Portable Breath Testers: A Potentially Dangerous Non-Specific and Non-Selective Measure at Roadside

[1]Features
[2]Justin McShane
[3]Josh D. Lee

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The history of alcoholic beverages can be traced to the Neolithic period (ca. 10,000 B.C.), shortly after the agricultural revolution. Even though alcohol’s impairing effects have long been known, its adverse consequences when combined with travel were not publicly condemned until the invention of the steam train locomotive. After the First World War, there was a dramatic rise in motor transportation that brought to the public’s attention the role alcohol could play in accidents on the roadways. This focus led to an outcry for legislative punishments for ‘drunk drivers.’ In 1939, Indiana and Maine became the first states to criminalize Driving Under the Influence. These events spotlighted the need for a reliable way for testing a person for intoxication.

Alcohol most affects the central nervous system. Cognitive functioning and psychomotor functioning changes caused by alcohol are rooted in this system. Because blood transports alcohol to the brain and affects the central nervous system, blood was first considered as a source for testing for alcohol concentration and in turn what is thought to be a useful convention to try to correlate a numerical value to a diminished ability to operate a motor vehicle safely.

In 1927, Emil Bogen became the first person to propose using breath analysis as a means to test for blood
alcohol content. 10 Breath testing soon became more popular than blood testing because of its noninvasive nature, its quick result, and its ease of use by police. 11 When the driver of a stopped vehicle is suspected to be under the influence of alcohol, the officers will retrieve the PBT device from their vehicle and have the driver submit to a test. It is the authors’ experience that the average time from stop to arrest is 7 to 9 minutes. Often the person is stopped near the location where they had recently consumed alcohol.

Today, many police officers carry devices for roadside testing of individuals for alcohol concentration in their vehicles. The use of these devices is growing in popularity every day across the country, so much so that they are even popularly offered in retail stores. These devices are called ?portable breath testers,? ?preliminary breath testers,? ?pre-arrest breath test? (PBTs), or ?passive alcohol sensors? (PASs). For purposes of this article, we will refer singularly to this family of devices as PBTs.

It is because of the increased use and popularity of PBTs that we need to understand how police devices work to determine if they are used correctly or incorrectly.

There are two technologies and two chemical processes of action that govern PBTs: fuel cell devices and Taguchi gas sensor devices. 13

Although the fuel cell was invented in the early 1800s, it was not applied to breath alcohol detection until the 1960s. 14 A fuel cell, which consists of two platinum-coated conduction electrodes separated by an ion-conducting electrolyte layer, is designed to convert a fuel and an oxidant into direct current. PBTs use alcohol as the fuel and oxygen from the air as the oxidant. 15 Alcohol is oxidized into acetic acid inside the fuel cell. 16 This oxidation produces two electrons for each molecule of alcohol. 17 In turn, these electrons produce an electrical current that is converted to a BAC and reported by the PBT. 18

Exhaling human breath is a continuous input into the machine. Yet, any machine can only report a digital signal as reported on the LED screen. This quantitation with an analog-to-digital signal translation is set based upon a dose-response curve constructed by using a wet bath calibrator that uses a partition ratio of 2100:1 derived from assuming that Henry’s Law applies to the lungs. The human lung is not a closed system. Human breath is not exhaled at a constant temperature or flow or pressure. Therefore, Henry’s Law does not apply. Taguchi gas sensors are small porous stannic oxide semiconductor elements. Alcohol in the breath is attracted to the sensor. This attraction increases the sensor’s electrical conductivity. Increasing the sensor’s conductivity increases the electricity flowing through the sensor. Just like with the fuel cell, the greater the electricity flows, the higher the alcohol reading becomes. 19 Of the two methods, the fuel cell has all but replaced this device in PBTs, and therefore, we will only discuss that method in any detail.

The Problems of Fuel Cell Devices

1.1. Lack of Specificity for Ethanol

As PBTs are used for purportedly forensic purposes, their specificity for ethanol becomes a critical factor. The electrochemical detector is not specific for ethanol. 21 Indeed, there is much evidence to show they are actually not specific for ethanol. 22 Garriott’s Medicolegal Aspects of Alcohol lists methanol, isopropanol, n-propanol, and acetaldehyde as other alcohols that fuel cells can respond to in addition to ethanol. 23 Other studies have also found fuel cells reacting to substances other than ethanol. 24

A. W. Jones, PhD, a renowned toxicologist, reports that fuel cells will respond to compounds that contain the hydroxyl group, other than ethanol. 25 In a later study, Jones again found that the fuel cell is not specific to ethanol and that other alcohols and aldehydes will also oxidize in the fuel cell. 26 This is important because it has been found that in the alcohol family there are over 1,500 chemical compounds that are not found in alcoholic beverages. 27 Moreover, it is claimed that ketones such as acetone are not detected by the fuel cell as they are with infrared devices. 28 Interestingly, there is at least one documented case where a
driver has tested over the legal limit for ethanol, due to acetone, when the driver had no ethanol in his system. 29 The fuel cell device used on the stop had falsely reported isopropanol as ethanol. 30 The individual had latent diabetes and had been fasting, causing acetone to be present in his system, which his body in turn reduced to isopropanol, resulting in a true false positive.

In addition, there are documented cases of methanol being mistakenly reported as ethanol by fuel cell devices. 32 Absent chromatographic separation, which PBTs do not employ, distinguishing ethanol from methanol is an extremely difficult task. 33 If not an impossible one. Of import is that when a PBT detects ketones and hydrocarbons, it can mistakenly report them as ethanol and add to the breath alcohol concentration.

Further proof of the apocryphal nature of the manufacturers? claims that these devices will not react to anything other than alcohol is documented on YouTube by one of the authors of this paper, Justin J. McShane, F-AIC, JD. The recording shows a .046 g/210L breath reading on an Intoximeters FST PBT, while free of ethanol and eating ordinary white bread. 34 In addition to white bread, there are other cases of a fuel cell device falsely reporting milk, soda pop, and cigarette smoke as ethanol. 35 Toothpaste (specifically Sensodyne) that contains Sorbitol, a type of alcohol, registers as ethanol on a fuel cell device. 36 This has been independently verified in testing by the Boston Herald.

Another source of Ethanol is by sugar fermentation. This process has been found to occur naturally in the human body when yeast from breads and carbohydrates are present. 38 Informal tests at DWI/DUI seminars across the United States have shown results over the legal limit (0.08 g/210L of breath) merely by chewing pizza, bread, or hot dog buns. 39 Common foods and drinks have even been found to contain alcohol. Diet 7-Up contains some small amounts of ethanol, and high-energy drinks such as Monster and 180 Energy contain several times more ethanol than Diet 7-Up. 40 Breads, pizza, English muffins, wheat bread, and apple walnut rolls have all been found to contain both yeast and ethanol. 41 See the endnotes for tables containing more detailed information about the alcohol content of various soft drinks and baked goods, and other beverages.

1.2. Residual Mouth Alcohol (RMA)

As discussed earlier, alcohol only affects the body once it is transported to the brain by the blood. The PBT and its method assume that the breath sample and source of ethanol comes only from the deep lung or alveolar air. 43 A second assumption is that there is no residual mouth alcohol (RMA). As such, we citizens interested in science must be concerned with the validity of these assumptions when testing breath samples. For there to be any measure of the true value, these key assumptions are required to be accurate.

With the above in mind, it is well known that after drinking an alcoholic beverage, the body retains alcohol in the mucosal lining of the mouth for some time. 45 When breath makes contact with mouth alcohol, then the alcohol reading will be falsely elevated, fantastically so at times. Sources of mouth alcohol include recent ingestion of an alcoholic drink, regurgitation of stomach contents, eructation of stomach gases, Gastroesophageal Reflux (GER), Gastroesophageal Reflux Disease (GERD), Laryngoesophageal Reflux (LER), Laryngopharyngeal Reflux (LPR), and use of breath freshening items.

PBTs are not designed with RMA safeguards. They do not contain slope detectors that would help in detecting RMA. 49 Most importantly, when RMA is present, it only works one way: against the defendant, creating a falsely high ethanol content reading. 50 Therefore, without these protections, PBTs have no way of distinguishing alveolar air from an inaccurate false high reading caused by any other source. One study found that it might take up to 19 minutes for RMA dissipation. 51 The same study cited another source that stood for the possibility of effects lasting for up to one hour after consumption.

This is why deprivation/observation periods are mandated in full Evidentiary Breath Testing (EBT) schemes like the Intoxilyzer 5000 EN. Yet, at roadside, there is no such requirement. Therefore, it is best practice that
a suitable deprivation/observation period be conducted at roadside to ensure the subject’s sample is only
deep lung air. Further, it would be best practice for the officer to conduct a replicate analysis after another
deprivation period to further give confidence to a PBT estimate.

1.3. Other Factors

Carry Over: Carry over is a potential problem where a portion of a previous breath specimen remains in the
PBT and is added to a subsequent estimate. As the National Highway Traffic Safety Administration has
cautioned, if the air temperature is low enough, it is possible for carry over to occur in that one person’s
sample remains in the PBT and carries over to the next person’s test. It is not difficult to see the problems
this could cause when the PBT is being used on many drivers, one after another. An example of where this
could be a problem is in a roadblock situation where multiple drivers are being tested or in an underage
drinking event.

Radio Frequency Interference: PBTs do not have detectors to guard against interference caused by radio
frequencies (RFI). Here, it is important to note that in Texas, EBT devices, like the Intoxilyzer 5000 EN,
are required to have RFI detectors by the Texas Department of Public Safety Breath Alcohol Testing
program. Absent an RFI detector, an officer will not know when RFI interference occurs because electric
fields are not detectable by the five human senses. One manufacturer even cautions officers to avoid
environments with high levels of radio interference or magnetic fields. For the patrol officer, there are
plenty of sources of RFI: e.g., hand-held and vehicle mounted radio transmitters, cell phones, CB radios,
light bars, in-car video, computer terminals with internet link inside the patrol vehicle, and police radar.

Independent Sources of Variation: These include the traditional metrological concerns of calibration and
bias of the device itself, and variations in taking of the breath sample: temperature fluctuations,
physiological differences of individuals, and phase of ethanol metabolism to name a few. Most police
agencies do not perform routine or preventive calibration or verification checks for these PBTs during the
entire period of their deployment in the field. If the police agencies do perform calibration or verification
checks, the efforts are typically not validated or well designed.

2. Texas Law

Texas law requires that analysis of a breath sample, to determine a BAC, must be performed according to
methods approved by the Texas Department of Public Safety (DPS). Texas Administrative Code establishes
the Office of Scientific Director to administer the regulations and qualifications for breath testing and for use
as evidence in court cases. Accordingly, the state director evaluates breath test instruments to determine
which instruments are approved devices for forensic breath alcohol testing and for use as evidence in court
cases. Devices that meet the state director’s approval are placed on a list of approved instruments, which is
maintained by DPS. This list contains all breath test instruments approved and certified for breath testing
in the state in compliance with rules of the Texas Breath Alcohol Testing Regulations.

There are no approved PBT devices on the DPS list. DPS also maintains a list of approved reference
sample devices. Again, there are no approved reference sample devices for any PBT device. Therefore,
PBT results are not admissible to establish any level of impairment or BAC.

Furthermore, attorneys should be familiar with the following Texas cases: Hartman v. State, Fernandez v.
State, and Kelly v. State. In Kelly the court adopted a two-prong test for the admissibility of scientific
evidence. The court must first determine whether the scientific evidence is sufficiently reliable and then
whether it is relevant. The court in Kelly adopted three ?common sense? criteria that must be met before
scientific evidence can be deemed reliable:

a) the underlying scientific theory must be valid;
b) the technique applying the theory must be valid; and

c) the technique must have been properly applied on the occasion in question.

_Hartman_ recognized the _Daubert_ and _Kelly_ test and applied or extended it to all forms of scientific evidence, including breath testing.

In _Fernandez_, a wrongly decided case, the court held that PBTs are not certified by DPS, and therefore are only admissible as another form of a field sobriety test and are not admissible for quantitative purposes. In other words, they cannot be used to report a specific BAC level, even though many of them will report an amount. Interestingly, the court ignored the _Kelly_ and _Hartman_ requirements. Following the doctrine of _stare decisis_, _Fernandez_ should have held that PBT evidence is not admissible where the state fails to meet the requirements set forth in _Kelly_ and reaffirmed and further clarified by _Hartman_.

3. Conclusion

In today's times, DWI/DUI enforcement is more organized and focused than ever. Everywhere you turn there is a public service announcement promoting strict DWI/DUI enforcement. Whether it is the ?Over the Limit, Under Arrest? or the ?Drink, Drive, Go to Jail? campaigns or another slogan from a powerful lobbyist and court-watching organization like MADD, DWI/DUI enforcement is serious business. Encouragement and incentives for officers to make DWI/DUI arrests come with serious consequences: false arrests and non-scientific shortcuts. The limitations of commonly used PBTs play directly into the confirmation bias and cognitive bias that exists in DWI/DUI enforcement. Accordingly, it is of utmost importance that we understand and appreciate what PBTs are, how they work, and what they can and cannot do. For when mistakes are made in this field and someone is arrested on an incorrect and false belief they were driving under the influence, it can have large detrimental effects on the person, their family, freedom, liberties, and career that last forever. This, of course, is a greater crime than DWI itself, because we Americans pride ourselves on protecting the innocent. Knowledge and appreciation of the PBT's limitations must remain constant in order to prevent wrongful arrests and convictions.

Notes


4. _Id._


8. _Id._

10. *Id.*


12. The term “alcohol” in the criminal justice system is usually assumed to mean the chemical compound “ethyl alcohol” or “ethanol” for it is ethanol that is found in beer, wine, and spirits.


14. *Id.*


16. *Id.*

17. *Id.*


20. The International Union of Pure and Applied Chemistry (IUPAC) describes the relationship between Specificity and Selectivity as follows: “A specific reaction or test is one that occurs only with the substance of interest, while a selective reaction or test is one that can occur with other substances but exhibits a degree of preference for the substance of interest. Few reactions are specific, but many exhibit selectivity.”


25. *Id.*


30. *Id.*

31. *Id.*


37. *Id.*

38. *Id.*

39. *Id.*

40. *Id.*

41. *Id.*

42. 
### Table I. Ethanol Content of Various Drinks

<table>
<thead>
<tr>
<th>Product</th>
<th>Ethanol concentration* (g/100 mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calistoga Lime Flavor</td>
<td>0.084</td>
</tr>
<tr>
<td>Diet 7UP</td>
<td>0.075</td>
</tr>
<tr>
<td>Canada Dry Ginger Ale</td>
<td>0.081</td>
</tr>
<tr>
<td>Diet Sprite</td>
<td>0.035</td>
</tr>
<tr>
<td>Calistoga Lemon Flavor</td>
<td>0.051</td>
</tr>
<tr>
<td>Hawaiian Punch</td>
<td>0.012</td>
</tr>
<tr>
<td>Mandarin Orange Slice</td>
<td>0.008</td>
</tr>
</tbody>
</table>

*Mean of three determinations.

### Table II. Ethanol Content of Various Baked Goods

<table>
<thead>
<tr>
<th>Product</th>
<th>Contains Yeast* (Y/N)</th>
<th>Ethanol concentration† (g/100 mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Downey's Original Jim Beam Kentucky Bourbon Cake</td>
<td>Y</td>
<td>1.662</td>
</tr>
<tr>
<td>Apple from Great Harvest Apple Walnut Roll</td>
<td>Y</td>
<td>3.006</td>
</tr>
<tr>
<td>Rosemary Onion Bread</td>
<td>Y</td>
<td>0.980</td>
</tr>
<tr>
<td>Great Harvest Apple Walnut Roll</td>
<td>Y</td>
<td>0.920</td>
</tr>
<tr>
<td>Raisin from Sun Maid Raisin Bread</td>
<td>Y</td>
<td>0.661</td>
</tr>
<tr>
<td>Horse Pride Wheat Bread</td>
<td>Y</td>
<td>0.470</td>
</tr>
<tr>
<td>Thomas' Sourdough English Muffin</td>
<td>Y</td>
<td>0.445</td>
</tr>
<tr>
<td>Domino's Raw Pizza Dough</td>
<td>Y</td>
<td>0.420</td>
</tr>
<tr>
<td>Original Wonder Bread</td>
<td>Y</td>
<td>0.471</td>
</tr>
<tr>
<td>QFC Plain Donut</td>
<td>Y</td>
<td>0.347</td>
</tr>
<tr>
<td>Oroweat Extra Sourdough Rye Bread</td>
<td>Y</td>
<td>0.326</td>
</tr>
<tr>
<td>Als Franciscan Sourdough Round</td>
<td>Y</td>
<td>0.307</td>
</tr>
<tr>
<td>QFC Chocolate Donut</td>
<td>Y</td>
<td>0.289</td>
</tr>
<tr>
<td>Sun Maid Raisin Bread</td>
<td>Y</td>
<td>0.276</td>
</tr>
<tr>
<td>Oroweat Oatcut Bread</td>
<td>Y</td>
<td>0.272</td>
</tr>
<tr>
<td>Oroweat X-Seed Bread</td>
<td>Y</td>
<td>0.248</td>
</tr>
<tr>
<td>Horse Pride Wheat Hamburger Buns</td>
<td>Y</td>
<td>0.188</td>
</tr>
<tr>
<td>Francisco Outdoor Rolls (Hoojie-type roll)</td>
<td>Y</td>
<td>0.132</td>
</tr>
<tr>
<td>Bason Baker Pitts Bread</td>
<td>Y</td>
<td>0.169</td>
</tr>
<tr>
<td>Crumpet</td>
<td>Y</td>
<td>0.160</td>
</tr>
<tr>
<td>Domino's Pizza Crust (edge)</td>
<td>Y</td>
<td>0.088</td>
</tr>
<tr>
<td>Domino's Pizza Crust (base)</td>
<td>Y</td>
<td>0.081</td>
</tr>
<tr>
<td>Koldin's Rugel</td>
<td>Y</td>
<td>0.040</td>
</tr>
<tr>
<td>Crisp Bread (toasted totally dry bread)</td>
<td>Y</td>
<td>0.006</td>
</tr>
<tr>
<td>Bread Stick</td>
<td>Y</td>
<td>0.004</td>
</tr>
<tr>
<td>Mini Pretzel</td>
<td>Y</td>
<td>0.000</td>
</tr>
<tr>
<td>Hostess Twinkie</td>
<td>N</td>
<td>0.029</td>
</tr>
<tr>
<td>QFC Poppy Seed Muffin</td>
<td>N</td>
<td>0.000</td>
</tr>
<tr>
<td>Ritz Cracker</td>
<td>N</td>
<td>0.000</td>
</tr>
<tr>
<td>Triscuit Cracker</td>
<td>N</td>
<td>0.000</td>
</tr>
<tr>
<td>Graham Cracker</td>
<td>N</td>
<td>0.000</td>
</tr>
<tr>
<td>Sun Maid Raisin</td>
<td>N</td>
<td>0.000</td>
</tr>
</tbody>
</table>

*Ingredients list indicates yeast.  †Mean of three determinations.


48. A ?Slope Detector? is a script written into the source code that evaluates a breath sample as it enters the machine. The script monitors the slope of the graph of ethanol in the subject?s sample. If the slope does not remain within the parameters programmed into the code, then the machine is supposed to flag the sample as RMA and terminate the test.


52. Id.


54. Id.


63. Id.


68. Kelly at 572.
69. *Kelly* at 573.


71. *Hartman* at 60.

72. *Fernandez* at 572.

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