COUNTERPOINT
The Journal of Science and the Law

ISSN 2369-2774

Case Studies:

Soberlink™

SCRAM™

Based on materials published in Volumes 1, 2 & 3 of *Counterpoint*

Industrial Training & Design Ltd.

Counterpoint is a publication of Industrial Training & Design Ltd.

PUBLISHER:

COUNTERPOINT is published bi-weekly by:
Industrial Training & Design Ltd.
Saskatoon SK Canada

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SUBSCRIPTION RATES:
ANNUAL QUARTERLY SUBSCRIPTIONS:
Pricing $99 USD per annual subscription (4 Volumes, 24 articles total).
GST 89262 2424

This publication is indexed in the International Periodical Index; ISSN 2369-2774 as a Registered International Educational Journal.

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Case Study 1

The Soberlink™ Alcohol Monitoring Device

INTERPRETATION OF APPARENT FALSE-POSITIVE RESULTS[1]

Introduction

I recently received a request for a letter of opinion concerning the operational logs of a Soberlink™ Alcohol Monitor. I had received this emergency request for assistance late on a Wednesday night, for a report that had to be completed, with a sworn affidavit, for an emergency court appearance Friday at noon. *Time was of the essence, to the extreme...*

Figure 1 - The Soberlink Alcohol Monitor combines facial recognition technology with a cellular link to supply results of a fuel cell based alcohol tester to a central data collection center which is then reported to interested parties.

The device in question was being used for court-ordered compliance monitoring where the subject had been alleged with a long history of alcohol abuse by his ex-spouse, who requested alcohol monitoring as a condition of his visitations. He had registered two positive results, which meant the man using the device was being brought before a Family Court judge, with the possibility that his visitation would be cancelled - over Christmas - and until further notice pending his compliance with the court's zero-consumption order.

The Soberlink ™ Alcohol Monitor

The Soberlink ™ Alcohol Monitor is *compliance monitoring* breath alcohol testing device that utilizes three combined components:

- A fuel cell-based ethanol sensor;
- A camera with facial recognition technology to ensure that the person *providing* the breath sample is the person *required* to provide the breath sample.
    - The manufacturer claims a high degree of accuracy with the facial recognition technology;
- Cell phone connectivity to transmit breath test results to a central database repository after the device receives each sample.

1 Originally published in two Counterpoint Volume 3 articles.

The results of any *positive* breath readings are then sent as an email notification to any interested party – the courts, concerned counsel or third parties, probation officers, employers, or health & safety professionals using the devices, etc.

Since it employs a fuel cell, the device is unable to employ any sort of slope detector (Residual Alcohol Detection System – or RADS) to ensure that the sample is not contaminated by any substance containing alcohol. The manufacturer's website publishes a list of items known or believed to contain levels of ethanol, and therefore a false-positive reading, in their user tutorial guidelines. *You may wish to review the operation of fuel cell devices.*

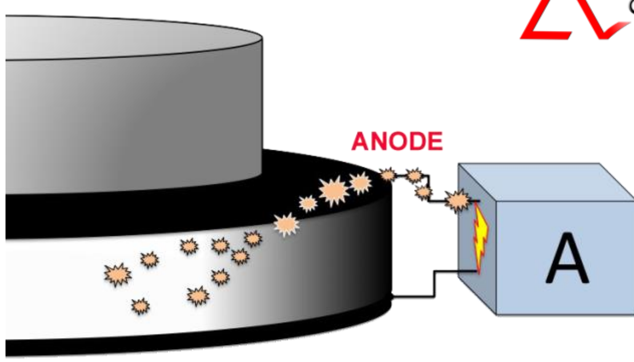

Figure 2 - A fuel cell oxidizes ethanol molecules to produce a weak electrical current. That electrical production is calibrated to a specific BrAC reading, which in turn can provide a fairly accurate measurement of BAC levels.

See the articles *"Fuel Cell Basics"* and *"An Overview of Roadside Testing Devices"* in Counterpoint's Free Sample Issue.

LIMITED DISCOVERY AVAILABLE:

CALIBRATION AND MAINTENANCE RECORDS

From a technical nature, I would argue that reviewing the device's maintenance and calibration logs is both relevant to its reported results and logically probative as it provides an understanding of the calibration, function and operation of the device over a period of time. Calibration drift errors either high or low, or conversely, correct calibration can be identified. Fuel cell devices, such as used in the analytical component of the *Soberlink*, are subject to this drift over time. Actually, *Soberlink* requires calibration of their devices after 1500 tests. Reported instrument malfunctions, if any, are also relevant, and only identifiable if we are allowed access to the complete performance history of the device.

By education, experience and training, I am primarily an investigator. Investigators should rely upon as complete a picture as possible in order to arrive at an investigative conclusion. This involves a complete data set from the breath testing device, including any calibration and error logs. I would really have liked to examine these calibration and error logs so that we could verify or refute the data to examine the reliability of the reported breath alcohol test results. Unfortunately, due to the time constraints, we couldn't get access to the calibration logs. The transmitted results of the device itself would have to suffice.

The First Event

By looking at these transmitted breath test results, in log form going back several months prior to the incident before the court where the subject had provided more than 100 random breath samples, I could tell there were two specific instances where the device had clearly provided false data.

An Important Note:

I want to make clear that this first event does NOT indicate a mistake, failure, or error on the part of the Soberlink device, but rather, identifies sub-standard conditions that created a false-positive reading that were dependent upon proper analysis and understanding of the circumstances. This is a failure of interpretation of the readings, not the device itself, of the reported BrAC readings.

WHAT HAPPENED?

CIRCUMSTANCES LEADING UP TO A FALSE-POSITIVE RESULT:

The subject had just brushed his teeth in the morning then was summoned by the device for a breath sample. His reported reading was .114 grams which promptly disappeared by the time of his next breath test 90 minutes later. This yields a physiologically impossible elimination rate of 0.070 grams *per hour*, therefore had to be a false positive due to fresh mouth alcohol from the toothpaste. Obviously, the device didn't know the toothpaste contained mouthwash, and therefore an amount of ethanol. The assumption made was that the reading reflected beverage alcohol. *However, the data supports a different conclusion…*

Here is an excerpt of the disclosed logs:

Event Description	Test Log Number	Date	Time	Reported BrAC	Comments
Test	102	Dec 4	2346	.000	
Sleep Period	-				No Testing Required – 7:02 hours
Test	103	Dec 5	0648	.114	
Test	107		0826	.000	1:38 hours elapsed time from positive reading

Figure 3 - The Soberlink logs indicate Test 103 had a reported reading of .114 grams/dL. Note that Tests number 104-106 were missed by the test subject (not knowing he had provided a positive result, he went back to bed). Test #107 showed a reading of Zero, meaning the test subject had eliminated .114 grams of alcohol on only 1 hours and 38 minutes, a physical impossibility.

The night before, a breath test (#102) was obtained at 2346 hours with a reported reading of .000 (zero) grams. Slightly more than 7 hours then elapsed before the next required breath test (#103), which was obtained at 0648 hours the next morning with a reported value of .114 grams/dL.

If we assume this reported breath alcohol test result is accurate and reliable, then one of three situations would have had to occur:

> **Scenario 1**- The subject began consuming a number of alcoholic beverages shortly after test 102, during the sleep period when no random testing is performed by the device.
>
> **Scenario 2**- The subject got up early in the morning and began consuming a number of alcoholic beverages shortly before test 103.
>
> **Scenario 3**- A combination of the two situations occurred.

Scenario 1 and 2 represent the extreme possibilities. Let’s look at each in turn to see if they make sense...

The test subject is an adult male who weighed about 220 pounds and stands 6’2” in height. A male of that height and weight will receive the BAC equivalent of 0.017 grams/100ml of blood for each Standard Drink consumed.

We have also discussed Standard Drinks previously. [2] A Standard Drink is measured as follows:

- **12** ounces of beer (or hard ciders) at **5%** alcohol content
- **3** ounces of fortified wine (port or sherry) at **20%** alcohol content
- **5** ounces of wine (including sparkling wine) at *12%* alcohol content, and
- **1.5** ounces of hard spirit liquor (gin, scotch, whisky, etc.) at **40%** alcohol content.

Figure 4 - Each of these is considered a "Standard Drink"

We have also discussed the metabolism and elimination of alcohol in the human body in previous Counterpoint articles [3]. In overview, for each hour the alcohol is in the human body, it will be metabolized and eliminated at a specific rate. This rate differs from person to person, with a reported low of 0.002 grams per hour up to an elimination rate of 0.045 grams per hour (Dubowski, 1985). These are extreme values. Most people fall between 0.010 – 0.020 grams per hours, with a median of 0.015 grams per hour. Without performing an elimination rate study on the test subject, we cannot identify his specific rate of elimination, but for educational and illustrative purposes a rate of 0.015 grams per hour is generally considered acceptable.

If Scenario 1 occurred - Drinking during the sleep period

Since about 7 hours of elimination would have occurred since the previous midnight test, we need to add that eliminated amount as a BAC equivalent to the reading obtained (7 hrs x 0.015 = 0.105 gram plus the reported reading of 0.114 grams). The total consumption of alcohol over this time would have necessitated a consumption that yielded a gross BAC of 0.219 grams. If we divide that by 0.017 grams (the equivalent BAC per Standard Drink for a male of that height/weight), the test subject would have had to consume about 13 Standard Drinks (12.8) for the reported reading at 0648 hours to be correct.

2 "Standard Drinks", Counterpoint, Free Sample Edition.

3 "The Metabolism & Elimination of Ethanol in Humans", Counterpoint, Volume 1, Issue 1, Page 249

If Scenario 2 occurred - Drinking just prior to the morning sample

Using the same assumptions, with only one hour prior to providing the reading in which to consume the alcohol beverages we have the reported reading of 0.114 grams plus an hour's elimination (0.015 grams) for a gross reading of 0.129 grams. Again, dividing by the Standard Drink equivalent for this person's height and weight yields a consumption of about 8 Standard Drinks (7.5) for this reading to be correct.

So, one of three possible scenarios occurred; the subject either consumed 13 drinks and went to sleep or got up an hour before his test and consumed 8 Standard Drinks for the reported reading to be correct. I would suggest Scenario 1 is possible, but Scenario 2 highly unlikely (knowing he has to take the test sometime after waking up). Scenario 3 falls somewhere between these two extremes (8-13 Standard Drinks) at some time prior to the morning breath test, i.e. middle of the night.

The big problem is the subsequent breath test at 0826 hours (test #107) which reports a .000 (zero) BrAC value. It should be noted that only 1:38 hours' time elapsed since the reported 0.114 reading. This would yield an elimination rate of 0.07 grams per hour, well beyond the highest reported elimination of 0.045 grams per hour, and certainly far outside our accepted range of 0.010 – 0.020 grams/dL per hour.

We are talking about 7 – 3.5 times the accepted elimination rate, depending upon which elimination value you use. *Does this make any sense at all??*

The Hypothesis of the Case:

Since this extreme elimination of alcohol cannot be considered a physiological possibility, the only other option is that the reported reading must be the result of some false-positive contamination in the mouth or oral pathway of the test subject. The BrAC (breath reading) cannot be considered a forensically reliable indicator of the test subject's BAC (true Blood Alcohol reading). The readings provided by the device show that the normal metabolism of ethanol in humans is NOT occurring, as shown by the measured elimination, even if the highest possible rate is factored into account. Something else MUST be occurring. The only other culprit possible is mouth alcohol contamination of the initial reading, caused by the toothpaste.

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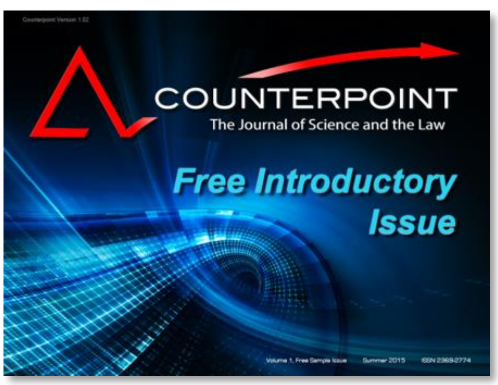
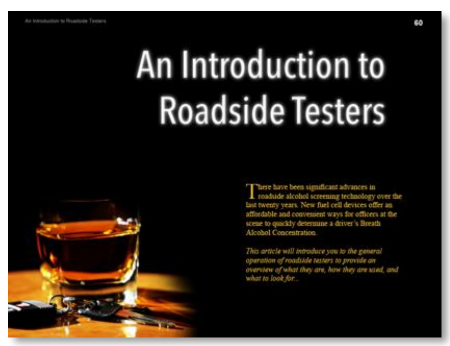
THE RELIABILITY OF BREATH ALCOHOL READINGS

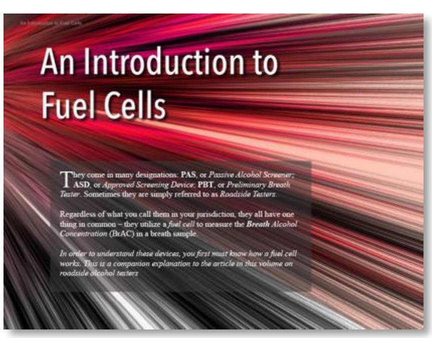
Reliability in any forensic measurement is established by creating specific acts, practices and conditions under which the testing is performed. If any one of these is compromised or performed under sub-standard circumstances, the resulting reported value is also sub-standard, and therefore must be considered unreliable. This is very much a "digital" condition. A reading is either considered reliable or unreliable. There is no middle ground.

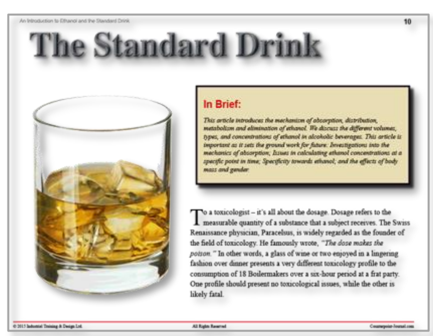
It should again be mentioned that the technology employed in the Soberlink device, a fuel cell, is not robust enough to include a means of detecting mouth alcohol contamination. A wait period of 20 minutes prior to sample provision is required (Soberlink Cellular Device Quick Start Guide, Page 4).

Some helpful Counterpoint articles from the Free Introductory Issue:









The Second Event

The second event of concern occurred when the Soberlink issued a *Missed Sample* message, when the unit itself displayed an *Error* message. The *Missed Sample* would be an indication of non-compliance on the part of the test subject, and therefore actionable. However, here is the log according to the device's transmitted and recorded data:

Event Description	Test Log Number	Date	Time	Reported BrAC	Comments
Test Completed	155	Dec 14	1547	.000	Prior completed test
"Test Missed"	156		1943	*ERROR*	• Screenshot of device shows sample attempt with error code generated. • *Missed sample* error message in reported data therefore unreliable. • Additional device error by not attempting multiple missed samples.
Test Positive	157		2350	.022	
Test Positive	158	Dec 15	0016	.018	• 26-minute interval rather than 15. • The unit should have reported a *test missed* instead at the 15-minute mark.
Test Missed	159		0031		Revert to correct 30-minute interval
Test Missed	160		0101		
Test Missed	161		0131		
Test Missed	162		0201		
Test Completed	163		0226	.000	1:10 hours elapsed time
Sleep Period	-				No testing required after ZERO test result. 4:35 hours elapsed time
Tests Completed	164 165 166 167 168		0701 1213 1547 1947 2358	.000 .000 .000 .000 .000	Subsequent tests for the day

Figure 5 - The Soberlink data presented here indicates a series of errors by the device.

DISCUSSION OF EVENT 2

A breath test (#155) was obtained at 1547 hours, 14 December 2018 with a reported reading of .000 (zero) grams. Slightly more than 8 hours elapsed before the next breath test (#157) was obtained at 2350 hours, 14 December 2018 with a reported value of .022 grams/dL. But the device was programmed to obtain a random sample about every 4-hours. Something was clearly wrong with the data presented, especially considering the evidence regarding the operation of the device obtained by the test subject himself.

Case studies like these are frequently presented in Counterpoint. Make sure your subscription is activated.

Error 1- The data that was presented in the Soberlink report was false. The printed report of 14 December 2018 indicated the error message "*missed test"* at 2000 hours (#156), with no device identification number provided. In fact, a sample attempt was made by the test subject at 1943 hours, as shown in the photograph of the *Soberlink's* display taken by the subject himself. Look at the "E" beside the 07:43pm time stamp:

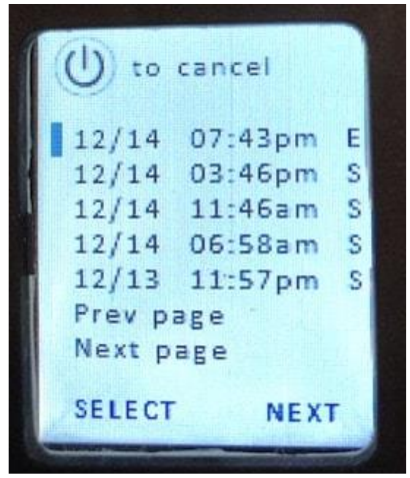


Figure 6 - The test subject had the presence of mind to photograph the *Error* message at 7:43PM. The log, on the previous page, incorrectly showed a *Missed Sample*.

Error 2– *Soberlink's* programmed protocols would then require another test attempt in 30-minute intervals until such time as a result was obtained. Therefore test #157 should have occurred at about 2030 hours, #158 at 2100, #159 at 2130, on so on, until a result was obtained. This did not occur. Instead, the device incorrectly reverted to a 4-hour interval for the now improperly numbered test #157. Something was wrong with the device's software.

Error 3– *Soberlink's* programmed protocols would then require another test attempt in 30-minute intervals until such time as a result was obtained. Therefore test #157 should have occurred at about 2030 hours, #158 at 2100, #159 at 2130, on so on, until a result was obtained. This did not occur. Instead, the device incorrectly reverted to a 4-hour interval for the now improperly numbered test #157. Something was wrong with the device's software.

After the missed test at 0031 hours (#159) the unit returned to 30-minute intervals.

We can speculate on a variety of causes as to the reliability or unreliability of the numerical results at 2350 hours (#157) and 0016 Hours (#158):

- First, we have to recognize that they may reflect true BrAC values.
- Equally, they may be the result of the device being in some sort of undetermined error condition.

We simply cannot know for certain, but we do know they are reported at the end of more than four-hours of cumulative errors. More likely than not, a simple re-boot of the device might have cleared the error (think of your tablet device, cellphone, or laptop freezing up... *What is the first thing you do? "Darn things not working again, I better reboot it"…)*

But the test subject didn't know the Soberlink device wasn't reporting the *Error* messages incorrectly, and even if he did, he had no ability to re-boot the device.

As with Event 1, the numerical results of tests #157 and #158 could be accurate given one of three situations:

> **Scenario 1** – The test subject began consuming a number of alcoholic beverages shortly after test 155.
> **Scenario 2** – The test subject began consuming a number of alcoholic beverages shortly before test 157.
> **Scenario 3** – A combination of the two situations occurred.

Using the same assumptions that we used in the article last week when we discussed the first event:

Recall that the test subject is an adult male who weighed about 220 pounds and stands 6'2" in height. A male of that height and weight will receive the BAC equivalent of 0.017 grams/100ml of blood for each Standard Drink consumed. We have also discussed Standard Drinks in a previous Counterpoint article [4] - a Standard Drink is measured as follows:

- 12 ounces of beer at 5% alcohol content
- 5 ounces of wine at 12% alcohol content, and
- 1.5 ounces of hard spirit liquor at 40% alcohol content.

We have also discussed the metabolism and elimination of alcohol [5] in the human body in the first volume of Counterpoint. In summary, for each hour the alcohol is in the human body, it will be metabolized and eliminated at a specific rate. This rate differs from person to person, with a reported low of 0.002 grams per hour up to an elimination rate of 0.045 grams per hour (Dubowski, 1985). These are extreme values. Most people fall between 0.010 – 0.020 grams per hours, with a median of 0.015 grams per hour. Without performing an elimination rate study on the test subject, we cannot identify his specific rate of elimination, but for educational and illustrative purposes a rate of 0.015 grams per hour is generally considered acceptable.

If Scenario 1 occurred - Drinking alcoholic beverages shortly after Test #155

After test #155 was provided with a reading of .000 (zero) grams at 1547 hours, the test subject had a schedules period of about 4 hours before providing the next measured sample. For whatever reason, an error message was generated, and the device did NOT ask for another sample for four more hours, leaving a total elapsed time of 8 hours. For the reading at 2350 hours to be correct (#157), he would have had to consume more than 9 Standard Drinks (9.3) in that time period.

4 "Standard Drinks", Counterpoint, Free Sample Edition.

5 "The Metabolism & Elimination of Ethanol in Humans", Counterpoint, Volume 1, Issue 1, Page 249

If Scenario 2 occurred - Drinking just prior to Test #157

Using the same assumptions, if reading #157 is correct, the test subject could have consumed slightly more than a single Standard Drink just prior to providing the sample. This is unlikely, as he knew he would shortly be providing his next scheduled breath sample… why risk it?

If Scenario 3 occurred - Drinking alcoholic beverages in some combination of Scenarios #1 & #2

The test subject could have realistically consumed a Standard Drink or two an hour or more before providing the breath sample, hoping it would clear his system before his next scheduled breath sample. People can "fall off the wagon" after a few months of absolute sobriety.

However, the test subject was adamant that this did not occur and had the presence of mind to photograph the screen captured error message - one that did not match the reported error in the device's own reported data. Something was wrong.

So, one of three possible scenarios occurred; the subject either consumed 9 drinks and totally disregarded that a sample would be required four hours later. When the device issued an error message, he continued consuming alcohol again disregarding the upcoming test. Scenario 1 is possible, if improbable, but Scenario 2 highly unlikely (knowing he has to take the test sometime in just a few minutes he downs a quick drink). Scenario 3 falls somewhere between these two extremes (1-9 Standard Drinks) at some time prior to the breath test, i.e. throughout the evening. OK, possible but for the photographed error message and timing failure of the device.

The more likely probability is that the device had malfunctioned. It did not require tests as is was supposedly programmed. Its own time capture was clearly malfunctioning. It did not reliably report its own error to the database. Can this reading be relied upon? SHOULD this reading be relied upon?

THE RELIABILITY OF BREATH ALCOHOL READINGS, REVISITED

As we discussed previously, reliability in any forensic measurement is established by creating specific acts, practices and conditions under which the testing is performed. If any one of these is compromised or performed under sub-standard circumstances, the resulting reported value is also sub-standard, and therefore must be considered unreliable. This is very much a “digital” condition. A reading is either considered reliable or unreliable. There is no middle ground.

It should again be mentioned that the technology employed in the *Soberlink* device, a fuel cell, is not robust enough to include a means of detecting mouth alcohol contamination. A wait period of 20 minutes prior to sample provision is required (*Soberlink* Cellular Device Quick Start Guide, Page 4).

What happened with these two reported readings?

OUTCOME

The letter of opinion with supporting data interpretation was tabled and reviewed by the presiding judge who ruled that the father had been in full compliance since he had been using the device (more than 100 negative breath test results), and more importantly, that the readings were improperly applied given the circumstance of the first test (the toothpaste contained mouthwash) and that the unit had malfunctioned in this last instance.

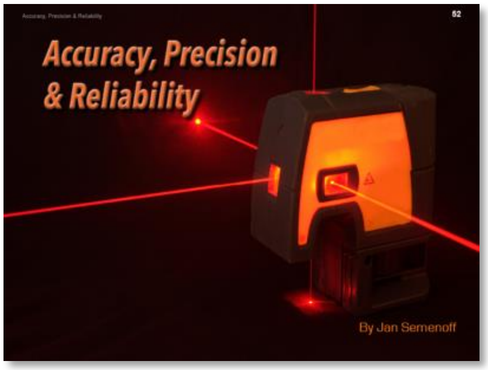
The judge ended up issuing a court order that his device needed to be replaced at no cost to the subject, allowed his supervised visits over Christmas, and dismissed any further actions or sanctions against the father. She also complimented the defense team on their thorough case presentation to the court, and clear evidence of no wrongdoing on the part of the test subject.

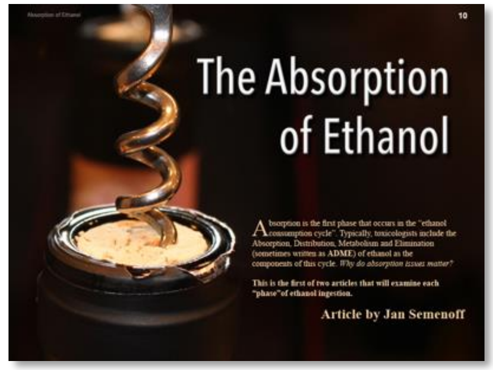
Practice Tip:

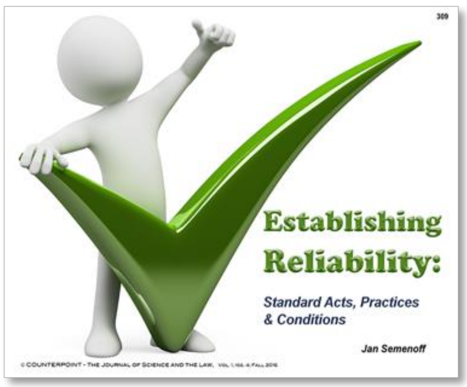
Always get as complete a picture as possible about the data surrounding any test results.

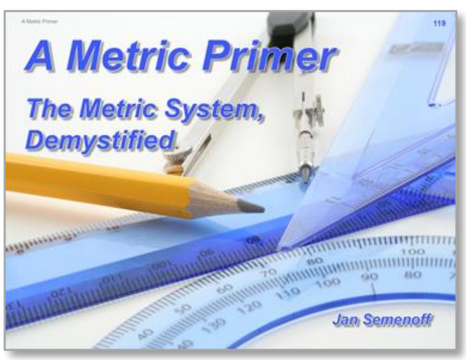
- What data is supported by the numbers?
- What does the data actually mean?
- Were the Acts, Practices, and Conditions that generated the numbers acceptable?
- If they were unacceptable, was the result reliable?
- Do you have a disconnect? Does the reading make sense?
- Is your client a suitable subject to be tested in this manner?
- What should have occurred for a proper investigation?

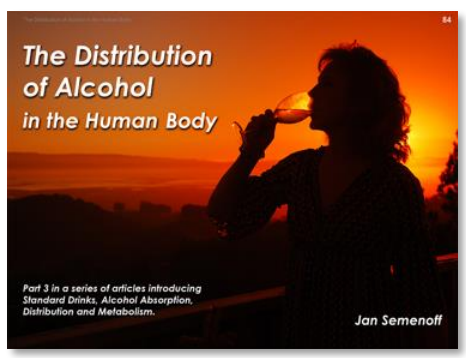
Some other helpful Counterpoint articles:

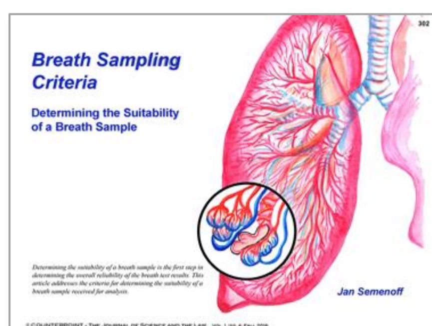












Case Study 2

The SCRAM™ Alcohol Compliance Device

POTENTIAL FALSE-POSITIVE ETHANOL READINGS OF A SCRAM DEVICE [6]

CASE STUDY #1

I was recently sent some SCRAM data for a quick review and comment. I ended up generating a complete letter of opinion for the attorney involved. The case revolves around a SCRAM report that indicated a positive alcohol reading. However, the subject of the report was sleeping under a brand new, out-of-the-bag (and static laden) blanket that had just been sprayed with Static Guard™ prior to sleeping. The question, of course, concerned the possibility that the Static Guard™ spray may have caused a false-positive reading on the SCRAM device. *Is this a true case of alcohol consumption, or a false-positive due to the sprayed chemical? What does the reported data tell us?*

SCRAM is an acronym for ***S****ecure* ***C****ontinuous* ***R****emote* ***A****lcohol* ***M****onitor*, a product of Alcohol Monitoring Systems, Inc. of Littleton, Colorado.

A SCRAM device is a transdermal alcohol sensor that continuously monitors a test subject for alcohol consumption. The sensor is slightly smaller than a small deck of cards, and is worn on the subject's ankle, secured by a tamper proof strap. Instead of a BAC, or BrAC reading, the device reports a *Transdermal Alcohol Concentration*, or TAC.

An Important Note:

I need to point out that this article does NOT identify the failure of SCRAM devices overall, nor does it indicate faulty or malfunctioning devices. It DOES identify potentially false-positive readings that are more a failure of the *interpretation* of the data presented, and probably an inappropriate application of the readings obtained. I've written before about sub-standard acts, practices or conditions leading to substandard results. This is one of those cases, where the substandard condition (the application of Static Guard™)

6 Originally from two Counterpoint Volume Two articles.

may have created a substandard (and therefore unreliable) reading. See also Counterpoint Volume One, Issue 4, *Reliability.*

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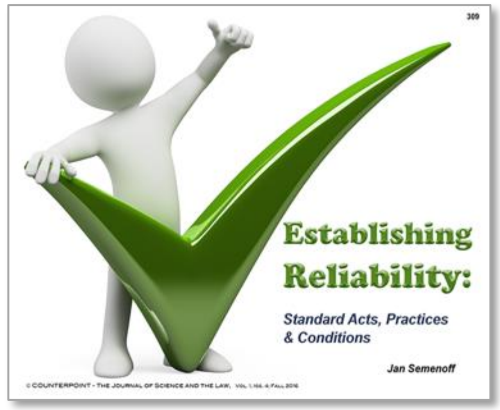


EVIDENCE OF ALCOHOL ELIMINATION PROVIDED BY THE SCRAM DEVICE

Let's start by looking at the raw data. In this case, the SCRAM report provides the following *Transdermal Alcohol Concentration* (TAC) data:

Time	TAC	Elimination Rate g/hr
1:05	0.260	*First Positive Reading*
1:35	0.217	*1/2 hour increment later*
2:06	0.179	0.081
2:36	0.143	0.074
3:07	0.105	0.075
3:37	0.089	0.054
4:08	0.068	0.037
4:38	0.054	0.034
5:09	0.046	0.022
5:40	0.039	0.015
6:10	0.035	0.011
6:41	0.026	0.013
7:11	0.014	0.021
7:42	0.013	0.013
8:12	0.008	0.006
8:43	0.005	0.008

Figure 7 - Data from the SCRAM report. I've indicated 1/2-hour increments in red and blue, and indicated the elimination rates, broken down by the hour. Notice the changed in the reported elimination rate over time.

It is perhaps easier to visualize the reported elimination graphically:

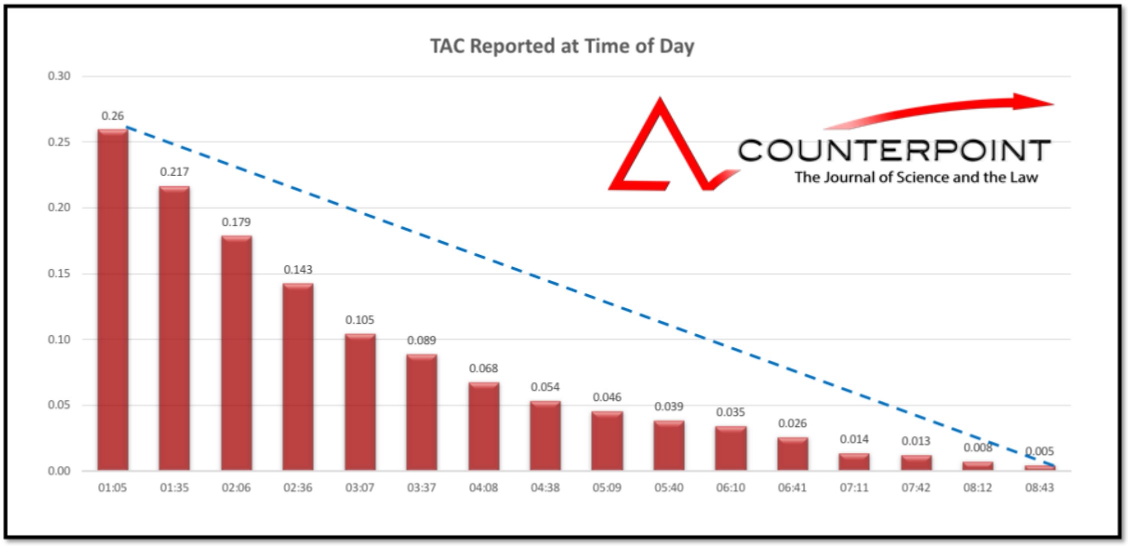
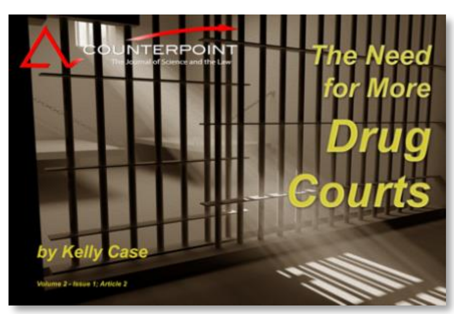


Figure 8 - The reported Transdermal Alcohol Concentration at various times during the night in question. Notice the elimination does NOT follow the anticipated linear rate, as shown in the blue dashed line. Is this indicating the metabolism of alcohol in the human body?

The SCRAM report in this case also incorrectly indicates that the elimination rate of the subject was measured at 0.030 grams per hour. While this is true on average, overall (taking the highest reading, subtracting the lowest reading, and dividing by the total time), it is NOT demonstrative of the elimination data, specifically from one hour to the next. In actuality, reporting the elimination rate in this manner is highly misleading

Let’s go back and look at Figure 17. You may notice that in the first hour, the reported elimination rate is 0.081 grams per hour, and 0.075 grams per hour again in the second hour. This is higher (double the upper end of 0.040 grams per hour among chronic alcoholics [7] than reported in any historical or current toxicological reports, as previously discussed. Then, in the third hour the elimination rate drops to 0.037 grams per hour, 0.022 grams per hour in the fourth, and 0.011 grams per hour in the fifth. This is clearly NOT a metabolic elimination rate. It is not linear and does not follow a Zero Order Kinetic. Again, the true Zero Order elimination is shown in a dashed blue line in the graph above for comparison.



7 Neuteboom & Jones reported an outlier elimination rate of 0.064 grams/100 mL per hour. This is the highest known and reported value.

THE ABSORPTION OF ETHANOL

My first point of concern is that the initial SCRAM reading immediately indicates a BAC of 0.260 grams, with no previously reported ascending rise in BAC levels. There was no positive reading 30 minutes prior, during the last SCRAM sample. Think about that for a moment. Apparently, the subject went from 0.0 - 0.260 grams BAC in less than 30 minutes. Given that the average adult human receives an equivalent BAC dose of 0.020 grams per Standard Drink the subject would have had to immediately consume 13 Standard Drinks [8] (equivalent to about 20 ounces of hard liquor) and have them completely and fully absorbed in just 30 minutes. From a physiological perspective of the absorption and distribution of alcohol, this is highly unlikely. It has been reported that full ethanol absorption takes between 9-192 minutes among healthy adults (Dubowski, 1985). Additionally, high bolus consumptions of alcohol have a tendency towards delayed absorption rates.

Figure 9 - This is what would have had to be CONSUMED AND FULLY ABSORBED between 12:35 AM and 1:05 AM in order for the first SCRAM reading to be reliable. Possible? Sure... Likely?

But, we are assuming the poison of choice was hard liquor. Can you imagine drinking the equivalent to 13 glasses of wine in 30 minutes? That is about 2 1/2 bottles. Perhaps a dozen or more beer in 30 minutes... You decide...

8 A Standard Drink is typically considered to be 12 ounces of beer at 5% Alcohol by Volume (ABV), 5 ounces of wine at 12% ABV, and 1.5 ounces of spirit liquor at 40% ABV. For a complete review on Standard Drinks, see the article Standard Drinks in the free Introductory Issue of Counterpoint.

THE ELIMINATION OF ETHANOL

We’ve discussed the ADME (Absorption, Distribution, Metabolism and Elimination) of ethanol in the human body in previous Counterpoint articles. In order to understand the data presented in this case, and indeed in any other case, it is important that you understand the concepts from those articles. See Counterpoint, Volume One for complete information of ADME.

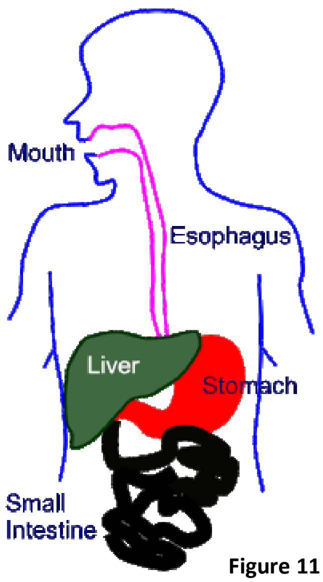
Alcohol can be eliminated without the body metabolizing or converting it into a by-product, or waste metabolite. Anywhere from 1-5% of the ethanol is eliminated in this fashion, unchanged. Ethanol is absorbed, and quickly eliminated before being metabolized in the body in two main ways. About 2-5% of the total ethanol consumed is exhaled unchanged in your breath or eliminated unchanged in your urine. A negligible amount, approximately 1%, is excreted unchanged through your skin. In short, you sweat out about 1% of what you’ve consumed.

Figure 10 - The Intoxilyzer AlcoBlow, a hand-held, fuel-cell "sniffer" device.

It is the unchanged ethanol in the breath that is read by a breath alcohol testing device, or in this case, sweated out through the skin into a transdermal alcohol detection device. Devices such as the Intoxilyzer AlcoBlow™ and various handheld police flashlights with so-called “sniffer’ technology can read the alcohol emanating from a person through their skin. The SCRAM device operates in the same manner.

We’ve talked previously about fuel cell devices and how they function (again, see the free Introductory Issue). At its heart, a SCRAM device is simply a fuel cell device that determines the presence and concentration of ethanol. It reads the alcohol emanating from the skin of the test subject and is calibrated to believe that the amount of alcohol eliminated unchanged through the skin is about 1% of the total Blood Alcohol Concentration (BAC). It basically multiplies the alcohol detected by 100 times to report a BAC level. The reported level is referred to as a Transdermal Alcohol Concentration (TAC)

CLEARANCE RATES – METABOLIC ELIMINATION RATES IN THE HUMAN BODY



Metabolic elimination rates or clearance rates of ethanol are dependent upon the type and amount of ADH enzyme (Alcohol Dehydrogenase Enzyme) found in the specific person. In a healthy person, the rate of clearance of alcohol from the blood by the liver is roughly 0.013 – 0.022 grams per hour, with a median rate of about 0.017 – 0.018 grams per hour. People who are on low-protein diets, or who are malnourished, are reported to have lower rates of elimination. Others, especially those chronically exposed to alcohol, have higher clearance rates. High-level, long-term alcoholics have a clearance rate of about 0.036 – 0.040 grams per hour (Jones, 1996), but this is considered an extreme.

Figure 11 - The metabolic function that reduces ethanol is carried out primarily in the liver, the stomach, and the small intestine.

KINETIC MODELS

There are a number of different models to express the kinetics, or movement, of alcohol, drugs or poisons through the human system:

In First Order Kinetics, the elimination rate of the drug or poison is directly proportional to the concentration of the substance in the first place. In short, if a test subject has a high concentration of a drug or poison in their system, and it is metabolized using a first order kinetic model, then they will rapidly start to process and eliminate the drug or poison. As the concentration of that drug or poison is reduced, the elimination rate will also begin to decline. Think of this as in taking half of the drug away in the first hour, half of the remaining drug away in the second hour, half of that remaining drug away in the third hour, and so forth. I would graph the elimination of the drug or poison this way in a First Order Kinetic elimination model, as shown in red in Figure 12, on the next page.

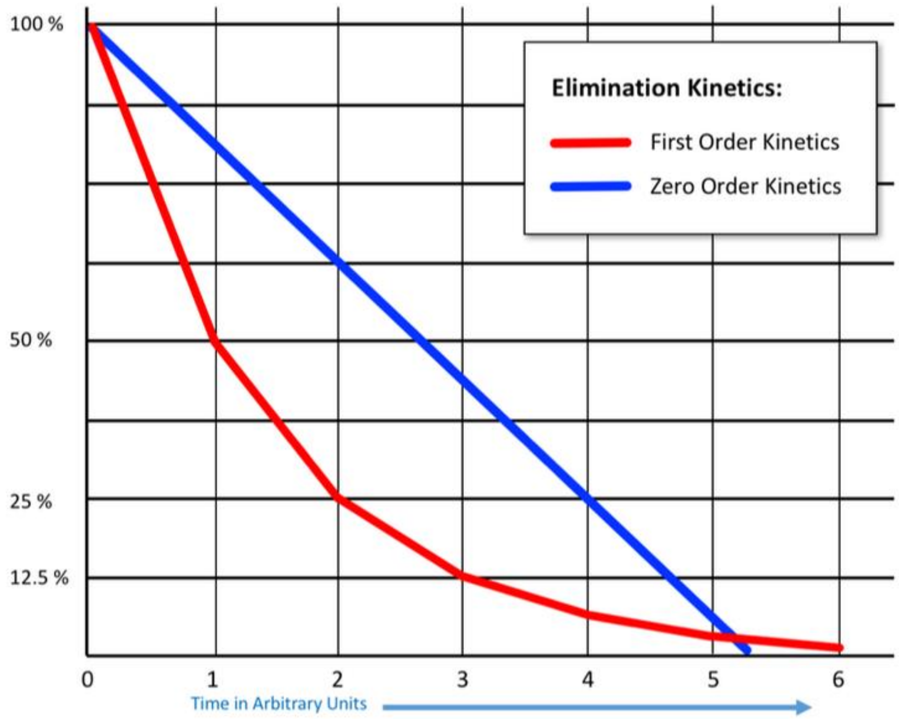


Figure 12-First Order Elimination (Red) and Zero Order Elimination (Blue). Alcohol most closely follows a Zero Order Elimination Kinetic model.

In Zero Order Kinetics, the elimination rate is constant. If a test subject reduces the drug or alcohol by X amount per hour, then each and every hour, X amount is metabolized and eliminated. The elimination is linear, again as shown above in blue in **Figure 12**:

Ethanol most closely follows a Zero Order Kinetic in humans (shown in blue, above). Regardless of the level of ethanol consumed by the subject, their elimination rate will be the same, hour after hour. A test subject doesn't sober up faster because they've had more to drink. The elimination rate is constant, maybe just tapering off and tailing a bit at the very end. Jones (2010) noted that the alcohol elimination followed Zero Order Kinetics until the subject had a BAC of about 0.020 grams, at which time it eliminated following a First Order Kinetic model.

VARYING ELIMINATION RATES – WIDMARK'S ß

In the traditional Widmark Formula [9], the elimination rate of ethanol is denoted as ß, sometimes referred to as a Beta-slope. Different people have different types and levels of Alcohol Dehydrogenase Enzyme (ADH) in their bodies, therefore, have different elimination rates of ethanol. It has been repeatedly established that the average elimination rate is, for the most part, the equivalent of somewhere between 0.006 – 0.028 grams/100 mL per hour (Dubowski, 1985).

- Jones reported a range of 0.010 – 0.048 grams/100 mL per hour (Neuteboom & Jones, 1990), and a range of 0.009 – 0.029 grams/100 mL per hour (for 95% of the sample of 1200 subjects, with a median and mean of 0.019 grams/100 mL per hour [Jones 2010]).
- Jones reported a range of 0.009 – 0.036 grams/100 mL per hour, again with a mean ß of 0.019 grams/100 mL per hour (Jones, 1993).
- Many toxicologists use an average of 0.017 grams/100mL per hour, and others widen this range from 0.010 – 0.020 grams/100mL per hour for computations.

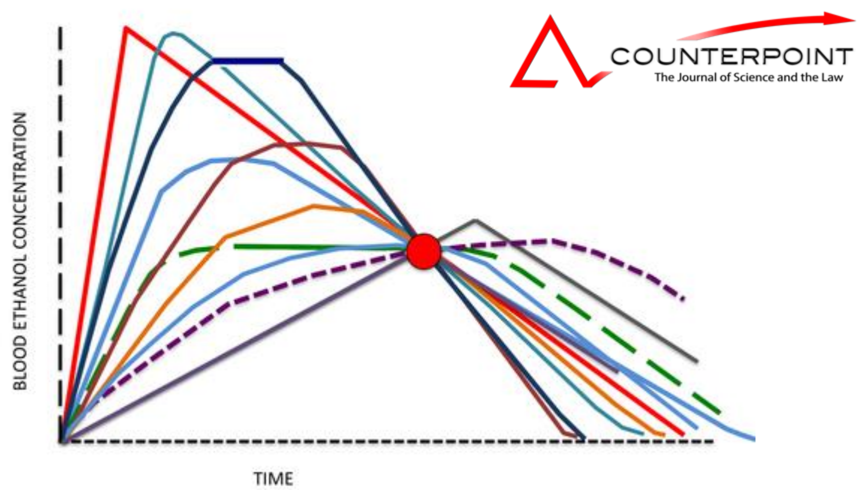


Figure 13 - Different absorption conditions, and different elimination rates create different BAC profiles, all read at a specific point in time by an alcohol measuring device.

So, the elimination rate value has been reported from 0.06 – 0.048 grams/100mL per hour in different individuals by a number of researchers. It is important to remember that without testing an individual subject, we just don't know what their specific elimination rate will be.

9 The Widmark Formula is used to determine the concentration of ethanol in a human being at a specific point in time and is used by Toxicologists or Forensic Criminalists to determine a BAC at a time of concern.

The most important thing to keep in mind is that the elimination of alcohol by metabolic means is primarily *linear* and *does not change in rate during the event in question*. As previously discussed, if a subject metabolizes ethanol at X rate at the beginning of a consumption episode, they will metabolize ethanol at X rate at the end of the episode. This is in sharp contrast to the elimination rates that was reported by the SCRAM device's data in this case. Look again at Figure 8:

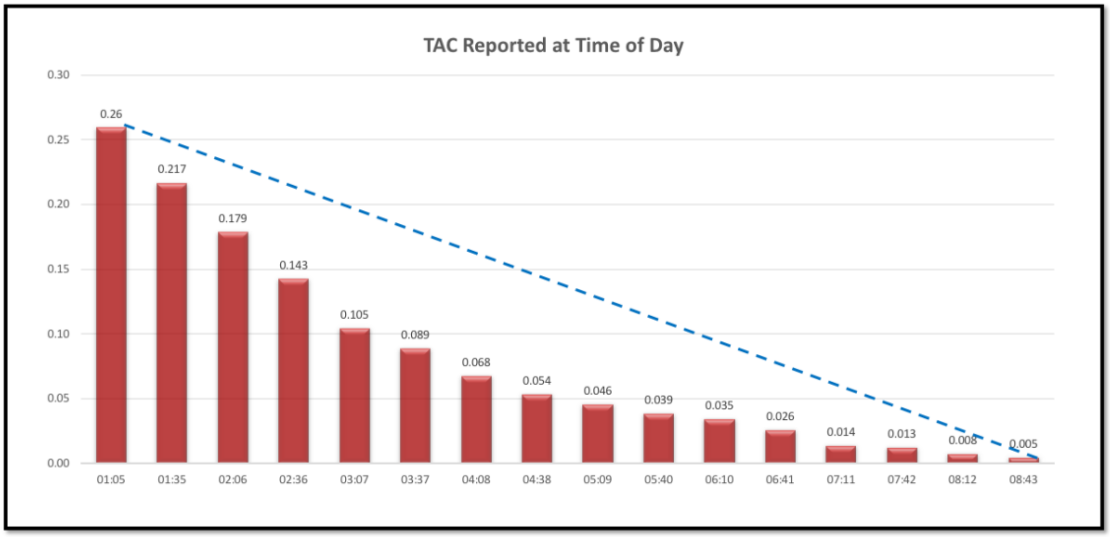


Figure 14 – (Reproduced again for ease of reference) The reported Transdermal Alcohol Concentration at various times during the night in question. Notice the elimination does NOT follow the anticipated linear rate, as shown in the blue dashed line. Is this indicating the metabolism of alcohol in the human body?

Continued on the next page

THE EVAPORATION RATE OF ETHANOL

The obvious question, therefore, is, *"What is being indicated by the data obtained?*

Ordinary evaporation of volatile[10] substances follow a complex logarithmic mathematical model, referred to in both thermal physics and chemistry as a Boltzmann Constant. When demonstrated graphically, it shows the following pattern:

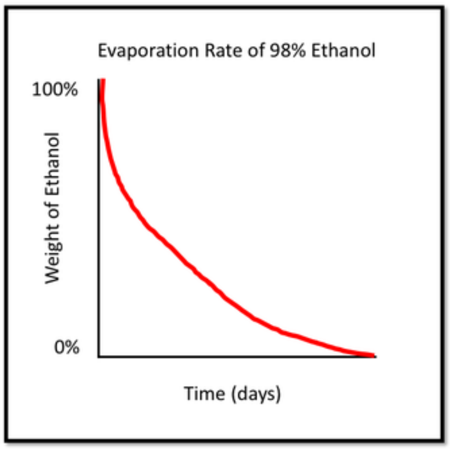


Figure 16 - The evaporation rate of 98% Ethanol.

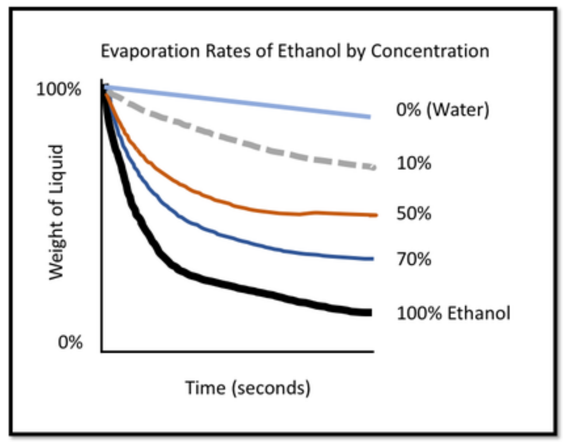


Figure 15 - The evaporation rate of ethanol based on its concentration

Figure 15 shows the logarithmic elimination pattern of 98% pure ethanol in red (Tyukodi, 2012).

Note that in **Figure 16**, the higher concentrations of ethanol have a steeper arc [100%, black at bottom] than the 10% ethanol solution [Gray dashed, second from top], (Hasegawa, 2016).

Both support that, graphically, ethanol elimination is NOT linear. Also, the time of the elimination can be measured in seconds, minutes, hours or in days. The logarithmic pattern is the same regardless of the duration of the study.

10 Volatile in the chemical sense refers to any substance that evaporates at room temperature. Ethanol is considered a volatile chemical.

THE CHEMICAL COMPONENTS OF STATIC GUARD ™

The Material Safety Data Sheet for Static Guard™ indicates the following chemical composition:

Chemical Name	CAS Number	Weight %	Trade Secret
Alcohol (Denatured Ethanol)	64-17-5	60-100	*
Isobutane	75-28-5	3-7	*
Propane	74-98-6	1-5	*
Quaternary Compounds	61789-80-8	1-5	*
Fragrance	N/A	0.1-1	*

*The exact percentage (concentration) of composition has been withheld as a trade secret

Figure 17 - The chemicals found in Static Guard, taken from the manufacturer's Material Safety Data Sheet (MSDS). Note that the actual percentages of the formula are a trade secret. Federal regulations allow this in published MSDS. (Poison Control Physicians can access more detailed information under emergency conditions by accessing a secure repository of published chemical information data).

Denatured alcohol is simply ethanol that has a bittering compound added to it (typically Bitrex™ - a completely safe compound that is the Guinness Book of Records holder as the bitterest known compound) that makes it taste extremely bitter and unpalatable to consume orally. The chemical nature of the ethanol itself is not otherwise altered. The propane and isobutane are used as a propellant in the compressed gas canister and are also volatile. Therefore, the formula is primarily ethanol, with a little surfactant soap (the quaternary compounds) and volatile fragrance.

Based on the chemical composition published by the manufacturer, we can conclude that the chemical composition is between 60-100% ethanol. The concentration of the ethanol itself is not listed. Most denatured ethanol used for industrial purposes is between 70 - 100% Alcohol by Volume Concentration. We would therefore expect the evaporation rate to follow somewhere in the 70-100% range indicated in **Figure 15**.

The elimination rate reported in the first few hours is ridiculously high when compared to known human metabolism and tapers off over time in a non-linear fashion. This data clearly follows the pattern of alcohol evaporation rather than alcohol metabolism and is more likely than not a false-positive contamination rather than an indication of alcohol consumption.

I think it is always important that forensic investigators rely upon as complete a picture as possible in order to arrive at a logical conclusion. This case involves the data set from the device used, including the usage logs, and in comparison, to the known science of both evaporation and metabolism. I would respectfully suggest that the data supplied by the SCRAM device supports the normal evaporation of ethanol outside the body and does not support a reasonable assertion that the metabolism of ethanol internally was correctly identified and reported by the device.

See the next page for the second case study on the SCRAM device

Case Study 3

The SCRAM™ Alcohol Compliance Device

Very quickly, I want to look at a second case study, on another SCRAM device that was sent to me while I was preparing the original Counterpoint article. The test subject's SCRAM device reported the following Transdermal Alcohol Concentrations (TAC):

Time of Day	TAC	Comment
4:50 PM	0.00	
5:20	0.00	
5:51	0.014	*First positive test*
6:21	0.006	
6:52	0.014	
7:22	0.019	
7:53	0.025	
8:24	0.026	
8:54	0.023	
9:25	0.020	
9:56	0.015	
10:26	0.012	
10:57	0.022	
11:28	0.028	
11:59	0.038	*Midnight*
12:29 AM	0.043	
1:00	0.046	
4:42	0.046	
2:33	0.046	
3:03	0.046	
3:34	0.046	
4:05	0.042	
4:36	0.037	
5:06	0.038	
5:37	0.035	
6:08	0.035	
6:39	0.047	
7:10	0.052	
7:40	**0.059**	**Peak TAC Reading**
8:11	**0.046**	
8:42	**0.036**	elimination @ 0.023 g/hr
9:13	**0.024**	elimination @ 0.022 g/hr
9:44	**0.00**	elimination @ 0.036 g/hr
10:14	**0.00**	elimination @ 0.024 g/hr

Figure 18 - The SCRAM report data from Case Study #2, showing TAC levels at the time of their measurements/

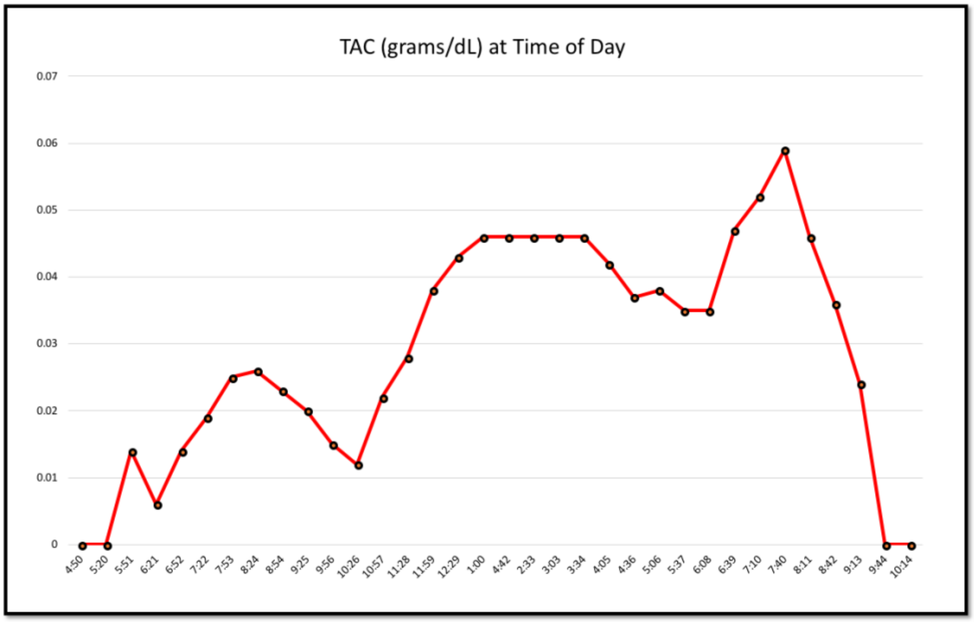


Figure 19 - A graphical representation of the Case Study #3 data from Figure 18

When I first looked at the data, I thought it might demonstrate an evening, well, actually an all-nighter, it seems, of concurrent consumption and elimination, resulting in the wildly fluctuating readings. The elimination rate is impossible to determine with data like this – the test subject needs to be fully absorbed to start to calculate elimination rates, and this can't be done during concurrent alcohol consumption. But, we see a key peak at 7:40 the following morning. Perhaps the end of consumption occurred at about 6AM, followed by an absorption rise to 7:40AM, then an elimination to 9:44AM?

Looking at the data, the first hour in this final elimination has a rate of 0.023 grams per hour, and 0.022 grams per hour (on a half-hour increment). Then, the last hour shows an increased elimination rate of 0.036 grams per hour. So again, clearly this cannot be an indication of the body's metabolism of alcohol.

The real problem? The test subject, completely unaware that the SCRAM device was collecting positive data, provided a breath sample into an ignition interlock device which registered 0.00 grams and started the car ***at 08:00 in the morning, near the time of the SCRAM's peak TAC reading.*** The widely fluctuating readings of the SCRAM device are an indication of false-positive readings from an unknown source. *Both devices cannot be correct.*

FINAL THOUGHTS

It is NOT the intention of this paper to pick apart or identify any short-comings with either the SCRAM or SOBERLINK devices, but rather, to illustrate the necessity of logically examining the reported data to determine what events were actually transpiring. But, to do this, you need to be able to put the data into context. Knowing about the sprayed Static Guard ™, the corresponding zero reading on the ignition interlock, and the reported error messages of the Soberlink™ device puts the data into the proper perspective.

Counterpoint is a resource that can help you understand these fairly complex scientific issues, with a focus towards applicability in your daily practice.

Jan Semenoff, B. A., EMA,
Forensic Criminalist
Editor-in-Chief

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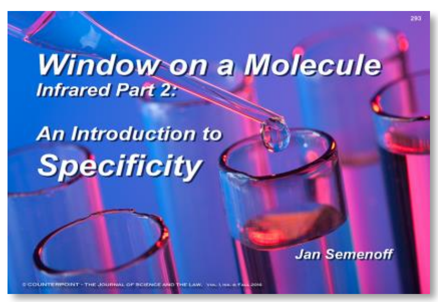

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