest pain and vomiting of bloody stomach bile. They are at high risk for developing fatal esophageal cancers.

Both these conditions are partially controllable through daily doses of medication, and alteration of the patient's diet. Increasing evidence indicates that smoking raises the risk for GERD. Studies suggest that smoking reduces LEV muscle function, increases acid secretion, impairs muscle reflexes in the throat, and damages protective mucous membranes. Asthmatic symptoms, such as coughing and wheezing, may occur. In fact, in one study, GERD alone accounted for 41% of cases of chronic cough in non-smoking persons.

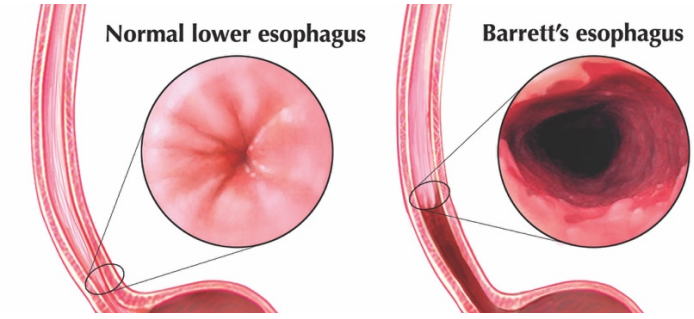


Figure 9 - Damage done to the esophagus by repeated introduction of stomach acid and contents causes Barrett's Esophagus.

Both GERD and Barrett's Esophagus are chronic conditions. Symptoms and patient complaint of reflux may occur years after the condition begins, that is to say, a person may be asymptomatic for a long while before seeking medical attention. Once they begin, they are

usually life-long conditions. If there is injury to the lining of the esophagus (Barrett's Esophagitis), this also is a chronic condition. Moreover, after the esophagus has healed with treatment and treatment is stopped, the injury will return in most patients within a few months.

Once treatment for GERD or Barrett's has begun, therefore, they usually will need to be continued indefinitely. It is somewhat manageable by daily medication, and changes to the diet.

GERD can be stimulated by the consumption of alcoholic beverages. GERD has been associated with non-cardiac chest pain, ulcers, gastritis, asthma, hoarseness, and chronic cough. Symptoms such as chronic cough or chest pain can be caused by acid reflux into the esophagus, because they do not experience classic heartburn symptoms or acid regurgitation. It has been suggested in studies that the GERD is a pre-cursor to the chronic cough, creating its condition.

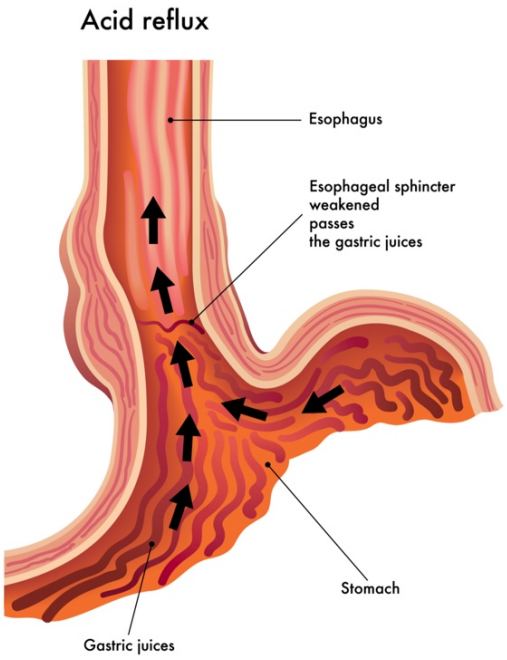
The Importance of Obtaining a Valid Medical History

Remember that the symptoms of heartburn and reflux may go on for years and be treated by the patient for some time using over the counter (OTC) medications. When confronted with an inexplicably high BrAC reading (one not supported by a reliable drinking pattern), it may be advantageous to inquire about medical problems that can lead to false-positive breath alcohol test results. Specifically, with GERD or Barrett's in mind, your intake questionnaire should ask:

- Do you suffer from frequent indigestion, or heartburn?
- Do you suffer from acid reflux?
- Do you have a chronic sore throat?
- Do you have chronic dry cough?
- Do you have a hoarse voice?
- Do you have excessive salivation?
- Do you have frequent nausea or vomiting?
- Do you have frequent bad breath?
- Do you have frequent chest pain?
- Do you have frequent insomnia? Does the reflux occur at night, or keep you up at night?
- Do you take over the counter (OTC) antacids?
    - TUMS™
- Do you take OTC or prescribed proton-pump inhibitors?
    - Prilosec™ (Omeprazole)
    - Nexium™ (Esomeprazole)

A diagnosis of GERD will probably be required to establish medical circumstances that give rise to inflated breath test results.

The Effect of GERD on Breath Test



A minority of patients with GERD, about 20%, has been found to have stomachs that empty abnormally slowly after a meal. With a known medical condition such as GERD, it is likely that the leakage in the LEV introduced a trace amount of alcohol remaining in the stomach into the esophagus. This would have the net effect of elevating the reading obtained. Dr. A.W. Jones *(2005)* identified the presence of unabsorbed alcohol in the stomach among GERD patients "several hours" after drinking.

Kechagias *et al* (1999) reported no apparent correlation between GERD and increased BrAC readings while in the absorptive phase of alcohol ingestion. *However, some of their test subjects showed elevated BrAC readings compared to their BAC's as tested by in vivo catheter.* ***Their assertion that GERD does not elevate reported BrAC readings is not supported by their own data.***

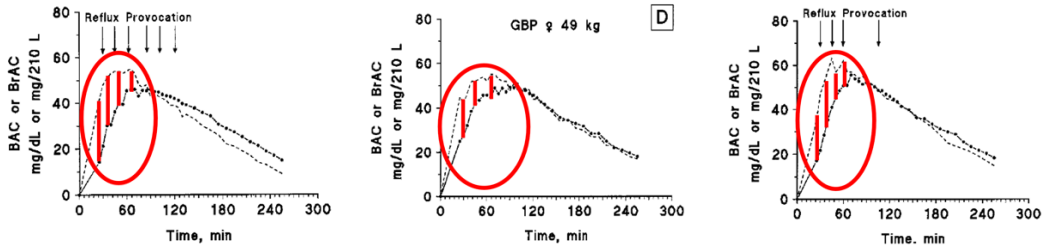


Figure 10 - Data shows that a percentage of people tested showed apparent false-positive BrAC-BAC readings during the absorptive phase of alcohol metabolism, with some readings as much as 0.030 grams/210L higher.

It should be noted that the reported BrAC elevated readings occurred during the *absorptive* phase, when unabsorbed alcohol is found in high concentrations in the stomach. The readings were as much as 0.030 grams/210 L higher.

This is not a single event. Booker *et al* (2015) reported an elevated BrAC-BAC reading in one subject of ten tested, also at 0.030 grams/210L higher. Gullberg (2001) additionally provided a case study where the reported BrAC reading exceeded the known BAC reading by a little more than 0.010 grams/210L. All these events were observed in the absorptive state.

Remember the notion of delayed stomach absorption as a sign of GERD, often approaching 2-4 hours or more, when the forensically accepted value to reach full absorption is 30-45 minutes.

What is of concern is that in all three papers mentioned above, researchers demonstrated that known GERD patients were providing elevated BrAC readings in comparison to known BAC blood draw values, from 10-30% of the time, with readings as much as 0.030 grams/210L higher, yet dismissed out of hand the possibility that GERD was playing a contributive factor.

The Residual Alcohol Detection Algorithm

Due to the pattern of emanation of alcohol from both the upper digestive tract along with the normal pathway from the lungs in a GERD patient, the Residual Mouth Alcohol Detection systems of modern breath alcohol analyzers are incapable of distinctly separating readings of the two. In short, alcohol emanates from BOTH the lungs AND the upper GI Tract, at roughly the same rate.

The residual alcohol detectors are designed to identify a sudden rise in measured BAC was a subsequent sharp drop in BrAC from second to second during the breath test. False positives associated with GERD do not follow this "rise and drop" pattern and are not easily detected by the programmed algorithms. Under these conditions, it is known that the so-called "slope detectors" can falsely interpret this mouth alcohol bias and over-report the true BrAC reading (Hlastala, 2006 and Gullberg, 2000).

It has been my experience that the slope detectors can, and often are, fooled under a variety of circumstances, most notably, recent consumption or regurgitation of an amount of alcohol, similar to what would occur during GERD emanation, which has a tendency to deposit alcohol-laden air in the oral cavity.

I have routinely observed the slope detector fail to register mouth alcohol that is as much as 12-15 minutes old, often allowing the unit to register an abnormally high reading given a simple swish of alcohol. Published studies indicate failure of the residual alcohol detection system to identify mouth alcohol bias between 37% (Harding et al, 1992) and 48 % failure (Simpson et al, 2004). Gullberg (2000) also reports on the inadequacy of the mouth alcohol detection systems. Harding reported that some of these failures occurred after more than 15 minutes of deprivation.

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