

The Forensic Blood & Urine Testing Program
May 14th – 17th, 2009

Examining Evidentiary Issues in Forensic Testing

San Diego, CA

Jan Semenoff

67 Baldwin Crescent
Saskatoon, SK, Canada, S7H 3M5
Office toll-free (888) 470-6620
Fax toll-free (866) 664-3051
jan@itd2.com
www.itd2.com



Contents

Introduction.....	2
Retrograde Extrapolation and Widmark, Revisited	2
Widmark Ratios “r” as Calculated by ARW Forrest.....	4
The Variables in Human Physiology – Partition Ratios, Elimination Rates and Your Client	6
Partition Ratios	6
The Elimination of Alcohol.....	9
The Fallacy of the Slope Detector	11
Mouth Alcohol Detection & the Residual Alcohol Detection System	11
Obtaining Proper Samples & Operational Implications.....	13
Operational Errors that Matter	14
The Big Green Button	14
What is an Invalid Test? A VERY IMPORTANT NOTE:.....	14
Occupational Exposure to Volatile Organic Hydrocarbons.....	15
Infra-red Interferents and Elevated Readings	15
Hydrocarbons, the Alcohols and Organic Chemistry	16
Occupational Exposure to Organic Hydrocarbons.....	17
Isopropanol and its Metabolite Acetone as Interferents.....	21
Material Safety Data Sheets	22
Medical Issues that Make a Difference	23
COPD /Emphysema /Chronic Bronchitis/Asthma	23
Radio Frequency Interference	25
Accuracy & Precision – Close Only Counts in Horseshoes and Hand Grenades	27
Accuracy.....	27
Precision	27
Calibration of Breath Testing Devices.....	28
Maintenance.....	29
Analysis of Download Data.....	29
Conclusion	31

Examining Evidentiary Issues in Forensic Testing

Or... Everything You Need to Know about Testing Inadequacies in 45 minutes!

Jan Semenoff

Industrial Training & Design Ltd

1(888) 470-6620

jan@itd2.com

www.itd2.com

Introduction

Breath alcohol testing is complex tasks that requires accuracy, precision and correct operational procedures in order to obtain acceptable results. Without appropriate quality controls in place, the testing process can go awry. This paper will present some of the neglected issues in the testing process that can affect the validity, reliability and accuracy of the tests.

Retrograde Extrapolation and Widmark, Revisited



In 1932, Dr. Erik M.P. Widmark (1889-1945) of the University of Lund in Sweden formulated *Widmark's Ratio*. He had been asked by the US Department of Justice, Bureau of Prohibition, to help develop a means by which tangible evidence could be presented concerning cases of "driving under the influence of liquor." Widmark had developed a test using a finger-prick technique that obtained a micro-sample of blood that could be subsequently analyzed for alcohol in the lab.

He was considered the foremost investigator of blood alcohol concentrations in his day, and set the testing groundwork for the legal examination of intoxication in much of Europe. It is interesting to note that Widmark submitted a paper to the *Journal of the American Medical Association* regarding his micro sampling of blood technique, but it was returned unpublished as space was limited in the journal at the time. Had that publication appeared in the United States, blood testing may have become the preferred method of alcohol detection, as it was to become in Europe for the next 50 years.

The *Widmark ratio*, r^1 , is the proportion of the concentration of ethanol in the *body* to the concentration of ethanol in the *blood* according to the following formula:

Equation 1 - Widmark's Ratio (*Widmark's Equation*)

$$A = [C_t + (\beta t)] p r$$

Where:

- **A** is the amount of alcohol consumed (*raw alcohol in grams, not alcoholic drinks*)
- **C_t** is the blood alcohol concentration
- **β** is the ethanol elimination rate constant – *Widmark's Beta Value*
- **t** is time
- **p** is the body weight
- **r** (rho) is the ratio of the total body ethanol concentration – *Widmark's Ratio*

The following general values were used by Widmark for **r**:

- A mean value of 0.68 (standard deviation +/- 0.085) in males and
- A mean value of 0.55 (standard deviation +/- 0.055) in females.

Solving for BAC:

$$C_t = \frac{A}{p r} - (\beta t) \quad \text{OR:}$$

$$\text{BAC (at a particular time)} = \frac{\text{Alcohol consumed (grams)}}{\text{Body weight x Widmark's Ratio}} - (\text{Elimination rate x Time})$$

You probably want to solve the equation for **C_t** most of the time. The calculations are fairly straightforward, but are best left to a professional toxicologist, especially if the calculations are to be presented as evidence or rebuttal evidence in court. There are also a number of computer-based calculators that are available to provide a determination of the BAC at a given point in time, based on an accurate portrayal of ethanol ingestion.

The variation in Widmark's Ratio results because absorbed ethanol is uniformly distributed throughout the body's water, but not in fatty tissue. People of a given body weight will have

¹ It is helpful to think of Widmark's reduced body mass value, or *r*, as representing the smaller portion of the body available for the absorption of alcohol.

varying proportions of fat to total body weight. This is sometimes expressed as the Body Mass Index. Females, so it is said, have a greater percentage of body fat, and therefore, a different Widmark Ratio. You should note that further work has been done on the value of *r*, (Forrest, 1986) and is available in table format.

Widmark Ratios “*r*” as Calculated by ARW Forrest

Males, Body Mass Index 15-30

(Widmark 0.68)

Wt lbs	99	110	121	132	143	154	165	176	187	198	209	220	231	242	253		
Wt kg	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	Ht M	Ht Imp
	0.78	0.75	0.72	0.69	0.67											150	4'11"
	0.79	0.77	0.74	0.71	0.69	0.66										155	5'1"
	0.80	0.78	0.76	0.73	0.71	0.69	0.66									160	5'3"
	0.82	0.80	0.77	0.75	0.73	0.71	0.68	0.66								165	5'5"
	0.83	0.81	0.79	0.77	0.75	0.72	0.70	0.68	0.66							170	5'7"
		0.82	0.80	0.78	0.76	0.74	0.72	0.70	0.68	0.66						175	5'9"
		0.83	0.81	0.79	0.77	0.76	0.74	0.72	0.70	0.68	0.66					180	5'11"
			0.82	0.81	0.79	0.77	0.75	0.73	0.72	0.70	0.68	0.66				185	6'1"
			0.83	0.82	0.80	0.78	0.77	0.75	0.73	0.72	0.70	0.68	0.67			190	6'3"
				0.83	0.81	0.79	0.78	0.76	0.75	0.73	0.71	0.70	0.68	0.67		195	6'5"
				0.84	0.82	0.81	0.79	0.78	0.76	0.74	0.73	0.71	0.70	0.68	0.67	200	6'7"
					0.83	0.82	0.80	0.79	0.77	0.76	0.74	0.73	0.71	0.70	0.69	205	6'9"

Table 1 - Forrest's Calculation of "r" Based on Widmark's Ratio for MALES

Due to an overall increase in obesity in the North American populace, further data points are required for persons in the shaded areas of the chart above (Males), and on the next page (Females).

Females, Body Mass Index 15-30

(Widmark 0.55)

Wt lbs	99	110	121	132	143	154	165	176	187	198	209	220	231	242	253		
Wt kg	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	Ht M	Ht Imp
	0.69	0.66	0.63	0.61	0.58											150	4'11"
	0.70	0.68	0.65	0.63	0.60	0.57										155	5'1"
	0.72	0.69	0.67	0.65	0.62	0.60	0.57									160	5'3"
	0.73	0.71	0.69	0.66	0.64	0.62	0.59	0.57								165	5'5"
	0.74	0.72	0.70	0.68	0.66	0.64	0.61	0.59	0.57							170	5'7"
		0.73	0.71	0.69	0.67	0.65	0.63	0.61	0.59	0.57						175	5'9"
		0.74	0.73	0.71	0.69	0.67	0.65	0.63	0.61	0.59	0.57					180	5'11"
			0.74	0.72	0.70	0.68	0.66	0.65	0.63	0.61	0.59	0.57				185	6'1"
			0.75	0.73	0.71	0.70	0.68	0.66	0.64	0.63	0.61	0.59	0.58			190	6'3"
				0.74	0.72	0.71	0.69	0.68	0.66	0.64	0.63	0.61	0.59	0.58		195	6'5"
				0.75	0.73	0.72	0.70	0.69	0.67	0.66	0.64	0.63	0.61	0.60	0.58	200	6'7"
				0.74	0.73	0.71	0.70	0.69	0.67	0.66	0.64	0.63	0.61	0.60		205	6'9"

Table 2 - Forrest's Calculation of " r " Based on Widmark's Ratio for FEMALES

Because of this, a "tall-thin" person or a "short-fat" person of the same body weight who consume the same quantity of ethanol will have different distributions of ethanol throughout their respective systems. The "short-fat" person will have a higher BAC because the same quantity of ethanol will be distributed in a smaller quantity of water. Indeed, some approaches to estimating BAC have employed values of r that depend on sex and body type. Widmark's assumptions are in doubt in some scientific circles. Forrest (1986) based r on the Body Mass Index (weight divided by height squared).

Widmark's Ratio is not actually used by breath alcohol analyzers, as a *direct means of measurement*. Rather, it is often employed by forensic toxicologists and other expert witnesses

as a means of confirming or disputing a reading obtained by one of these instruments in processes called *retrograde extrapolation* and *anterograde extrapolation*.²

Widmark's Ratio has been used since its initial postulation more than 70 years ago³. It must be noted that Widmark used only 20 men, and 10 women in his initial postulation of the ratio, therefore his sampling population must be considered too small to provide a statistically valid result. As well, the ratio, *r*, may in fact change in individuals over time. Forensic evidence suggests that other alcohol distribution models may provide a higher degree of probability in determining BAC after the fact.

Some experts feel that back extrapolation is an unsound process, as there are too many physiological factors that affect an individual during the elimination phase. Some feel elimination is linear, while others plot a curved elimination. The most critical factor is when the subject reached peak BAC. Not knowing when peak BAC is reached may invalidate any attempts at back extrapolation.

The Variables in Human Physiology – Partition Ratios, Elimination Rates and Your Client

Partition Ratios

The second issue is one of the most contentious issues surrounding breath alcohol testing to date. This is the ratio between the alcohol *dissolved in the blood* to the alcohol *exhaled in the breath*⁴ 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

² Extrapolation in a backward manner is retrograde. Extrapolation in a forward manner is anterograde.

³ Widmark EMP. *Die theoretischen Grundlagen und die praktische Verwendbarkeit der gerichtlich-medizinischen Alkoholbestimmung*. Berlin: Urban & Schwarzenberg, 1932. (Widmark EMP, "Principles and Applications of Medicolegal Alcohol Determination". English translation of the 1932 German edition.)

⁴ 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.

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 literature⁵ 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 America⁶ 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.*

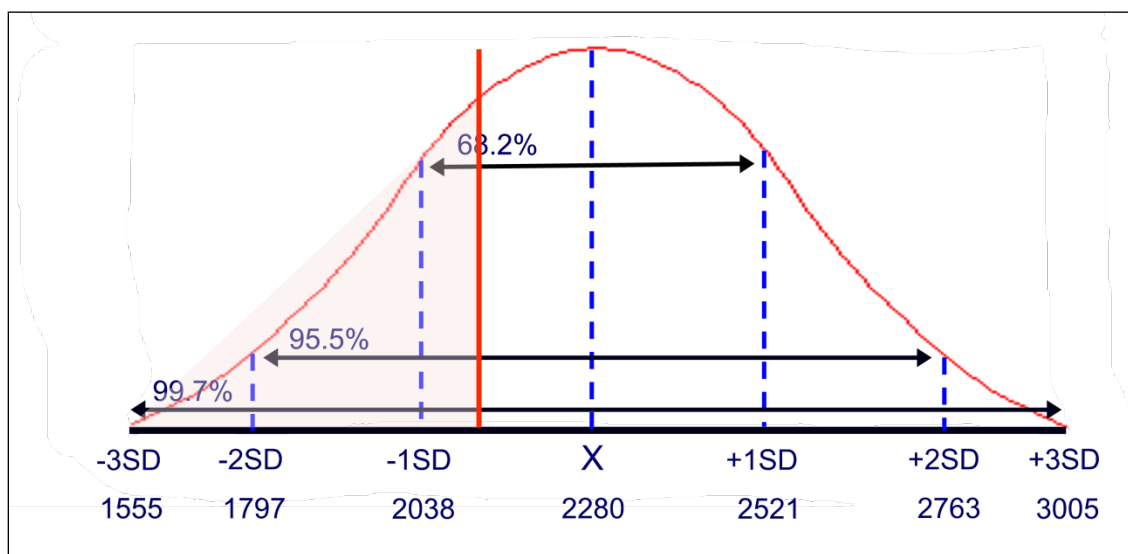


Figure 1 - Partition Ratio Distribution Curve

⁵ Kurt M. Dubowski, "Absorption, Distribution and Elimination of Alcohol: Highway Safety Aspects", 10 J. Stud. Alcohol Suppl. (1985).

⁶ 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 distinctly hope not. I certainly 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 over-estimates roughly 4 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. Jones⁷ measured the low-end of the ratio at 1756:1 (in 1983) and 1663:1 (in 1992)⁸, 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.

⁷ Jones, AW. Determination of liquid/air partition coefficients for dilute solutions of ethanol in water, whole blood, and plasma. *Journal of Analytical Toxicology* 7: 193-197, 1983.

⁸ A. W. Jones, K. M. Beylich, A. Bjorneboe, J. Ingum, and J. Morland, "Measuring Ethanol in Blood and Breath for Legal Purposes: Variability between Laboratories and between Breath-Test Instruments" *Clinical Chemistry*, Volume 38, Number 5, pages 743-747, 1992.

respond to incessant metabolic poisoning. This may account for their faster degree of metabolization of alcohol. While the typical person has an alcohol elimination rate varying between 13-18 mg% per hour¹¹, British researchers found that chronic alcoholics may eliminate alcohol by 20-40 mg% per hour. Once the metabolic stress of alcohol is reduced, the ADH levels of these persons may return to normal values.

New studies indicate that the ADH enzyme levels vary between individuals based upon race or hereditary factors. A person may be less able to metabolize alcohol due to lowered levels of one or more of the ADH enzymes. This trait may be passed down from generation to generation. Persons of Oriental, North American First Nations and Inuit heritage, and Australian Aborigines have been shown by some researchers to have lower overall levels of ADH in their bodies (*beginning with Fenna et al, 1971*). This finding is in dispute (*Bennion & Li, 1976, Lee et al, 1999*). Some researchers believe that the levels of ADH are adaptive processes, as none of these cultures had a history of alcohol consumption prior to its introduction by European settlers.

Again, Widmark's Ratio is used to calculate the elimination of alcohol in retrograde extrapolation. *See Part 1*. Some experts feel that back extrapolation is an unsound process, as there are too many physiological factors that affect an individual during the elimination phase. Some feel elimination is linear, while others plot a curved elimination. The most critical factor is when the subject reached peak BAC. Not knowing when peak BAC is reached may invalidate any attempts at back extrapolation.

average, which means the alcohol consumed will be dispersed in less tissue with water, resulting in a proportionately higher BAC.

¹¹ The total amount of ethanol broken down per hour is estimated in the range of 0.1-0.3 grams per kilogram body weight per hour. This is usually translated into 6 – 9 grams of ethanol per hour for a healthy subject. This is usually estimated at 0.013- 0.018 grams per hour. I've tested subjects as low as 0.009 per hour, and as high as 0.026 per hour.

The Fallacy of the Slope Detector

Mouth Alcohol Detection & the Residual Alcohol Detection System

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:

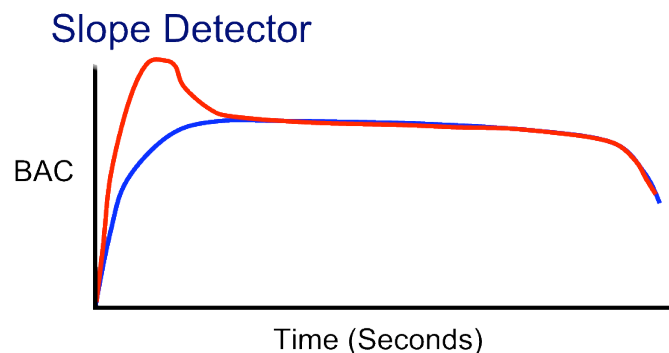


Figure 2 – Sample Slope Caused by the Introduction of Fresh Mouth Alcohol.

I have tried to draw the “true BAC” along the same curve as the first sample. The red line indicates the sample provided with a false fresh-mouth alcohol micro-burp. The slope detector is designed to measure this rapid decline, greater than 0.005 per second, at the start of the sample, and alert the operator with an error message that the sample obtained was improper. The testing sequence will not allow the reading to be recorded, and the testing process will be aborted while we wait for 15-20 minutes for fresh-mouth alcohol to dissipate.

If the rise is more than +0.003 per second, WITH an immediate decline greater than -0.005 per second, the *Residual Alcohol Detection System* will be triggered. This is purely a software-driven algorithm that determines changes in the slope detector ($\Delta \text{BAC}/\text{second}$). Note that there is no part of the Intoxilyzer 5000 internal component that is physically present.

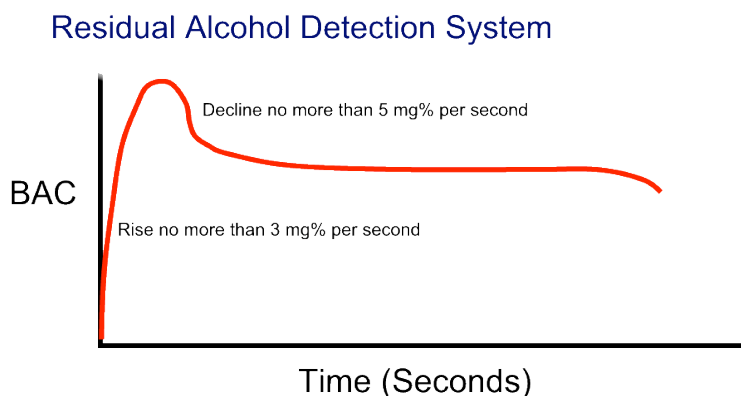


Figure 3 - The Residual Alcohol Detection System

The forensically acceptable standard of obtaining two readings within 0.02 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 observe 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.**

Keep in mind that older instruments such as the Breathalyzer Model 900 had no indicator for false positives. A micro-burp would be added to the reading, but only if it was captured in the cylinder. Hopefully, the second reading would then produce a result outside the acceptable 0.020 range for the two readings, and the third-sample procedure would be implemented to clarify the discrepancy. *Could someone have been convicted with a true BAC under 0.08 g, but two unintentional and unnoticed micro-burps that just happened to produce similar readings within 0.02?* I hope not. The residual alcohol detection system programmed into the Model 5000 was designed to ensure that this situation does not occur, however, I don’t believe it is reliable enough to warrant this degree of faith.

Certainly, those jurisdictions that do not employ a two-sample protocol leave the possibility for a false positive open for argument. Relying solely upon the slope detector to identify a fresh mouth alcohol false positive is, in my opinion, unsuitable for a criminal prosecution. I have seen the detector fail too often under controlled circumstances to rely upon it “beyond a reasonable doubt.” I recommend that single test jurisdictions that rely upon this feature should re-think their testing protocols, adding a second test that must be within 0.02 grams agreement.

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 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 as there is on some roadside screeners that are capable of automatically drawing a breath sample into the test chamber. The Model 5000 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 30 times per second¹². 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”.

¹² It is unfortunate that the complete results of the actual test are not available for printout. It would be nice to generate a graph that indicates, among other things, the FVC of the subject, a graphical representation of the force and duration of their breath sample, the BAC slope – indicated as a graph, the lung temperature, and a database of the actual values of the 339, 348 and 380 channels. Although the information would undoubtedly lead to an increase in court challenges, it would also, to some extent, provide quantified data, much the same way a DNA chart provides a verifiable result.

Operational Errors that Matter

The Big Green Button



Figure 4 - The START Button on the Intoxilyzer Model 5000

With the exception of pushing the start button, and entering subject data, the operation of the Intoxilyzer Model 5000 is fully automated. This degree of automation assists the operator in obtaining a suitable sample, and enables the testing procedure to proceed smoothly. The degree of control that an operator has had over a breath testing sequence has always been a matter of contention, and newer breath test devices attempt to nullify much of that debate.

What is an Invalid Test? A VERY IMPORTANT NOTE:

I have observed a point of great concern in disclosure files on a number of occasions. I refer you back to **the table below** for the true meaning behind the message “Invalid Test.” The device is indicating that the START button has been pressed at the wrong time, aborting the testing process. This is NOT an indicator of an inadequate sample on the part of the test subject. Some officers argue that the button is *both* a START and STOP button, and that its use is justified to terminate a sample deemed unsuitable.

INVALID TEST	<ul style="list-style-type: none"> • The START button is pressed at the wrong time • The test card is removed from the printer • The purge pump is unable to purge the chamber
---------------------	--

Table 3- The meaning of the INVALID TEST Error message on the Intoxilyzer 5000

However, I have observed disclosure videos where clearly the subject is providing a suitable sample, the operator is observed pushing the button, and the test subject cautioned or charged with refusal. Key evidence, namely the result of the aforementioned test, is destroyed by the operator. I’m left to wonder why. *Is the preliminary display showing a reading below the statutory limit? Why not let the unit receive the sample in the fullest and perform an analysis on the breath – particularly in documented long-blow samples, or when you can clearly see the*

pressure-time indicator appear on the screen? What aren't we seeing? I'm frankly **very** alarmed by this police procedure, and believe that any indication of an "Invalid Test" coupled with a refuse breath test charge warrants a high degree of scepticism, and a great deal of further scrutiny by the courts.

Occupational Exposure to Volatile Organic Hydrocarbons

Infra-red Interferents and Elevated Readings

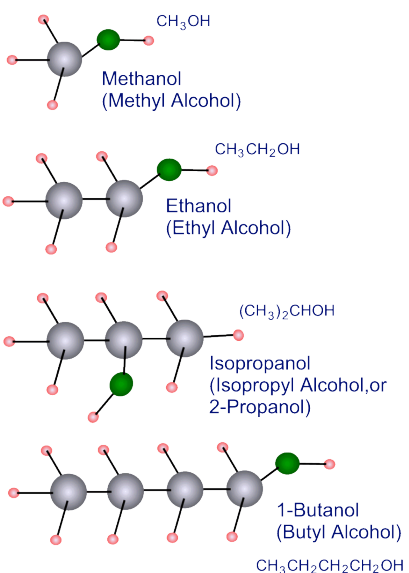
The alcohol typically consumed is ethyl alcohol. The ideal evidentiary instrument should be able to discriminate between ethanol and other alcohol types. *Specificity* refers to the ability of breath testing devices to distinguish between ethanol, and other substances that might be found on the breath of the test subject. We need a reading of, for example, .120 grams to refer to a true B_rAC of 120 milligrams of ethanol dissolved in 100 millilitres of blood.

Anything else that may be on the breath of the test subject, and that either masks or enhances the reading of alcohol is referred to as an *interferent*. In practical applications, there are a few interferents that can adversely affect the outcome of a test.

In order to be considered an interfering substance to this true B_rAC reading, an interferent must have a few important characteristics:

- The substance must be **volatile**. Volatility refers to the ability of the substance to evaporate easily enough that it can be found on the breath of the test subject. Even if a compound is in the blood, and furthermore, even if it is capable of causing impairment, it won't be detected on the breath unless it is volatile. Most solid substances don't have volatile components, unless they contain alcohol. Gums, candies and most breath mints will not cause an interferent reading. Mouthwashes, candies with an alcoholic component, and some breath fresheners will cause a false positive reading. Usually, this is because they contain alcohol.
- The substance must be **non-toxic**, or no more toxic than ethanol. Any substance that is so toxic that it would provide a discernible reading must not be so toxic as to poison the test subject. In general terms, methanol (found in windshield washing fluid, cleaning products, and paints) falls into this category. However, people can build up chronic exposure doses that are considerable.
- The volatile and non-poisonous substance must be present in a **sufficient concentration** that it can provide a false-positive reading when compared to ethanol.

- It must have **chemical properties** that make it unlikely to be distinguished from ethanol by the breath testing instrument.
- It has to have a reasonable and demonstrable **route of entry** into the human body, preferably not involving voluntary consumption. This is more of a practical consideration.



The Alcohols

Figure 5 – Representative Diagrams of the Alcohol Family

different levels of toxicity for each alcohol type. Alcohol is a hydrophilic compound, meaning that it is completely soluble in water. This solubility makes it easy for alcohol to be absorbed in the body.

Methanol exists as a “chain” of a single hydrocarbon group, Ethanol has two hydrocarbons in the chain, Isopropyl alcohol has three hydrocarbons, and Butyl alcohol has four, as shown in **Figure 5**. Each one of these collections of carbon-carbon chains forms a marriage with the oxygen-hydrogen group, to form *an alcohol*. *The presence of the hydroxyl group makes the molecule an alcohol*. Because the alcohol molecules are similar in form, they behave similarly in function.

Hydrocarbons, the Alcohols and Organic Chemistry

Organic chemistry deals with the bonds of carbon compounds. Alcohols have a chain of hydrogen-carbon bonds, called the *alkyl group*, (sometimes referred to as the methyl group), with a “tail” attached that is an oxygen-hydrogen pairing, called the *hydroxyl group*. Each of these is referred to as a *functional group*¹³. By adding more and more alkyl groups together in the chain, the alcohol molecule gets longer and more complex. In theory, the chain of hydrocarbons in an alcohol molecule could be infinitely long; however, we are concerned with only a few alcohol molecules. It is the difference in the alcohol’s structure that creates different metabolites when they are broken down by the body, resulting in

¹³ A functional group in chemistry refers to a particular pattern of atoms that occurs time and time again in different molecules.

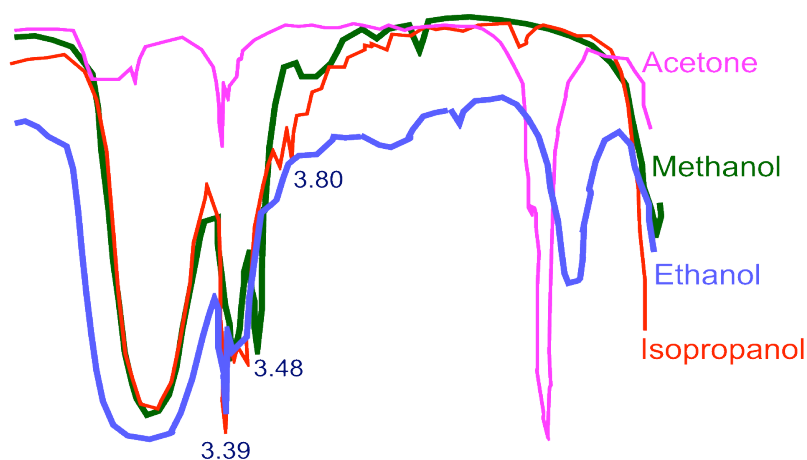


Figure 6 - Overview of the Common Interferents Compared to the Fingerprint of Ethanol.

The bonds keeping those molecules bound together are continuously vibrating, even if the compound is in a solid or liquid state. Think of the bonds not as straight sticks, but as flexible springs. The bonds between two atoms in a molecule will vibrate perpetually at their own rate, or *frequency*. The bonds between hydrogen and oxygen atoms vibrate at different frequencies than between a pairing of hydrogen and carbon molecules. The bond energy is measurable, in the form of a *frequency rate*.

Occupational Exposure to Organic Hydrocarbons

Some workers are known to have been occupationally exposed to isopropanol or methanol. If tested while exposed to isopropanol or methanol alone the Intoxilyzer 5000EN would certainly be able to determine that the interferent did not produce the expected result as with ethanol and would therefore report an unknown interfering substance. However, in *combination* with ethanol, the Intoxilyzer has the tendency to over-report the BAC present in combination with a small concentration of isopropanol or methanol, and will not trigger the interferent detector. Hak (1995) reported that an isopropanol level will enhance a reported BAC while identified as an interferent less than half the time, depending upon the concentration of the interferent.

Ethanol is an organic hydrocarbon. The Intoxilyzer 5000EN reads the methyl (CH_3) portion of the ethanol molecule along the 3.36 – 3.80 micron range to determine the presence and concentration of ethanol in the test cylinder. The infra-red signature of isopropanol also includes a strong absorptance in this range, as outlined in Figure 6. The high degree of overlap in the 3.36 – 3.80 micron range is emphasized in red. This is due to the presence of the CH_3 molecules in both substances concerned. Note that this is the only infra-red range that is measured by the Intoxilyzer 5000EN.

It has been identified by various researchers that certain hydrocarbon compounds, in concert with low levels of ethanol cause inflated readings on the Intoxilyzer 5000 that are not always detected by its interferences-detect algorithm (Hak, 1995, Jones et al, 1996, Caldwell & Kim, 1997, and Memari, 1999). The Intoxilyzer 5000EN attempts to mitigate this tendency through the inclusion of two additional filter points (3.36 μ and 3.52 μ). However, these points will only assist in the detection of toluene and acetaldehyde.

I have identified the tendency of the Intoxilyzer 5000EN to over-report the true BAC of a sample of ethanol in the presence of interferences such as isopropanol, methanol, menthol, dimethyl sulfone and D-limonene. With a mixture of both ethanol and another infra-red absorbing hydrocarbon, the interference detection algorithm often fails to report the presence of the interference, while inflating the true concentration of ethanol reported as a BAC. I am concerned that a combination of hydrocarbons, as illustrated in Figures 7 - 12, falsely reports the BAC of ethanol in a test subject.

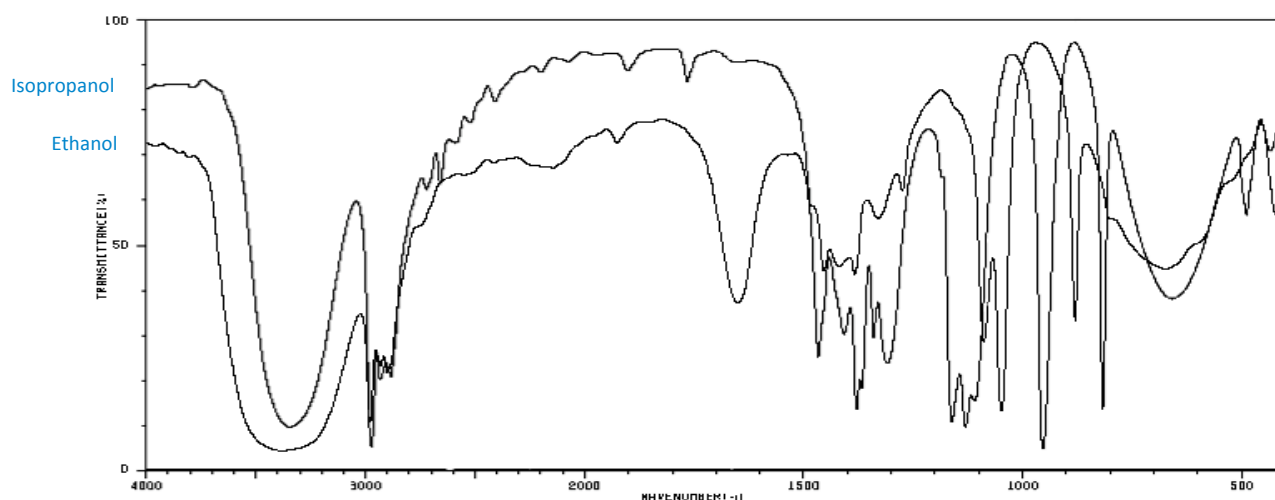


Figure 7 – A comparison of the fingerprints of isopropanol and ethanol.

The infra-red signature of Dimethyl Sulfone, Methyl Sulfonylmethane, and the organic volatile compound Biofreeze[®] (containing isopropanol and menthol) also includes a strong absorptance in this range, as outlined in Figure 9. The high degree of overlap in the 3.36 – 3.80 micron range is emphasized in red. This is due to the presence of the CH₃ molecules in all the substances concerned. *Note that this is the only infra-red range that is measured by the Intoxilyzer 5000EN.*

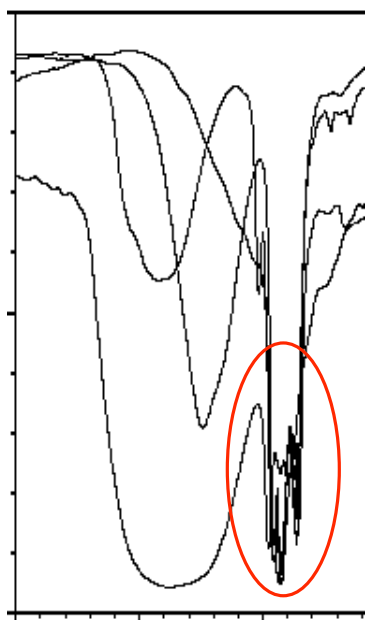


Figure 8 - The overlapping infrared signatures of Castor Oil, Adipic Acid, Methanol and Ethanol (bottom)

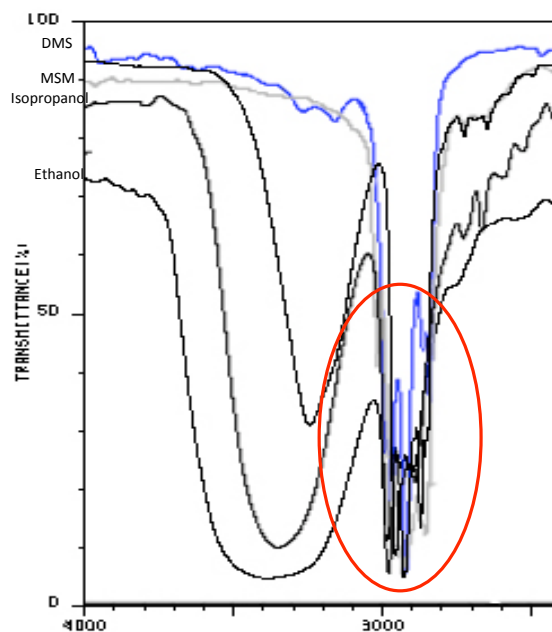


Figure 9 - Overlapping infra-red detection points of DMS, MSM, Isopropanol and Ethanol (bottom)

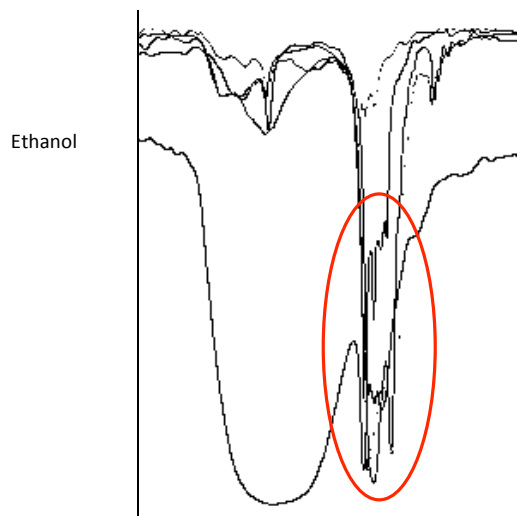


Figure 10 - The overlapping infra-red signatures of MEK, THF, Acetone and Cyclohexanone compared to Ethanol

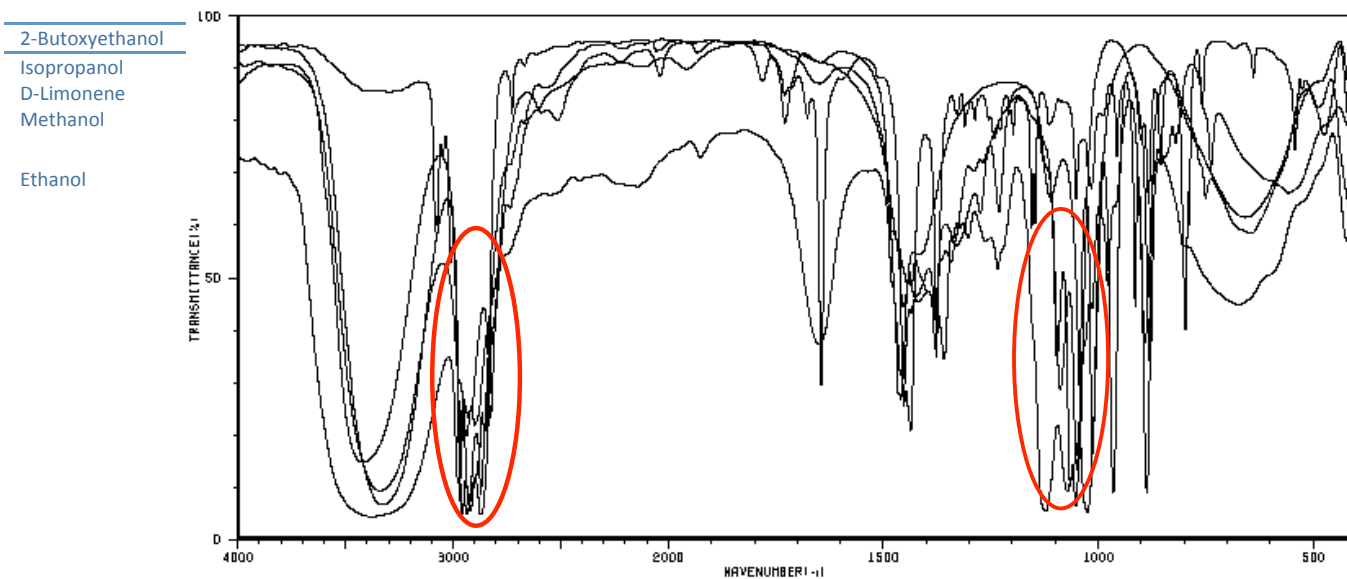


Figure 11 – The overlapping infra-red fingerprints of ethanol with common commercial degreasing compounds

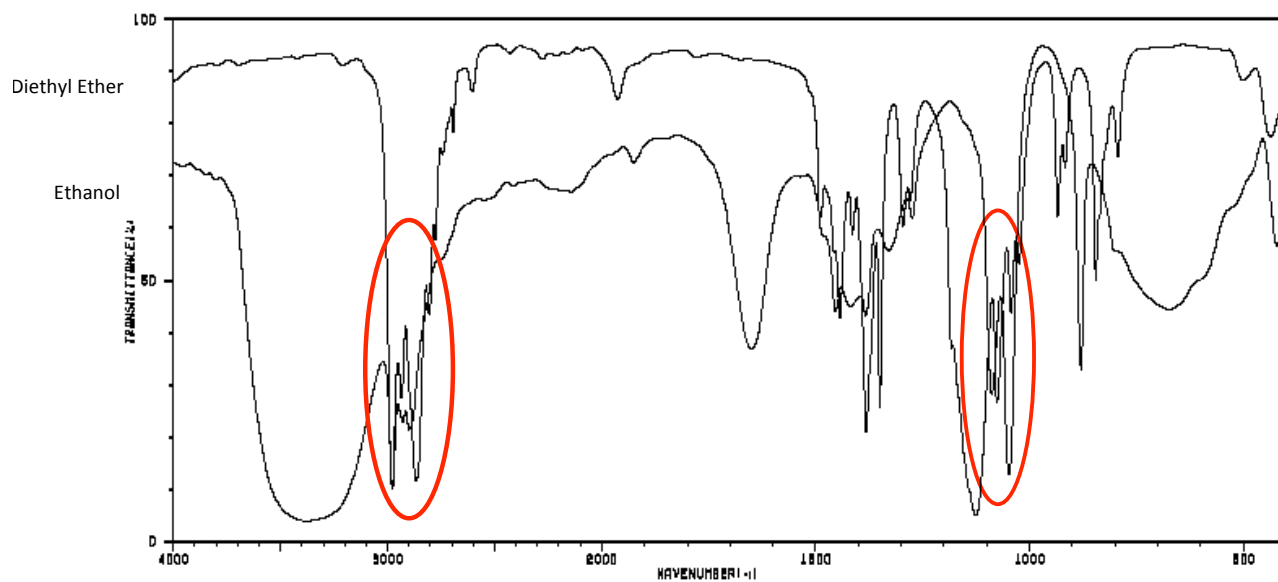


Figure 12 – The Infrared Spectra Overlap of Diethyl Ether (top) and Ethanol (bottom) at the 3 and 9 μ (micron) ranges

I conducted a series of sample tests on an Intoxilyzer 5000EN with methanol in concert with ethanol as itemized in Table 4:

Phase	Test	Result - grams	Remarks
1	1	.058	1.0 ml ethanol (50%) in 500 ml distilled water. Average reported BAC .060 grams
	2	.063	
	3	.060	
	4	.060	
	5	.060	
2	6	.154	1.0 ml ethanol (50%) with 1.0 ml methanol dissolved in 500 ml distilled water. No interferent detected. Average reported BAC .165 grams
	7	.165	
	8	.166	
	9	.172	
	10	.170	

Table 4 – Abbreviated Test results using interferents with .06 ethanol solution (more than these ten tests were performed).

Isopropanol and its Metabolite Acetone as Interferents

I have observed that, when confronted with a variety of potential interferents, the Intoxilyzer 5000 and 5000EN will report exaggerated BAC readings. The Intoxilyzer 5000, even the enhanced EN version, is just not sophisticated enough to discern the overlapping infra-red 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 5 for these test results:

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

Table 5 – Test results using 1.0 ml isopropanol and 1.0 ml acetone in 500 ml water

I am left to reasonably conclude, as have other researchers, that a combination of infra-red 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 algorithm.

Material Safety Data Sheets

In the United States and Canada, federal laws require that Material Safety Data Sheets (MSDS) are readily available to workers to inform them of the hazards of materials used in the workplace. MSDS are an important component of workplace safety, and are intended to provide both workers and emergency personnel with safe handling information, and procedures to deal with incidental exposure and decontamination.

Material Safety Data Sheets (MSDS) have a wealth of information concerning a substance being used.

- They must be available to a worker on site
- They must be up-to-date, and provided by the manufacturer.
- They have environmental, health & safety, spill, and storage & handling information.

Information includes:

- **Product description**
- Trade names, synonyms, chemical name, formula, use
- Physical data
 - Melting or boiling point, spec. Gravity, appearance and odor
- Health data – including *route of entry* information
- Protection information

- Reactivity data
- Spill and disposal procedures
- Storage and handling characteristics and procedures
- Ecological data
- Hazards classification

Keep in mind that the concentration and duration of use of many chemicals is far higher than their typical household counterparts. Often, low-dose exposure over years leads to symptoms of chronic poisoning that is a justifiable health concern. Background levels of a chemical of substance may be identifiable in a worker, and may provide false-positive readings on a handheld or evidentiary alcohol testing device. The MSDS are a first point of examination to determine if inhalation exposure, or dermal absorption could possibly create this situation.

Medical Issues that Make a Difference

COPD /Emphysema /Chronic Bronchitis/Asthma

Chronic obstructive pulmonary disease (COPD) is a term referring to two lung diseases, chronic bronchitis and emphysema, that are characterized by obstruction to airflow that interferes with normal breathing. Both of these conditions frequently co-exist, and as such, physicians prefer the term COPD. It does not include other obstructive diseases such as asthma. COPD is the fourth leading cause of death in America, claiming the lives of 122,000 Americans in 2003. The main symptoms of COPD include Dyspnea (shortness of breath) lasting for months or perhaps years, possibly accompanied by wheezing, and a persistent cough with sputum production. It is possible the sputum may contain blood, usually due to damage of the blood vessels of the airways. Severe COPD could lead to cyanosis (bluish de-colorization usually in the lips and fingers) caused by a lack of oxygen in the blood.



Figure 13 – A portable spirometer

COPD is particularly characterised by a spirometry measurement of a ratio of forced expiratory volume over 1 second (FEV1) to forced vital capacity (FVC) being < 0.7 and the FEV1 $< 70\%$ of the predicted value as measured by a plethysmograph. Other signs include a rapid breathing rate and a wheezing sound heard through a stethoscope.

Asthma is a chronic illness involving the respiratory system in which the airway occasionally constricts, becomes inflamed, and is lined with excessive amounts of mucus, often in response to one or more triggers. These episodes may be triggered by such things as exposure to an

environmental stimulant (or allergen), cold air, warm air, moist air, exercise or exertion, or emotional stress. This airway narrowing causes symptoms such as wheezing, shortness of breath, chest tightness, and coughing. The airway constriction responds to bronchodilators. Between episodes, most patients feel well but can have mild symptoms and they may remain short of breath after exercise for longer periods of time than the unaffected individual. The symptoms of asthma, which can range from mild to life threatening, can usually be controlled with a combination of drugs and environmental changes.

To obtain what is believed to be suitable samples of deep lung air, most breath alcohol testing devices require a flow of 1-2 litres per minute sustained for at least 5 seconds duration. The pressure required by most instruments was around 15-17 cm or 6 inches of water. The ability of the COPD patient to provide the exhalation force required to activate the pressure transducer may be in question with certain individuals. Many are able to provide a hard enough sample to activate the transducer, but are not able to blow for the minimum time for a test (5 seconds).

I was involved with a study¹⁴ in 1990 that examined the ability of COPD patients to provide a sample of air into a portable breath test device. In all, 102 patients (68 with chronic asthma and 34 with COPD) were studied. Only three, including the one patient that I observed, were unable to provide a suitable sample into the breath test device within the three attempts that were allotted as the measurable study objective. Our study concluded that patients with a FVC more than 1.43 liters could do the test. Patients with a FVC less than 1.0 liter would probably not be able to provide a sample. One particularly stubborn patient with a FVC of 0.75 liters was successful on his third attempt. The other two patients with a FVC of 0.81 and 0.78 were also unable to pass the test.

A British study¹⁵ conducted by Briggs et al in 1990, concluded that in using the Lion Alcolmeter S-L2, subjects with a FVC less than 1.5 litres were unlikely to be able to activate the pressure transducer.

Establishing a “normal” FVC is not as simple as it seems, as it combines age, gender, predicted values, allowances for history of smoking, etc. In simple terms, a “normal” person will have a FVC between 3-5 litres, as a general rule of thumb. In light of those values, our study was conducted on severely affected patients with long-term histories of asthma or COPD. Yet, only 3/102 were unable to provide a suitable sample. Regardless, the data points to a basic threshold of an FVC of approximately 1.5. If your client’s spirometry is below this value, they

¹⁴ MB Prabhu, TS Hurst, DW Cockcroft, C Baule and J Semenovff, “Airflow Obstruction and Roadside Breath Alcohol Testing”, *Chest* 1991;100;585-586.

¹⁵ Briggs JE, Patel H, Butterfield K, Honeybourne D. “The Effects of Chronic Obstructive Airway Disease on the Ability to Drive and Use a Roadside Alcolmeter”, *Respiratory Medicine* 1990; 84:43-46, as cited in our paper.

will not be able to provide a suitable sample, and may be seeking your advice due to a refusal charge.

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 error. 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 detector built into the Intoxilyzer 5000 series of breath alcohol testing devices is based on technology of circa 1970. Although the Intoxilyzer 5000 itself has undergone various upgrades in its capabilities, the RFI detector circuitry it employs has remained essentially the same since its creation almost forty years ago. It was designed to detect the presence of radio frequencies in the 10-300 Megahertz (MHz) range, as was commonly found in police radios of that era. Due to their poor performance, most of these radio devices have long been abandoned.



Figure 14 - The BlackBerry Curve™

The detectors do not recognize the presence of either upper-band analog or more modern digital transmissions that may be present and interfering with the internal circuitry of the Intoxilyzer. As well, the type of RCA plug used to connect the rudimentary antennae of the Intoxilyzer is only suitable for detecting radio frequencies in the much lower 5-6 MHz range. Simply put, the detector utilized by the Intoxilyzer is “blind” to modern portable transceivers, used by both civilians and police agencies.

Modern police radios commonly transmit and receive within frequencies between 400 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 operation¹⁶. RFI interference to devices such as ventilators, patient monitors, pacemakers, neonatal incubators, motorized wheelchairs, and anaesthesia delivery equipment has been reported and documented. A recent study in Holland concluded that RFI affected the majority of 61 different medical devices tested.

Additionally, although there has only been one reported case of an air crash where the use of cellular telephones has been alternately purported as responsible¹⁷, the United States Federal Communication Commission bans the use of cellular phones in aircraft entirely (*per 47 C.F.R. § 22.925*). 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 off is warranted.

Shortly after the introduction of the types of technology used by the Intoxilyzer and similar 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 Blood Alcohol Concentration (BAC) 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 BACs. As such, the cautious and prudent approach is to absolutely eliminate the possibility of RFI altogether.

Any breath alcohol tests obtained where radio frequency interference is thought to be present are the products of substandard acts on the part of the operator. Any test result that is obtained by a sub-standard act is, by definition, a sub-standard reading, and should not be considered prima facie evidence "beyond a reasonable doubt."

¹⁶ I have served as both a Police Constable and Emergency Medical Technician in my community in the last 25 years. 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.

¹⁷ 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.

Accuracy & Precision – 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 three important concepts:

- Accuracy
- Precision
- 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 earlier, sets the working ratio between B_rACs 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.*

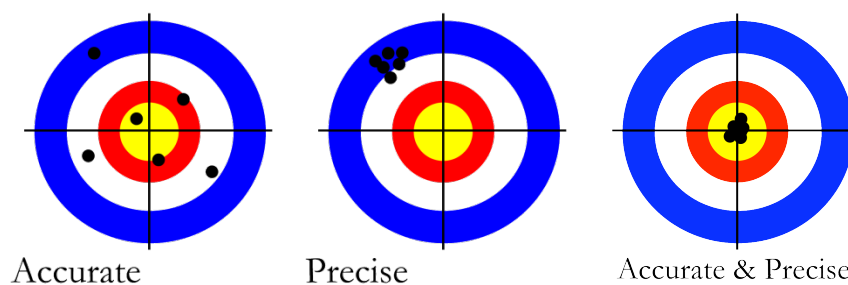


Figure 15 - Accuracy versus Precision

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.

Calibration of Breath Testing Devices

Calibration and maintenance are necessary if any degree of accuracy and precision are to be maintained. Infra-red sensors, being analog devices, are subject to a degree of drift. Some sensors become more sensitive over time, and others become less sensitive. Therefore, some breath alcohol devices will have readings that go up over time, and others will have readings that go down over time. The sensor, typically made of a material called lead selenide, will require periodic calibration to maintain its degree of accuracy and precision.

Note that the calibration is not the same as the calibration check conducted during the test sequence. During its annual maintenance, the device will be calibrated according to a set of procedures to a known and verifiable external standard. Then, once calibrated – or corrected – the device will have that calibration verified – or checked – during the actual breath test.

In the Intoxilyzer line of breath test devices, COBRA (Computer **O**nline **B**reath **A**rchive) data may be available that can be examined to determine whether or not the device was operating correctly – that is to say, that the unit was operating in a precise and accurate way. The external standard solution, if used with appropriate controls in place, verifies that the unit was reading a known concentration of ethanol

reliably. Often, a review of the COBRA data indicates that a specific unit was reading either high or low for a majority of the time. This becomes critical in those cases very close to a statutory limit.

Maintenance

Another part of a correctly functioning breath test protocol is the maintenance of the units themselves. In some jurisdictions, this is done on a routine basis, and is done very well indeed. Funding and resources are available to ensure that the devices receive routine maintenance, cleaning and adjustment. In other jurisdictions, breath test devices are only fixed when broken.

Analysis of Download Data

Regardless of assertions to the contrary, the historical performance of a specific instrument IS fundamental in determining its accuracy, precision and reliability. The Intoxilyzer 5000EN used in many jurisdictions stores its historical performance onboard in a .txt file that is accessed by various software programs, most notably the COBRA extraction software. COBRA stands for the **C**omputerized **O**nline **B**reath **A**rchive, and presents its data in spreadsheet format.

In addition to stored data that includes information relating to the test subject, arresting officer and breath technician, the COBRA data stores information relating to the internal standards test performed, if any, and their results, and the calibration check data. Most importantly, any error messages or abnormal circumstances generated during the testing process are revealed. Often, these error messages help assess the ability of the Intoxilyzer to correctly interpret breath test data, and sometimes show errors in the way the breath samples were collected. More often, they show an instrument that is properly calibrated, reading precisely, and being operated correctly.

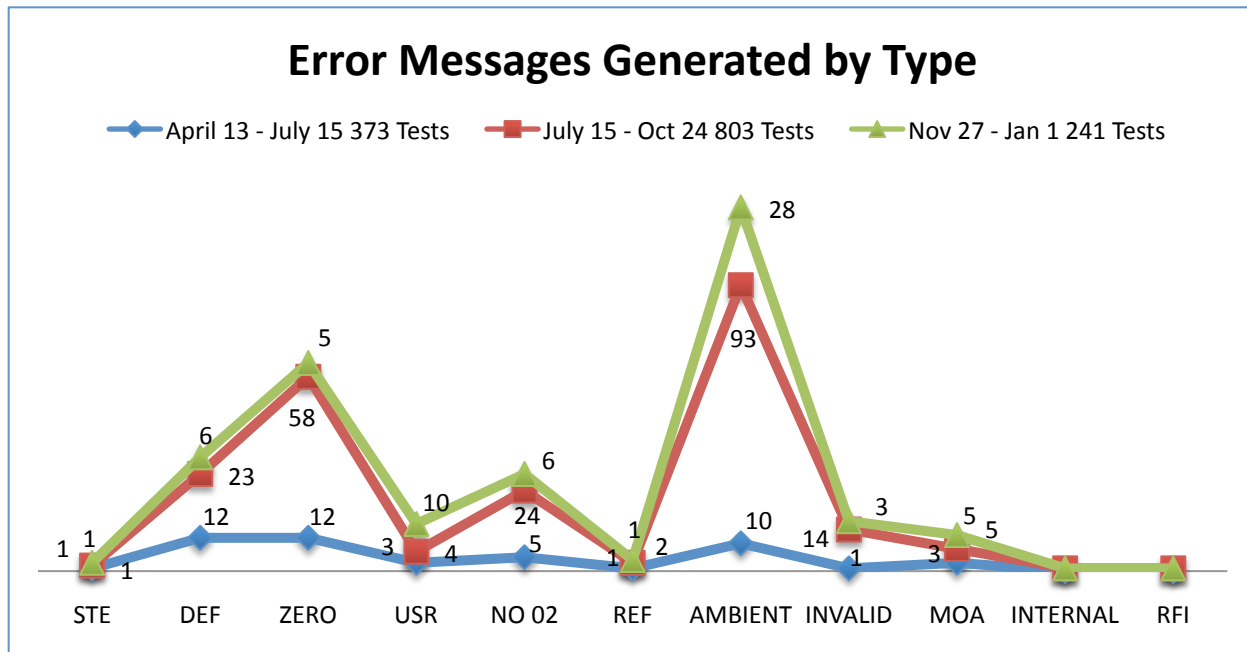


Chart 1 – Error messages generated by type, comparing three periods of time.

Notice the inordinate number of Ambient Fail errors in the chart above. The “fix” for this situation has been to increase the threshold value at which a specific error is reported. As an example, I recently heard testimony indicating that the Ambient Fail error message was fixed by raising the threshold value from .012 to .020 before the issue was regarded as an error. This does absolutely nothing to resolve the underlying factors generating the ambient error message in the first place, and should be considered more of a panacea than a proper analysis and return to acceptable standards for this issue. However, Colorado is not alone in this specific circumstance.

Downloaded data can also reveal the experience and overall performance of the breath test operator. Specifically, I look at the number of times a specific operator used that specific instrument. Perhaps they did not know of its overall performance. Does the unit have a tendency to read high or low, and is this within a matter of concern for this specific breath test? Does a specific operator generate an abnormally high number of refusals? Are procedures being followed, as when a Mouth Alcohol detected error is followed by a wait of just a few minutes. Often, this sort of situation is not disclosed in the police report, and must be ferreted out by an external review of the data.

The ability to independently analyze the performance of a specific instrument allows an unbiased view of the performance characteristics of the instrument itself, and indicates how breath test protocols are followed.

Conclusion

I like to describe the breath testing process like the spokes on a wheel. The hub is the target – the bull’s eye – of forensic testing, in other words, the results obtained. Each individual spoke represents a component of the testing process. One spoke is the training of the operator, one spoke the components of the program used in that jurisdiction. Another spoke represents the compliance with those components of the program, and whether or not practices are being followed, or sub-standard acts or practices have evolved. Fundamental hypothesis represent a number of spokes, and instrument design, including software used, represent others. Maintenance represents another spoke, calibration yet another and so on.

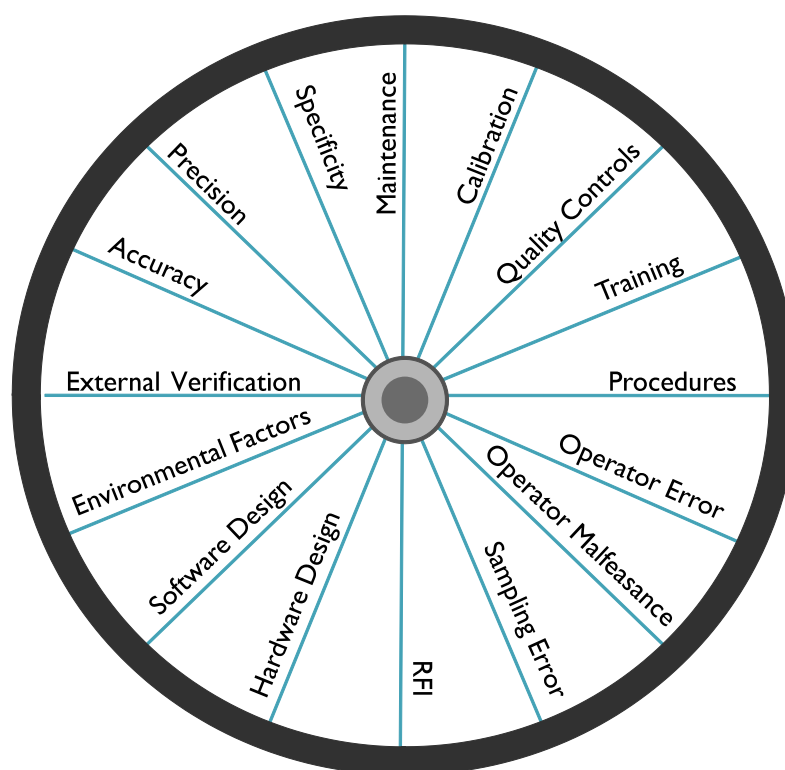


Figure 16 – Components of Breath Alcohol Testing

When too many spokes of a wheel are loosened or damaged, or not there at all, the wheel falls off the cart. The target, the breath test result, is compromised if the individual components of the testing protocol are below-standard.

This is an excerpt from my upcoming book, *“Principles & Practices of Breath Alcohol Testing”*