Breath and Blood Tests in Intoxicated Driving Cases

Why They Currently Fail to Meet Basic Scientific and Legal Safeguards for Admissibility

By Patrick T. Barone and Ted Vosk

In the vast majority of intoxicated driving (DUI/OWI) cases, the key piece of evidence is a breath or blood test. Most courts and many lawyers accept the reported test results without question or contest. This is true despite the fact that the scientific underpinnings of breath and blood testing in Michigan sometimes fail to meet the basic requirements of either law or science. A question worth asking is, Why? Part of the answer is that most lawyers lack scientific sophistication. Another part is that forensic science is often satisfied with "good enough" to be admitted even if it fails to be good enough to constitute science.

Defense attorneys have worked to bring Michigan's breath and blood alcohol programs in line with basic requirements of established scientific practice. This begins with the understanding that no breath or blood test result can tell us anything about an individual's breath alcohol concentration (BrAC) or blood alcohol concentration (BAC) unless accompanied by its uncertainty. A result's uncertainty is necessary for determining which conclusions it supports and answering the question: Did the driver have an unlawful amount of alcohol in his or her system while driving?

If a breath alcohol or blood alcohol concentration result fails to include its uncertainty, it should not be admissible as evidence. However, to make this argument, one must have an understanding of measurement uncertainty and its importance.

Background and uncertainty basics

Measurement uncertainty exists because, no matter how well a measurement is performed, it never permits us to know the "true" value of a quantity intended to be measured—the measurand. To the contrary, for any measurement, "there is not one value but an infinite number of values dispersed about the result that are consistent with all of the observations and data and one's knowledge of the physical world, and that with varying degrees of credibility can be attributed to the measurand."[1]

Measurement uncertainty is "[a] parameter associated with the result of a measurement that characterizes the dispersion of the values that could reasonably be attributed to the measurand."[2] That is, it provides a range of values that an individual relying on the result of a measurement may reasonably believe can be attributed to the measurand. It is typically reported as a coverage interval in the form:

$$Y_{99\%} = Yc \pm U$$

This tells us that:[3]

- The best estimate of the measurand's value (as determined by the bias-corrected mean[4] of our results) is Yc;
- The values that can reasonably be attributed to the measurand lie within a range from $Yc - U$ to $Yc + U$ (where U is the uncertainty[5]); and
- The probability that the measurand's value is one of those within this range is *99%*.

The conclusions supported by a measured result cannot be determined without an estimate of its uncertainty. Absent this, a measured result is ambiguous at best and may even be meaningless.[6] According to the International Organization for Standardization:

> Knowledge of the uncertainty associated with measurement results is essential to the interpretation of the results. Without quantitative assessments of uncertainty, it is impossible to decide whether observed differences between results reflect more than experimental variability, whether test items comply with specifications, or whether laws based on limits have been broken. Without information on uncertainty, there is a risk of misinterpretation of results. Incorrect decisions taken on such a basis may result in unnecessary expenditure in industry, *incorrect prosecution in law*, or adverse health or social consequences.[7]

This is why ISO 17025—internationally recognized as setting forth the minimum standards required for competence to perform scientifically valid measurements—requires that measurement uncertainty be determined and reported along with all measured results.[8]

These same principles apply to forensic measurements. According to the National Academy of Sciences, "*[a]ll results for every forensic science method should indicate the uncertainty in the measurements that are made*. . . ."[9] "For example, *methods for measuring the level of blood alcohol in an individual . . . can do so only within*

Fast Facts

Like all measurements, breath and blood test results have associated uncertainty.

A reported uncertainty is required to evaluate any measurement result as well as answer the basic question in a DUI/OWI case: Did the driver have an unlawful amount of alcohol or drugs in his or her system at the time of driving?

Judges around the country, including in Michigan, have begun suppressing breath and blood tests for a failure to report uncertainty.

a confidence interval of possible values."[10] Accordingly, it concluded that breath test "*results need to be reported, along with a confidence interval that has a high probability of containing the true blood-alcohol level.*"[11] This is well recognized within the forensic breath and blood testing communities.[12] Because a jury may be easily misled by a result unaccompanied by its uncertainty, it is not only unscientific to fail to do so, but also unethical.[13]

Many sources contribute to a result's overall uncertainty, including random fluctuations, scale resolution, and traceability. Each source affecting the use to which a measured result will be put must be included in the final tally. An uncertainty budget is commonly used to list sources of uncertainty included in the tally along with their type and magnitude, as illustrated in the chart below.[14]

Uncertainty Source	Type A	Type B	
Calibration			
Ref. Mat.		.052	
Precision	.080		
Bias	.068		
Combined Uncertainty by Type	.105	.052	
Combined Uncertainty Calibration			.117
Instrumental			
Mechanical Effects	.064		
Electronic Stability	.055		
Detector		.041	
Combined Uncertainty by Type	.084	.041	
Combined Uncertainty Instrumental			.093
Measurement			
Environmental Factors	.101		
Sampling	.112		
Operator	.064		
Measurand Effects		.055	
Combined Uncertainty by Type	.164	.055	
Combined Uncertainty Measurement			.173
Total Uncertainty			
Combined Uncertainty			.229
Expanded Uncertainty ($k=2$)			±.458

This makes an uncertainty budget very important for determining whether a lab's estimate of measurement uncertainty is sound. If important sources of uncertainty have been omitted or their magnitude underestimated, the uncertainty reported will mislead those relying on a result to have more confidence in it than is warranted by science.

Breath and blood test uncertainty in Michigan

Like other measurements, breath or blood tests cannot reveal an individual's actual breath alcohol or blood alcohol concentration. Rather, both have associated uncertainty which must be determined and reported if they are to lead to verdicts consistent with scientific reality. The result of either test is only a rough approximation of an individual's breath alcohol or blood alcohol concentration and cannot be properly interpreted until its uncertainty has been provided.

For example, in a case out of Washington state, two breath tests from different individuals with identical results exceeding the per se limit were provided to a panel of judges during a week-long hearing.[15] Each test satisfied the same scientifically rigorous quality assurance standards and were performed in identical scientifically rigorous manners so that each was deemed to be identically accurate and reliable. Without more, most jurors would conclude as the judges initially did. First, they would presume that both tests supported the same set of conclusions and could be treated identically. Second, since both tests were deemed to be accurate and reliable, most jurors would conclude that they easily established that both individuals' breath alcohol concentrations exceeded the per se limit beyond a reasonable doubt. However, neither of these conclusions is supported by the results.

First, the coverage interval associated with each test was different. This means that the range of breath alcohol concentrations each permitted to be attributed to its driver was different. Moreover, the uncertainty associated with one of the tests yielded a 10 percent likelihood that the individual's breath alcohol concentration was below the per se limit while the second test yielded a likelihood of 20 percent for the other individual. Yet without their uncertainties, there is no way to distinguish between these identical results or the conclusions each supported. Unfortunately, breath and blood test results are presented without their uncertainties in many U.S. jurisdictions. According to some forensic scientists, caselaw in these jurisdictions is largely to blame, permitting forensic science to ignore proper scientific methodology and providing little incentive for it to change.[16]

Michigan had been one of those jurisdictions permitting breath and blood test results to be presented without their uncertainties. For that reason, Michigan has permitted citizens charged with the crime of DUI/OWI to be convicted based on incomplete and often misleading "scientific" evidence. Contrast this to most European countries, which have long required the uncertainty of forensic alcohol tests to be reported:

> When the first alcohol per se drunk driving law was introduced in Sweden in 1941[,]...the Supreme Court mandated that the laboratory charged with the task of analyzing the blood samples should allow for uncertainty or error in the analytical procedures. The forensic chemistry government laboratory therefore from the very beginning always made a deduction from the mean result of analysis.[17]

Similarly, in the United Kingdom, "under the UK Road Traffic Act 1981[,]...[p]rosecution only takes place when the measured level exceeds the legal limit by a margin which aims to take account of the measurement uncertainty."[18]

Michigan courts have begun to appreciate the importance of this uncertainty and rule accordingly pursuant to MRE 702 and *Daubert v Merrell Dow Pharmaceuticals, Incorporated*.[19] For example, in 2011, the first court to consider this issue found that:

> blood test results are not reliable until the state police crime lab calculates an uncertainty budget or error rate and reports that calculation along with the blood test results.... [and] that calculation of an uncertainty budget or error rate and the reporting of the same is an essential element of the scientific methodology for analyzing blood alcohol content using gas chromatography. This requirement is determined to be part of the scientific methodology generally accepted by the scientific community for this particular test. It is one of the essential foundational requirements referred to in *Daubert* [ ] to assure that tests are reliable.[20]

In other words, for breath and blood test results to be admissible, the prosecuting entity must include the measurement uncertainty. Subsequent courts have explained that this also requires the prosecution to establish that the uncertainty reported has been determined in a scientifically acceptable manner.[21]

The Michigan State Toxicology Lab and Police Breath Test Unit have developed budgets for determining uncertainty associated with forensic breath and blood alcohol tests. The questionable validity of these uncertainty budgets, however, requires defense practitioners to challenge the admissibility of breath alcohol and blood alcohol concentration results until it can be established that the uncertainties provided have been determined in a scientifically sound manner. This means that the state of

Michigan must reveal which sources of uncertainty have been included and how those sources were combined to yield the uncertainty reported.

The potential sources of uncertainty are numerous. For breath and blood tests, these include:[22]

- Instrumental factors related to the DataMaster or gas chromatograph used to perform a test (e.g., instrumental precision)
- Relevant biological and sampling variables (e.g., duration of breath sample)
- Traceability (e.g., uncertainty associated with the simulator solutions)
- The legal definition of the measurand (e.g., definition of breath alcohol concentration)[23]

If forensic breath and blood alcohol tests are to be relied on to deprive a citizen of liberty, and Michigan's citizens are to have confidence in verdicts obtained based on those test results, they must adhere to the same fundamental principles that science does.

Once a sound uncertainty budget has been constructed, the state of Michigan will be in a position to develop or adopt an algorithm which will combine the appropriate sources of uncertainty to yield a reliable estimate of a breath or blood test's uncertainty.

Can Michigan breath and blood test programs construct valid uncertainty budgets?

The answer is, unequivocally, *yes*. In response to similar court rulings, the Washington State Breath Test Program and Toxicology Laboratory have developed uncertainty budgets that have withstood scrutiny.[24] Unfortunately, the respective divisions of the Michigan State Police responsible for these activities have had difficulty doing the same. So far, their attempts have failed to produce uncertainty budgets that satisfy appropriate scientific and legal scrutiny.[25]

One of the difficulties encountered is a lack of clarity, if not understanding, concerning the measurand of breath alcohol tests. Although all breath tests probe the same quantity, the alcohol in a sample of expired breath—the measurand, which is an element of the per se crime—is dictated by statute and varies between jurisdictions.[26] The three measurands found in the United States are "end respiratory air," alveolar air, and blood alcohol concentrations.[27] Thus, identical results obtained from tests in disparate jurisdictions may refer to completely different quantities whose uncertainties must be determined differently.

Michigan is an alveolar air jurisdiction.[28] A significant limitation of the uncertainty budget currently employed by the state, however, is that it does not address the *nature* of the measurand in question. Rather, it ignores what may be the greatest source of uncertainty associated with breath alcohol concentration results: the distinction between the alcohol concentration of end expiratory air and alveolar air.[29] The relationship between these two quantities contributes sizeable uncertainty to breath test results

obtained under Michigan law. Failure to account for this makes the state's uncertainty budget incomplete and leads to an underestimate of a result's uncertainty.

Where uncertainty budgets are concerned, the devil is in the details. Only by examining the content of a particular uncertainty budget can one determine whether it is capable of yielding a reliable estimate of a result's uncertainty.

Requirements of justice

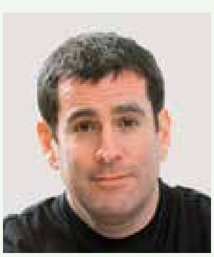
"The ultimate mission of the system upon which we rely to protect the liberty of the accused as well as the welfare of society is to ascertain the factual truth...."[30] The determination and reporting of the uncertainty associated with breath and blood test results:

> ...promotes honesty in the courtroom. It is axiomatic that measurements are inherently uncertain. As the Washington cases emphasize, it is misleading to present the trier of fact with only a single point value. There is a grave risk that without the benefit of qualifying

testimony, the trier will mistakenly treat the point value as exact and ascribe undue weight to the evidence. The antidote—the necessary qualification—is a quantitative measure of the margin of error or uncertainty.[31]

Providing a measured result without its uncertainty to a jury is equivalent to intentionally lying to the jury. The proper determination of a result's uncertainty is not only required by science, but also for determining factual truth in the courtroom. If forensic breath and blood alcohol tests are to be relied on to deprive a citizen of liberty, and Michigan's citizens are to have confidence in verdicts obtained based on those test results, they must adhere to the same fundamental principles that science does. This requires the proper determination and reporting of the uncertainty associated with breath and blood alcohol results relied on in prosecutions in Michigan. Justice demands nothing less. ■

Patrick T. Barone is the founding partner at Barone Defense Firm. With offices in Birmingham and Grand Rapids, the firm exclusively handles DUI cases, including those involving death or serious injury. Since 2009, the firm has been included in U.S. News & World Report*'s "America's Best Law Firms." Mr. Barone has an "AV" rating from Martindale-Hubbell, is rated "Seriously Outstanding" by Super Lawyers, and "Outstanding/10.0" by AVVO. His blog is www.YourMichiganDUILawyer.com.*



A Goldwater Scholar in theoretical physics and mathematics from Eastern Michigan, Ted Vosk obtained his JD from Harvard. He received the President's Award from the Washington Association of Criminal Defense Lawyers and a Certificate of Distinction from the Washington Foundation for Criminal Justice. A Fellow of the American Academy of Forensic Sciences, he is an international speaker and co-author of Forensic Metrology: Scientific Measurement and Inference for Lawyers, Judges, and Criminalists.

ENDNOTES

1. Joint Committee for Guides in Metrology, *Evaluation of Measurement Data—Guide to the Expression of Uncertainty in Measurement* (September 2008), p 51 <http://www.bipm.org/utils/common/documents/jcgm/JCGM_100_2008_E.pdf>. All websites cited in this article were accessed June 17, 2015.
2. Ellison & Williams, eds, *EURACHEM/CITAC Guide CG 4: Quantifying Uncertainty in Analytical Measurement* (3d ed) (2012), p 4 <https://www.eurachem.org/images/stories/Guides/pdf/QUAM2012_P1.pdf>.
3. Vosk & Emery, *Forensic Metrology: Scientific Measurement and Inference for Lawyers, Judges, and Criminalists* (Boca Raton: CRC Press, 2015).
4. The "bias-corrected mean" is the mean of the measured results corrected for instrumental bias which must be determined at the time the instrument is calibrated.
5. "U" is actually the expanded uncertainty.
6. American Association for Laboratory Accreditation, *Guide for Estimation of Measurement Uncertainty in Testing* (2002), G104 § 1.
7. International Organization for Standardization, *Guidance for the Use of Repeatability, Reproducibility and Trueness Estimates in Measurement Uncertainty Estimation* (2004), ISO/TS 21748 v.
8. See International Organization for Standardization, *General Requirements for the Competence of Testing and Calibration Laboratories* (2005), ISO 17025 §§ 5.4.6.2, 5.10.1, 5.10.3.1. The same is recognized in the United States. See National Institute of Standards and Technology Handbook 150, *National Voluntary Laboratory Accreditation Program: Procedures and General Requirements* (2006), §§ 5.4.6.2, 5.10.1, 5.10.3.1.
9. National Research Council Committee on Identifying the Needs of the Forensic Sciences Community, *Strengthening Forensic Science in the United States: A Path Forward* (2009), p 184 (emphasis added) <https://www.ncjrs.gov/pdffiles1/nij/grants/228091.pdf>.
10. *Id.* at 116–117 (emphasis added).
11. *Id.* at 116 (emphasis added).
12. See, e.g., Jones, *Dealing with Uncertainty in Chemical Measurements*, 14 Int'l Assoc Chem Testing Newsl 6 (2003).
13. Gullberg, *Professional and Ethical Considerations in Forensic Breath Alcohol Testing Programs*, 5 J Alc Testing Alliance 22, 25 (2006); *Dealing with Uncertainty*, 14 Int'l Assoc Chem Testing Newsl 6.
14. Two types of uncertainty are distinguished by the way they are determined: Type A uncertainty refers to uncertainty that has been determined by statistical sampling. Type B uncertainty refers to uncertainty that has been determined by nonsampling means relying on prior knowledge, experience, and judgment. See *Forensic Metrology*, note 3.
15. *Washington v Fausto*, No. C076949 (King Co Dist Ct Wash, 2010).
16. See Gullberg, *Estimating the Measurement Uncertainty in Forensic Breath Alcohol Analysis*, 11 Accred Qual Assur 562, 563 (2006).
17. *Dealing with Uncertainty*, 14 Int'l Assoc Chem Testing Newsl 6.
18. King & Long, *International Interlaboratory Study of Forensic Ethanol Standards*, 124 Analyst 1123 (1999).
19. *Daubert v Merrell Dow Pharm, Inc*, 509 US 579; 113 S Ct 2786; 125 L Ed 2d 469 (1993).
20. *People v Jabrocki*, No. 08-5461-FD (79th Dist Ct Mason Co Mich, 2011).
21. *People v Carson*, No. 12-01408 (55th Dist Ct Ingham Co Mich, 2014).
22. *Estimating the Measurement Uncertainty*, 11 Accred Qual Assur at 563.
23. Vosk et al, *The Measurand Problem in Breath Alcohol Testing*, 59 J Forensic Sci 811–815 (2014).
24. See, e.g., *Estimating the Measurement Uncertainty*, 11 Accred Qual Assur at 563; Sklerov & Couper, *Calculation and Verification of Blood Ethanol Measurement Uncertainty for Headspace Gas Chromatography*, 35 J Forensic Sci 402 (2011).
25. See *Carson*, No.12-01408 (55th Dist Ct Ingham Co Mich, 2014).
26. See *The Measurand Problem in Breath Alcohol Testing*, 59 J Forensic Sci 811–815.
27. *Id.* at 812.
28. Mich Admin Code, R 325.2651.
29. See *The Measurand Problem in Breath Alcohol Testing*, 59 J Forensic Sci 811–815.
30. *Commonwealth of Northern Mariana Islands v Bowie*, 243 F3d 1109, 1114 (CA 9, 2001).
31. Imwinkelried, *Forensic Metrology: The New Honesty About the Uncertainty of Measurements in Scientific Analysis*, UC Davis Legal Studies Research Paper No. 317 (December 2012).