
MASSACHUSETTS BREATH TESTING FOR ALCOHOL: A COMPUTER SCIENCE PERSPECTIVE

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I. Introduction

Massachusetts relies primarily on the technology of breath testing¹ in the prosecution of criminal complaints for driving under the influence of alcohol.² Breath testing is performed on Draeger Alcotest 7110 MK III-C machines, which are purchased statewide as the machine of choice for state police and city police departments.³ The Draeger Alcotest 7110 is used statewide in two other states: New Jersey and Alabama. Other states, such as New York and California, manage their breath testing programs on a county by county basis, using different machines throughout the state.

Prosecutions for Operating Under the Influence have decreased in recent years, as reflected in statistics collected by the Massachusetts

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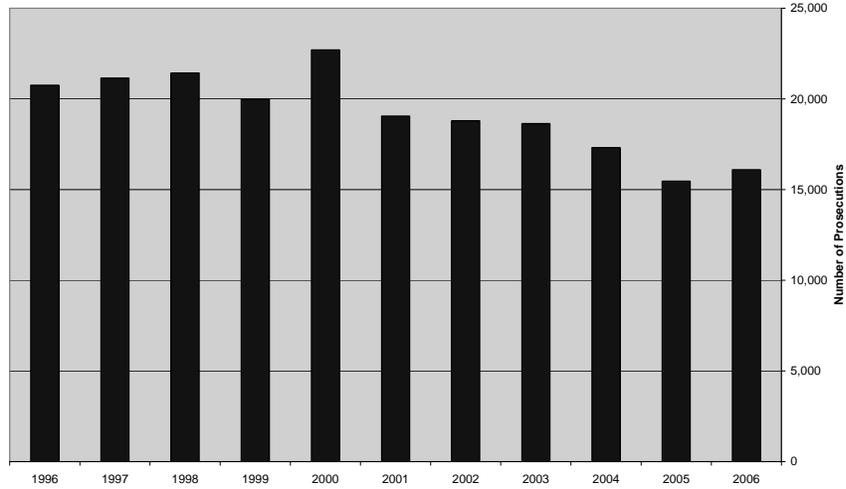
1. MASS. GEN. LAWS ch. 90, § 24(e) (2007) provides: "In any prosecution for a violation of paragraph (a), evidence of the percentage, by weight, of alcohol in the defendant's blood at the time of the alleged offense, as shown by chemical test or analysis of his blood or as indicated by a chemical test or analysis of his breath, shall be admissible and deemed relevant to the determination of the question of whether such defendant was at such time under the influence of intoxicating liquor"

2. See MASS. GEN. LAWS ch. 90 § 24 (2007).

3. Federal law enforcement in Massachusetts is believed to utilize the Datamaster, a machine manufactured by National Patent Corporation.

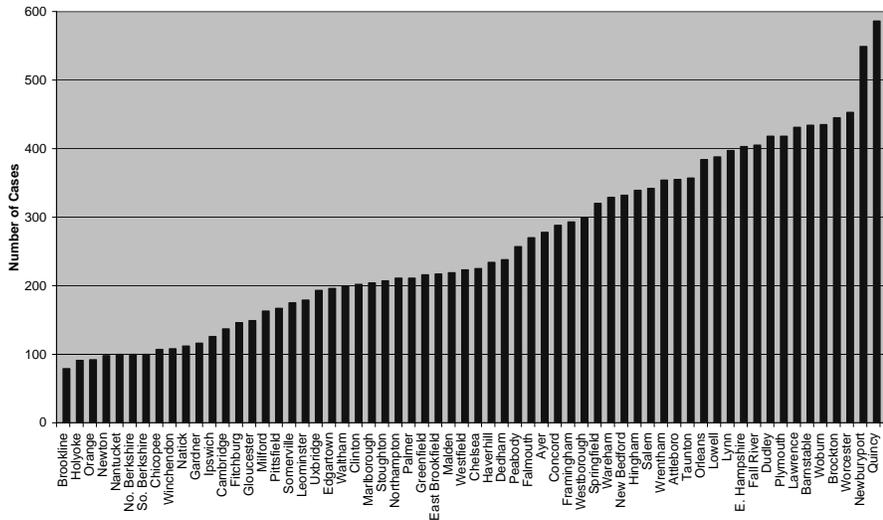
District Courts, where most prosecutions are adjudicated.⁴

Prosecutions for Operating Under the Influence in Massachusetts



Prosecutions also vary from Court to Court, again as reported by the Clerks of the District Court through the District Court’s webpage, whose data is presented here.⁵

Massachusetts Operating Under the Influence Cases Entered in Fiscal 2006



4. The Massachusetts Court System, District Court Department, Fiscal Year 2006 Statistics, *archived at* <http://www.webcitation.org/5YDH6tUYy>.

5. The Massachusetts Court System, District Court Department, Fiscal Year 2006 Statistics, Criminal Cases by Court, *archived at* <http://www.webcitation.org/5YDHMuMdf>.

Cases are prosecuted on the theory that the citizen was impaired, and the evidence of impairment is proved through the testimony of witnesses as to the manifestations of that impairment.⁶ A second method is now available, as the “per se” provisions of Mass. Gen. Laws ch 90 § 24 provide that the presence of .08 % alcohol in the blood, as exhibited by that percentage present in the breath, is per se a crime, provided that the other elements of the offense are present.⁷

The advent of the “per se” statutory provisions placed an increased burden on the science of breath testing, because the testing of breath in the previous statutory scheme permitted a defendant to argue that despite an alcohol level that exceeded .08, that in fact they were not impaired. Under the new statutory scheme, that defense is no longer available.⁸ One can argue that the machine was not operating properly, and that the reported result is incorrect.⁹ This places a new emphasis on the science of breath testing, for prosecutors, defense attorneys, and Judges.

In the United States, four companies manufacture nearly all of the evidentiary machines used by law enforcement to evaluate human breath for ethanol. CMI has the largest market share, and manufactured the Intoxilyzer 5000 (the machine that was employed statewide in Massachusetts prior to the statewide deployment of the Draeger Alcotest 7110 MK III-C).¹⁰ The Datamaster models, from National Patent Analytical Systems, are the second most popular machines.¹¹ The Draeger and EC/IR machines share a small minority market share.

II. The Appearance of Simplicity

The User Interface for breath testing devices is designed with simplicity in mind. Basically, the power is turned on, the start button is pressed, and the subject blows into the machine until the operator tells them to stop.¹² The sequencing of the test is controlled by the software in the machine, and the operator’s role is to follow the steps as directed

6. See *Commonwealth v. Orben*, 53 Mass. App. Ct. 700 (2002).

7. See Mass. Gen. Laws ch 90 *supra*, note 1.

8. See *Commonwealth v. Paiva*, 16 Mass. App.Ct. 561 (1983) (holding that a .10% BAC was sufficient evidence alone for a finding of guilty).

9. See, e.g. *Commonwealth v. Durning*, 406 Mass. 485 (1990) (holding that the defendant’s challenge to the breathalyzer test was denied).

10. Intoxilyzer 5000 Brochure, *archived at* <http://www.webcitation.org/5YDI38aEA>; Draeger Alcotest 7110, *archived at* <http://www.webcitation.org/5YIrEBXOZ>.

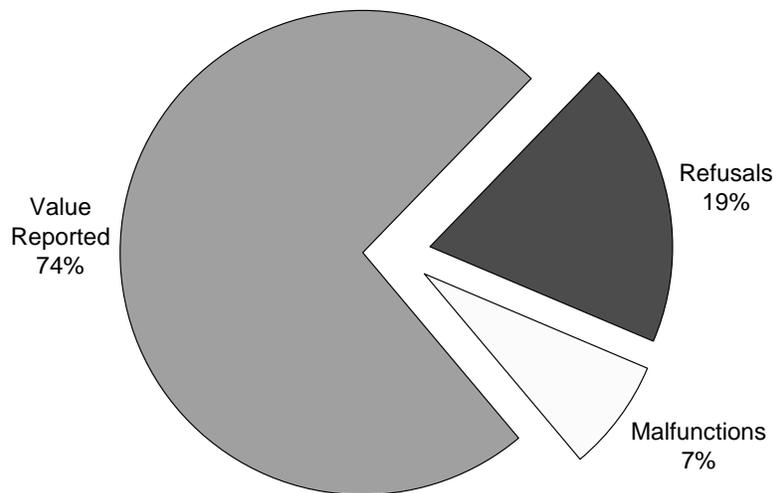
11. National Patent Analytical Systems Website, *archived at* <http://www.webcitation.org/5YDID4exy> (stating that 3,500 units of the breathalyzer have been sold).

12. See Intoxilyzer 5000 Brochure, *supra*, note 10.

by the display.¹³ To the casual observer, the machine is like a bathroom scale: blow into it and it reports ethanol content.

What goes on inside the machine is anything but simple and straightforward. Statistics of breath tests are not available for Massachusetts (the data has not been provided in response to requests), however data is available from other states. Breath test data is available on the internet for the state of Washington.¹⁴ Florida data has been analyzed and presented here, and it is expected that the data in Massachusetts is not significantly different from data in other states.¹⁵

One in four tests in Florida do not report a numeric result.¹⁶ In Arizona, which uses the same machine that is used in Florida (the Intoxilyzer 8000), one in three tests does not report a result.¹⁷ The distribution of test “Results” for Florida’s data set of 90,000 breath tests is as follows:



13. *Id.*

14. See Washington State Patrol, Forensic Laboratory Services Website, archived at <http://www.webcitation.org/5YDISnbin>.

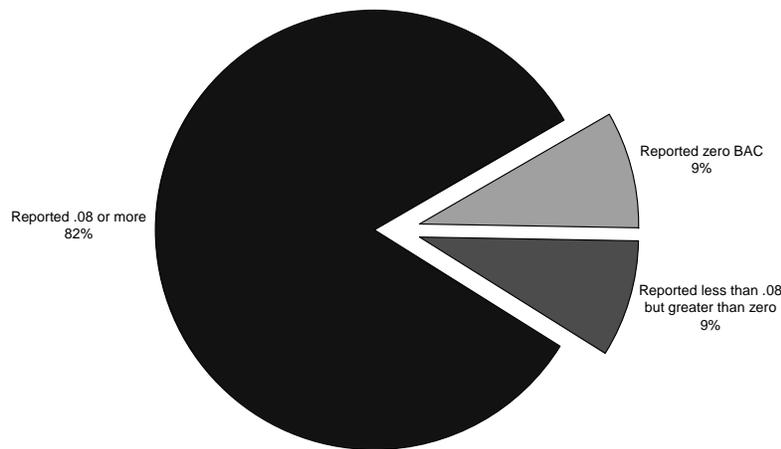
15. See Florida Department of Law Enforcement Public Records [hereinafter *FL Records*], archived at <http://www.webcitation.org/5YDIXsW6B>; Thomas E. Workman, Jr., *Measuring the Subjective Component of Breath Testing for Alcohol: A Study of the Florida Breath Testing Data*, Mastering Scientific Evidence Conference, March 2008 (describing methods used in analyzing Florida data) (on file with author).

16. See *FL Records*, *supra* note 15.

17. ARIZ. ADMIN. CODE § 13-10 (2006).

III. Breath Tests that Report a Value

Of the tests reporting a value for the amount of ethanol in the subject's system, one in five reported a result less than the statutory .08 threshold.¹⁸ A subject who "passes" the test is equally likely to have a zero Breath alcohol content, as they are to have a value below .08 but above zero.¹⁹



The Florida tests are tainted by a software defect which reported results when the volume of the breath test sample was less than the required 1.1 liter sample.²⁰ In addition to this problem, some breath tests, which measured a sufficient sample of breath, were incorrectly rejected and reported as a "Refusal."²¹

IV. Breath Tests that Result in a "Refusal"

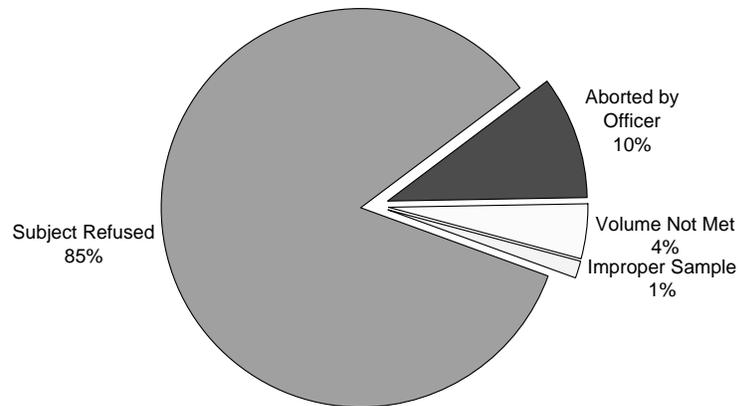
Most breath testing machines report different explanations for tests that result in a "Refusal". Some subject samples are rejected due to improper processing by the machine. Other tests are rejected because of improper instructions (e.g. the Operator tells the subject to stop blowing before an adequate volume of air is supplied). The distribution of "Refusals" is provided graphically here:

18. See *FL Records*, *supra* note 15.

19. *Id.*

20. See *FL Records*, *supra* note 15; Workman, *supra* note 15.

21. *Id.*



Not all “Refusals” are caused by the subject. Of the Refusals in Florida where a valid first sample was measured, 92% of the subjects supplied a first sample that was sufficient for the machine to measure the ethanol, and that first sample was alcohol free.²²

Breath testing machines, including the Draeger Alcotest 7110 MK III-C used in Massachusetts, permit the operator to abort a test, generating a refusal, even after the subject has supplied a sample that has been evaluated by the machine and has generated a valid measurement of subject alcohol. On these machines, operators are trained that at any time they can press the “Start” button and the machine will “Reset.” They also learn that if a test is in progress, pressing the “Start” button test will record a “Refusal.” All known breath testing machines discard the data associated with the aborted sample. This “feature” has no known legitimate purpose, and abuse of this “feature” permits a police officer to generate a “refusal”, with all of the administrative penalties associated with a refusal, at will.

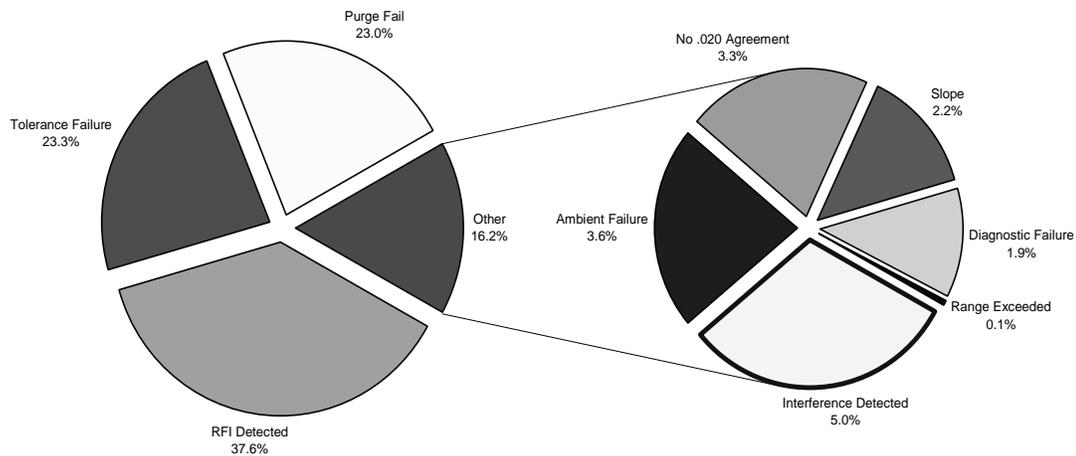
In addition to the problems of operator-induced refusals, courts in Florida have ordered the suppression of breath tests because the conduct of the operator can manipulate the result. In *State v. Briggs*, the Court held an evidentiary hearing to evaluate the degree of operator

22. A zero reading reports a “0.000” value, and a subject with no measurable alcohol is not likely to exhibit any physical symptoms that are often reported: glassy eyes, slurred speech, strong odor of alcohol on the breath. See *FL Records*, *supra* note 15.

manipulation that is possible and, at the conclusion of that hearing, ordered the suppression of breath test results.²³

V. Self-Diagnosed and Reported Malfunctions

An examination of the “malfunctions” that are self diagnosed and self reported, for the Florida dataset,²⁴ discloses the following distribution:



- **RFI Detected:** Self reporting of RFI indicates that Radio Frequency Interference has been detected by the machine. RFI can be self generated by components that are failing within the machine, or they can be the result of electronic equipment, which includes cell phones, police radios, air conditioners, refrigerators, computer printers, fluorescent lights, or virtually anything that either plugs in or has a battery.
- **Tolerance Failure:** The calibration sample supplied to the machine with a known amount of alcohol does not compute a value that is within the accepted tolerance.
- **Purge Fail:** The machine was unable to remove all of the ethanol from the chamber by blowing fresh air through the machine.

23. Florida v. Briggs, et al., 14 Fla. L. Weekly Supp. 973b, August 20, 2007.

24. See *FL Records*, supra note 15.

- *Interference Detected*: The machine has detected the presence of some material that distorts the ability to measure the subject's breath.
- *Ambient Failure*: The machine is unable to calibrate itself based on the initial evaluation of the chamber of air before the test begins.
- *No .02 Agreement*: The samples supplied by the subject produce results that are more than .02 apart, which indicates that the machine is not able to measure the samples correctly.
- *Slope*: The machine is unable to calculate a result because the sensors vary more than a predetermined amount during the course of measuring 120 values per second over the course of a breath sample.
- *Diagnostic Failure*: The self diagnostic that is performed at the beginning or end of the test has determined that some aspect of the machine is not functioning correctly.
- *Range Exceeded*: The amount of measured alcohol exceeds .500, and it is presumed that the machine is not working correctly.

When errors are encountered, the common practice is to have the subject submit to an additional testing procedure, in an effort to get a test result that is admissible in Court. The statute in Massachusetts does not explicitly require a citizen to submit to multiple attempts to test their breath, and in fact, includes language that is singular in syntax, inferring a single test.²⁵ Notwithstanding the requirement for citizens to submit to "a test," multiple testing on the same breath testing instrument is commonplace. In Arizona, one in every three administered tests is a repeat test. The practice of requiring an additional test when the machine self diagnoses an error is the norm. In states where there are enhanced penalties for breath levels that are higher than .08 (referred to as "aggravated" DUI in some states), it is not uncommon for a citizen with a test result just below the statutory aggravated limit to be re-tested in an attempt to obtain a test result that carries a more severe penalty.²⁶

25. MASS. GEN. LAWS ch. 90 § 24(f). "If a person refuses to take a test under this paragraph . . ." (emphasis added) The inclusion of the word "a" as it modifies "test", and the expression of "test" in the singular, should be construed to require that a citizen submit to one and only one test.

26. See National Conference of State Legislators, National Highway Traffic and Safety Administration, *State High BAC Standards and Penalties* (listing 31 states

In Florida, one citizen was tested 13 times on one machine, by one officer, in one hour.²⁷ These instances occur because in some situations, a machine that registers an error or multiple errors may finally produce a value that has the appearance of being a valid test. The Courts are usually unaware of the history of failures on the machine, and believe that the result is legitimate, when in fact may not be.

In Florida, CMI machine 80-001344 was removed from service after a visiting officer reported that the machine was not functioning correctly, as it was too difficult to blow into.²⁸ The machine was used for 55 successive DUI breath tests, from August 13, 2007 to September 23, 2007, with over half of the administered tests terminating without providing a result.²⁹ Using these criteria for detecting other machines that were not operating correctly, the Florida data was processed by locating every combination of 55 consecutive DUI tests, on every machine, and computing the portion of tests that failed to provide a measured result.³⁰

One of every nine DUI tests in Florida was administered on a machine that failed to function correctly in more than half of the 55 tests that included the relevant breath test.³¹ This criteria for removal of a machine from service, a 52% failure in a 55 test window, was utilized by Florida on the 80-001344 machine and was applied to the other 379 machines in the state.³²

Machines that fail more than half the time cannot be relied upon to produce valid results. Any results that are produced are suspect. While the machines have the ability to detect a history of failures, as a rule they do not shut themselves down when it is clear that they are malfunctioning. The machines also do not self-report a distress message to the Office of Alcohol Testing (OAT).

with enhanced penalties for high blood alcohol content ranging from .15 to .26), archived at <http://www.webcitation.org/5YEKjcdFs>.

27. See generally, Workman, *supra* note 15 (describing method used to analyze Florida's extensive data); *FL Records*, *supra* note 15.

28. *Id.*

29. *Id.*

30. *Id.*

31. *Id.*

32. See generally, Workman, *supra* note 15 (describing method used to analyze Florida's extensive data); *FL Records*, *supra* note 15.

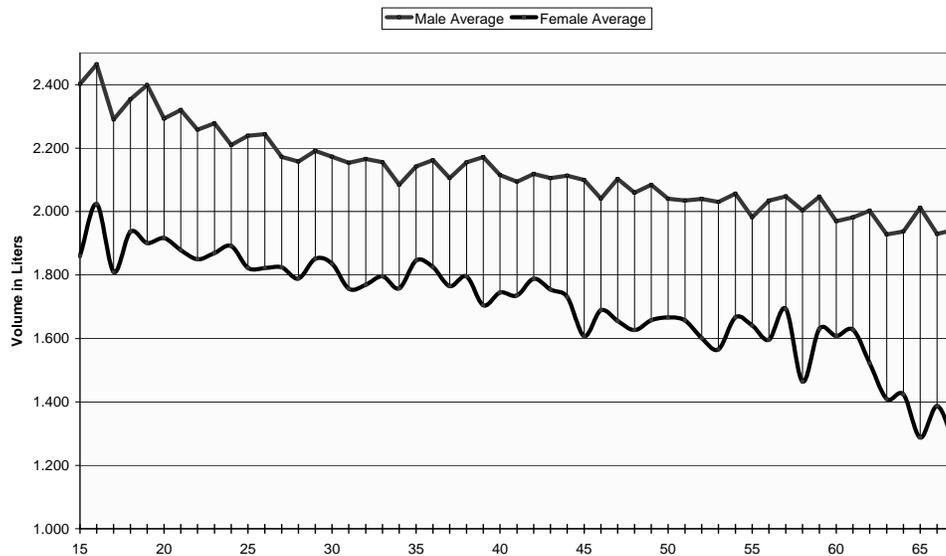
VI. One Size Does NOT Fit All

At least two aspects of breath testing create unfair and unreliable results for some citizens. Both have their roots in assumptions that the testing methods are made for all citizens, when in fact it is well known that these assumptions are not valid.³³ Some citizens are unable to supply the volume of breath that the machine arbitrarily requires, and there are unfair variations in measurements caused by differences in body temperature.

VII. The Physiology of Breath Volume

The Draeger machine requires a minimum breath volume before it will report a result. Machines cannot measure volume directly, but they can detect breath pressure through a pressure sensor and they can measure the amount of time that a given breath pressure is present. Mathematically, volume is the quotient of air flow and time. Air flows at a rate that is proportional to the instantaneous pressure. The machines make assumptions about how hard the subject is blowing, and compute volume based on these assumptions. When these assumptions do not apply to all subjects, the results are incorrect.

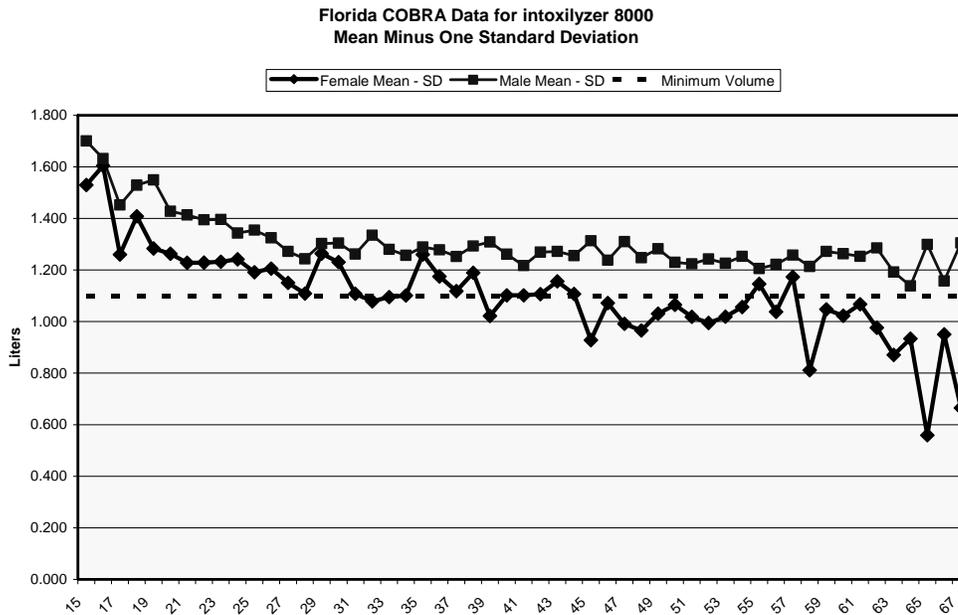
Average Breath Sample Volume in Florida, by Age



33. See generally, David Polin, Annotation, *Challenges to Use of Breath Tests for Drunk Drivers Based on Claim That Partition or Conversion Ratio Between Measured Breath Alcohol and Actual Blood Alcohol is Inaccurate*, 90 A.L.R.4th 155 (1991).

The preceding chart shows the arithmetic mean for breath tests which produced numeric results for the measurement of breath alcohol.³⁴ The breath volume for each test is the average of the two breath samples provided. These are sorted by age, based on the age of the subject on the date of his or her breath test. They are further sorted by the gender of the subject. There were insufficient breath tests for subjects older than sixty-seven years of age.

Women of all ages provided, on average, breath samples that were twenty-percent (20%) to forty-percent (40%) lower, with the greatest deviations occurring in women over the age of sixty. By computing the standard deviation of samples for each gender, and for each age, the *average minus one standard deviation* can be determined which demonstrates the statistical breath sample that a subject can be expected to provide. This data is presented graphically below:



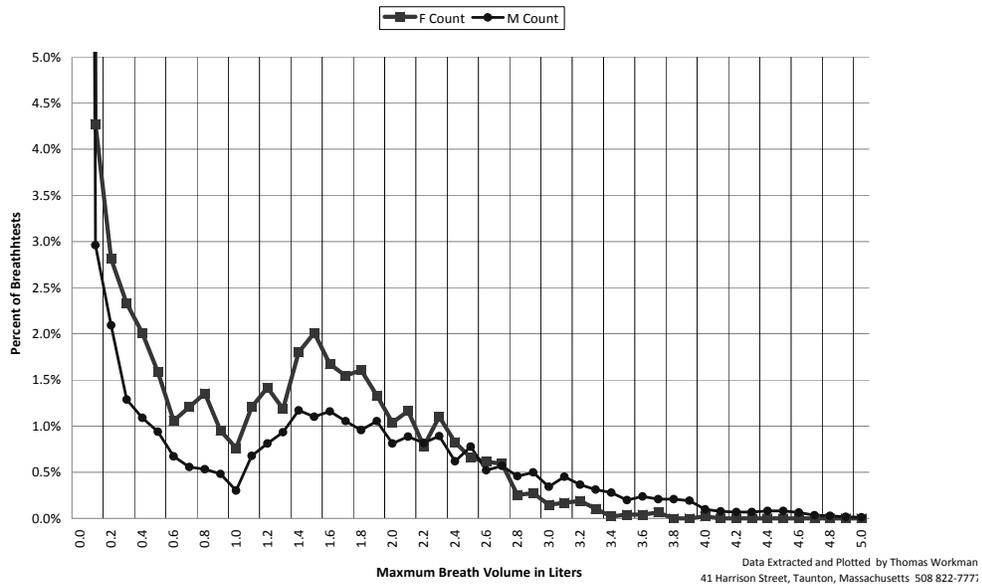
Women aged 40 and older, whose lung capacity is at the lower end of those included within one standard deviation, are physically unable to provide the sample volume that the machine arbitrarily requires. Failure to provide this volume will result in a refusal. While a person who has a lung capacity of several liters cannot be evaluated with a sample less

34. *FL Records*, *supra* note 15.

than the arbitrary threshold, and thus the requirement is reasonable, for those with smaller physical capabilities, these arbitrary requirements can be unfairly punitive.

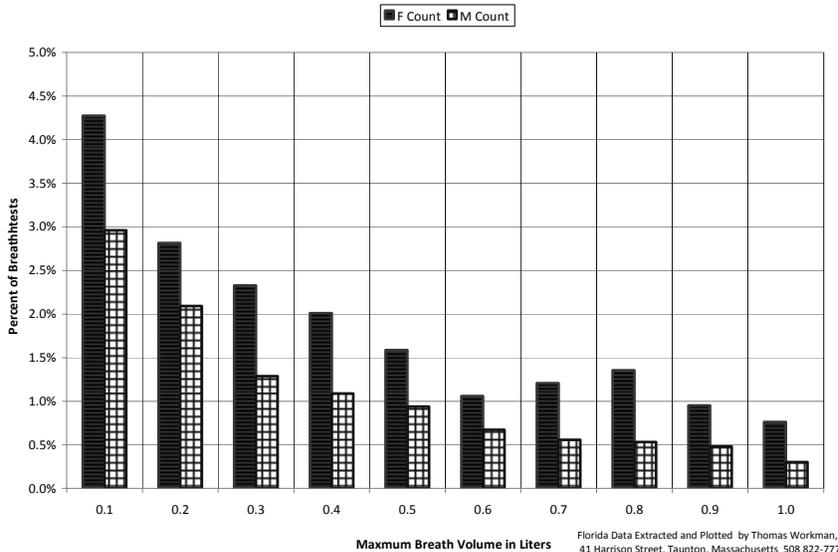
Comparing men and women whose tests did not produce a numerical result, there is a marked difference in the distribution of breath volume. When all tests that resulted in either a refusal or an error message are analyzed against the maximum volume sample that was produced and the portion of all failed tests for that gender at that maximum volume are presented the following chart is produced:

Number of Failed Breathtests, by Volume, Gender



When the maximum volume is more than zero, but less than the arbitrary minimum volume, the data shows the differences as follows:

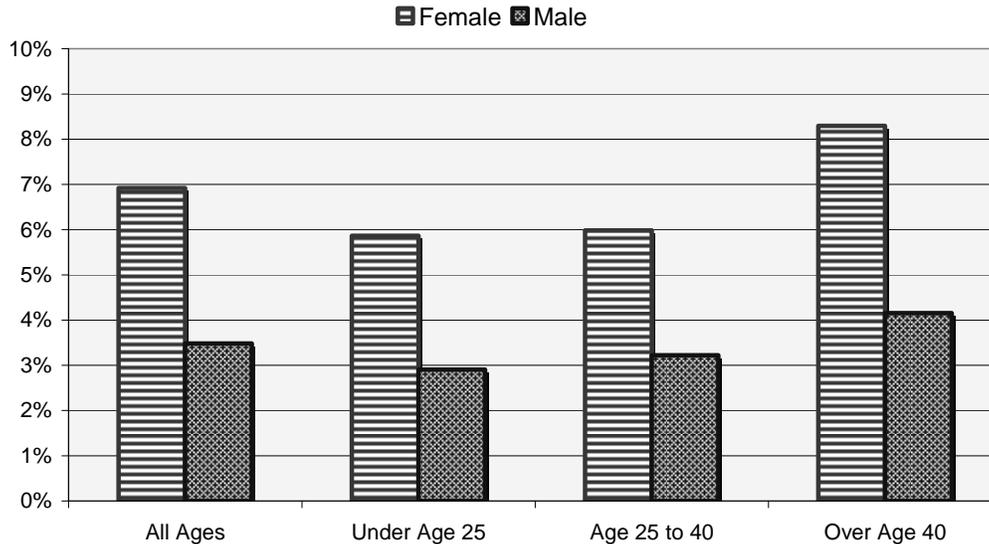
Number of Failed Breathtests, by Volume, Gender



The ages of subjects are distributed into three equally sized groups. Subjects aged twenty-five and below, those over twenty-five to age forty, and those over forty are each aggregated. These three groups are separated by gender, and those tests which did not yield a test result are analyzed within these age groups. The data demonstrate that women are penalized because they are unable to provide a volume of breath sample that the machine arbitrarily requires. In every age group, women are twice as likely to be penalized with a refusal as compared to men.

Of perhaps greater concern are the tests which produce a value with the appearance of correctness, but which are, in fact, incorrectly computed.

Probability that a Failed Breathtest includes a .5 to 1.0 Liter Breath Sample, Contrasting Genders and Age Groups



Many states utilize a magnetic strip card swipe system that permits an officer to swipe a drivers license, and by that process read recorded information on the magnetic strip.³⁵ This information usually includes the name, drivers license number, gender, and date of birth.³⁶ The machines incorporate a clock and electronic calendar, from which the date and time of reports are derived. The date of the test and the

35. See e.g., Secretary Land Announce Service with a Swipe!, State of Michigan, Dept. of State website (June 4, 2003), archived at <http://www.webcitation.org/5YEdrx7lv>.

36. *Id.*

birthday of the subject enables the computation of the subject's age. These calculations, however, are not made by the system.

Minimum volume requirements do not consider either the possibility of medical conditions (such as asthma or COPD, which prevent a citizen from providing a sample suitable for measurement), nor do they consider differences in physical capability based on gender or age.

When a citizen cooperates and completes a breath test and is still denied an opportunity because of limitations on the design of the software that controls the breath test machine, an exculpatory breath sample cannot be analyzed and reported.

VIII. Inflated Results Caused by Body Temperature

The Draeger Alcotest 7110 MK III-C is available with an option that measures the temperature of the breath sample.³⁷ Massachusetts elected not to purchase that option. Alabama purchased the temperature option on their Draeger 7110 (the same machine used in Massachusetts).³⁸ In Alabama, recorded temperature data indicates that the average body temperature (which is directly related to the breath temperature) of those providing breath samples was nearly a full degree centigrade higher than the value assumed by the machine. According to an article published by the director of a breath testing program in Alabama, if Alabama defendants are indicative of defendants generally, then between eighty-one percent and ninety-three percent of breath tests in Massachusetts are falsely elevated on the basis of temperature alone.³⁹ In Massachusetts, the reported breath alcohol results are being systematically overstated.

Studies have shown that for each increase in body temperature of one degree centigrade, breath alcohol results are inflated by 7.5%.⁴⁰ For each degree centigrade cooler, the citizen benefits by a comparable amount.

In *New Jersey v. Chun*,⁴¹ the Court found that temperature of the breath sample should not be taken into account.⁴² Other jurisdictions

37. See *New Jersey v. Chun*, No. 58,879, 37 (February 13, 2007), archived at <http://www.webcitation.org/5YEsnhzqe>.

38. *Id.*

39. Dale A. Carpenter and James M. Buttram, *Breath Temperature: An Alabama Perspective*, 9 IACT NEWSLETTER 16, 16 (July 1998).

40. Glynn R. Fox and John S. Hayward, *Effect of Hyperthermia on Breath-Alcohol Analysis*, *Journal of Forensic Sciences*, Vol 34, No. 4, July 1989, pages 836-41.

41. *New Jersey v. Chun*, 943 A.2d 114 (N.J. 2008).

42. *Id.* at 144-147.

have reduced the computed value by a percentage, as a way of compensating for the systematic overstating in the vast majority of tests.

IX. Overview of the Technology of Breath Testing

Two technologies are commonly employed to evaluate breath for ethanol. Infrared spectroscopy measures the absorption of light in the infrared spectrum, applying the theory that frequencies may be selected that are good detectors of alcohol.⁴³ Fuel cell technologies depend on the interaction of alcohol with a catalyst so that the ensuing chemical reaction produces an electrical current that is proportional to the quantity of alcohol present in a breath sample.⁴⁴ Machines manufactured by CMI and National Patent employ Infrared Spectroscopy exclusively. The EC/IR and Draeger evidentiary machines utilize both fuel cell and infrared spectroscopy in a single machine.⁴⁵

Most breath testing technologies assume that it is possible to estimate the content of alcohol in blood by measuring the amount of alcohol in deep lung breath. As the theory holds, alcohol reaches an equilibrium between blood and air sacs in the lung in a proportion that is constant for the substance dissolved in the blood, in this case ethanol. In the science of physics, Henry's Law provides that for a given temperature and pressure, a material dissolved in water (and by analogy in blood) passes from the blood into deep lung air in a predictable amount.⁴⁶ The measurement of ethanol in a breath sample can predict the amount of ethanol in blood.⁴⁷

Human breath does not contain a uniform amount of ethanol throughout exhalation. The presence of ethanol in the oral cavity will invalidate ethanol measurements.⁴⁸ The machines that attempt to measure ethanol evaluate measurement fluctuations in order to estimate whether the amount of ethanol has stabilized in the breath stream and

43. HAROLD TRIMM, *FORESNSICS THE EASY WAY* 187 (Barron's Educational Series 2006).

44. *Id.*

45. *See* N.J. v. Foley, 851 A.2d 123, 126 (2003).

46. JAMES GIRARD, *CRIMINALISTICS: FORENSIC SCIENCE AND CRIME* 317 (Jones & Bartlett Publishers 2006).

47. *Id.* at 317-318.

48. Presence of ethanol in the mouth is referred to as "mouth alcohol". The imposition of a 15 minute observation period is designed to eliminate the possibility of alcohol in the mouth. Recent studies presented at the International Conference of Alcohol and Drug Traffic Safety indicate that mouth alcohol can survive in the mouth for periods in excess of fifteen minutes. *See* M. Rankine Forrester, A Novel Approach to Detecting Mouth Alcohol, The International Council on Alcohol Drug and Traffic Safety Conference, Aug. 2007.

whether the stabilized amount is contaminated by any extraneous source of ethanol.⁴⁹

Using minimum thresholds for volume of breath and standards for the minimum duration of the breath sample, as well as evaluating multiple samples, are intended to insure that the measurement is scientifically acceptable. In Massachusetts, a minimum of two breath samples is required, which must be within 0.02 to be valid.⁵⁰ Between the two submitted breath samples, a calibration solution of a known concentration is supplied and measured by the machine. If the calibration measures within an established tolerance the test results are considered valid.⁵¹

All evidentiary breath testing machines are controlled by a microprocessor.⁵² The Draeger Alcotest 7110 employs a Motorola microprocessor,⁵³ and the computer program that directs the microprocessor consists of approximately 60,000 lines of instructions written in "C" computer language.⁵⁴ Utilizing an internal clock circuit that directs the machine to take measurements 120 times a second, the machine reads the sensor that measures the amount of light transmitted through a chamber of air containing the subject's breath.⁵⁵ The changes in the measurements of the infrared detector are monitored according to formulas contained in the computer programs. When the supply of breath is complete, the computer directs a fuel cell cuvette to draw in breath from the chamber,⁵⁶ and the computer then monitors the flow of electricity from the fuel cell.⁵⁷

49. See Girard, *supra*, note 46 at 317-318.

50. 501 MASS. CODE REGS. 2.56 (2008). The requirement of agreement within .02 is provided in the Code of Massachusetts Regulations. The software in the Draeger 7110 accepts two results that differ by as much as .029, a defect in the algorithms in the Source Code.

51. *Id.* The solution must be read as a .14, .15 or .16 %. *Id.* at 2.56(6)(b).

52. DONALD L. PAVIA, ET AL., INTRODUCTION TO ORGANIC LABORATORY TECHNIQUES: A SMALL SCALE APPROACH 244 (Thomson Brooks/Cole 2004).

53. The 68HC10 microprocessor used in the Draeger Alcotest 7110 is approximately 25 years old, and is used in many dedicated systems with low computational requirements, such as controlling gasoline pumps. See *New Jersey v. Chun*, No. 58,879, 198 n.52 (February 13, 2007), archived at <http://www.webcitation.org/5YEsnhzqe>.

54. The source code for the Draeger Alcotest 7110 MK III was evaluated in *New Jersey v. Chun* and as a result, the general size of the Massachusetts Source Code, as well as the language of the Massachusetts Source Code can be reasonably predicted. See *New Jersey v. Chun*, No. 58,879, 202 (February 13, 2007), archived at <http://www.webcitation.org/5YEsnhzqe>.

55. See *N.J. v. Foley*, 851 A.2d at 126-127.

56. The "cuvette" is a small syringe like plunger that draws in air from the chamber, exposing that breath to the fuel cell, and thereby permitting the breath to react with the fuel cell, thereby producing an electrical current that is thereafter

X. Defining the Relevant Scientific Community

In *Lanigan*,⁵⁸ the Massachusetts Supreme Judicial Court wrestled with an issue involving DNA technology. DNA technology had reached a level of reliability that would assist the trier of fact, but which had not matured from a perspective of peer review and publications. Such is not the case with technologies used in the breath testing process. The fields of science are summarized below.

- The principles of evaporation and equilibrium are studied by physicists and chemists, and are established.
- The electronics principles underpinning breath test machines are established with components that may be difficult to obtain because they are sometimes considered obsolete. Electrical Engineers have studied and designed electronic systems for many years.
- The principles of infrared spectroscopy matured in the 1950s and 1960s with very little published literature in the past fifty years. This science deals with the fields of quantum mechanics (electrical engineers study the electrical properties of how molecules behave) and chemistry.
- The principles of fuel cells are mature and have been studied by electrical engineers for many years. Fuel cells are basically batteries for which electrolyte material is supplied as the test material and the electrochemical reaction produces a current to be measured.
- The principles of software, which control the sequencing of a breath test machine, as well as the taking of measurements and combination of data according to the algorithms implemented in the software, are studied and

measured by the machine, and that measurement is “read” by the software.

57. See *N.J. v. Foley*, 851 A.2d at 126-127.

58. The SJC held in *Lanigan*: “We accept the basic reasoning of the *Daubert* opinion because it is consistent with our test of demonstrated reliability. We suspect that general acceptance in the relevant scientific community will continue to be the significant, and often the only, issue. We accept the idea, however, that a proponent of scientific opinion evidence may demonstrate the reliability or validity of the underlying scientific theory or process by some other means, that is, without establishing general acceptance. This consideration has some application to the issue in the case before us, but the parties' significant arguments bear on the acceptability of the ceiling principle by the relevant scientific community.” *Mass. v. Lanigan*, 419 Mass 15, 26 (1989).

understood by those in the field of computer science. The construction and testing of the software can be studied to determine the reliability of the machine controlled by the software.

XI. How Computer Science Relates

Computer Scientists study the behavior of software by evaluating the results of breath test machines that manipulate information and by studying the source code that represents the program that control the computers.

The results of the software's execution include all of the information computed by the machine. Some portion of that information is recorded on paper, and some of the information is recorded in the machine. The information recorded in the machine is often referred to as the "vital" data for the testing process. That vital data is electronically transmitted to a centralized computer that is usually located at the jurisdiction's agency headquarters.

Centrally managed data is generically referred to as the "COBRA" data, named after the application program sold by CMI which collects and manages data for breath tests performed by Intoxilyzer models built and sold by CMI.⁵⁹ Massachusetts collects data on each breath test performed in the state.⁶⁰

The author requested an electronic copy of the Massachusetts Office of Alcohol Testing (OAT) data for breath testing, but OAT referred the request to their legal department, and no response was available at the time that this paper was written. Consequently, the author utilized Florida's published data for the graphs included in this paper.

XII. Evaluation of the Source Code

The software is represented by the source code, which is all of the materials required to create the machine code. The machine code is delivered in the EPROMS⁶¹ contained in the breath testing machine. The "machine code" is the form of the software that represents the

59. The Intoxilyzer 5000 used in Massachusetts utilized the COBRA application. See Intoxilyzer 5000 Brochure, *supra*, note 10.

60. According to information obtained from a Freedom of Information Act request, which provided the specifications and bids from Draeger for the systems purchased by the Commonwealth (on file with author).

61. Erasable Programmable Read Only Memory

commands and data needed by the microprocessor to carry out the steps defined by the source code.

If they are operating correctly, computers will execute the instructions contained in the software the same way each time the program encounters the same stimulus. The manuals for the administration of Field Sobriety Tests are discoverable in order to determine what the police officer was supposed to do in instructing the citizen. The source code for the machine is analogous to these manuals in the manner in which the machine is instructed to carry out the breath test.

Manufacturers have resisted turning over the source code for their machines, and prosecutors have acted as their first defense. Some prosecutors fear that the machines do not work, and do not want to permit the disqualification of the machines. The prosecutors argue that they do not have the source code and thus do not have to provide it. The companies claim that the source code is a trade secret and cannot be disclosed.

XIII. State Possession of the Source Code

In many states where access to the source code has been litigated, for example in Minnesota and Arizona, state procurement organizations negotiated contractual provisions which transferred all intellectual property rights in the source code from the manufacturer to the state.⁶² This kind of provision is important because for a given machine the software that enables the machine to function is available exclusively from the manufacturer. Should that manufacturer refuse to provide further upgrades to the source code, or should they stop doing business, or shut down the business unit that manufactures the machines purchased by the state, the state would be unable to implement required modifications to comply with statutory changes.

Such cessation of support has already been observed in the arena of spare parts for some older breath test machines. Police officers reportedly scour pawn shops to purchase specific models of Video Cassette Recorders (VCR).⁶³ The VCR motors are removed and placed in breath test machines as replacements.⁶⁴

62. *Minn. v. CMI*, 08-CV-603 (D. Minn. March 3, 2007); Contract to Purchase Intoxilyzer 8000, Arizona Dept. of Public Safety, § 3.8 Ownership of Intellectual Property Rights (Sept. 10, 2004) (on file with author).

63. Interview with Jan Semenoff, Industrial Training and Design, Ltd. (on file with author).

64. *Id.*

XIV. Trade Secret Claims

Manufacturers often claim that the source code is a trade secret, and cannot be disclosed. Massachusetts is one of a handful of states whose trade secret law is not based on the Uniform Trade Secret Act (UTSA).⁶⁵ Forty-four states, and the District of Columbia,⁶⁶ model their statutes after the UTSA.⁶⁷ Four states base their trade secret law on the common law.⁶⁸ Alabama's trade secret law is loosely modeled on the UTSA, but has differences.⁶⁹ The remaining state, Massachusetts, protects trade secrets through statutes that are based neither on common law, nor on the UTSA.⁷⁰

65. MASS. GEN. LAWS ch. 266, §30; The American Bar Association has published a treatise with two supplements for 1999 and 2007. These volumes cover the development of trade secret law in each of the fifty states, with citations to caselaw and relevant scholarly works. ARNOLD H. PEDOWITZ, ROBERT W. SIKKEL, ROBERT A. DUBAULT, BRIAN M. MALSBERGER, TRADE SECRETS: A STATE-BY-STATE SURVEY (BNA Books 2006).

66. These forty-four states (and the District of Columbia) are: ALASKA STAT. §§ 45.50.910 to 45.50.945 (1988); A.R.S. §§ 44-401 to 44-407 (1990); ARK. CODE ANN. §§ 4-75-601 to 4-75-607 (1981); CAL CIV CODE §§ 3426.10 to 3426.11 (1985); COL. REV. STAT. ANN. §§ 7-74-101 to 7-74-110 (1986); CONN. GEN. STAT. ANN. §§ 35-50 to 35-58 (1983); DEL. CODE ANN. TIT. 6, §§ 2001 to 2009 (1982); D.C. CODE §§ 36-401 to 36-410 (1989); FLA. STAT. §§ 688.001 to 688.009 (1988); GA. CODE ANN. §§ 10-1-760 to 10-1-767 (1990); HAW. REV. STAT. §§ 482B-1 to 482B-9 (1989); IDAHO CODE ANN. §§ 48-801 to 48-807 (1981); 765 ILCS 1065/1 to 1065/9 (1988); Ind. Code §§ 24-2-3-1 to 24-2-3-8 (1982); Iowa Code §§ 550.1 to 550.8 (1990); Kan. Stat. Ann. §§ 60-3320 to 60-3330 (1981); Ky. Rev. Stat. §§ 365.880 to 365.900 (1990); LA. REV. STAT. ANN. §§ 51-1431 to 51-1439 (1981); 10 ME. REV. STAT. ANN. §§ 1541 to 1548 (1987); CODE, COMMERCIAL LAW, §§ 11-1201 to 11-1209 (1989); MICH. COMP. LAWS. ANN. §§ 445.1901 to 445.1910 (1988); MINN. STAT. §§ 325C.01 to 325C.08 (1981); MISS. CODE ANN. §§ 75-26-1 to 75-26-19 (1990); MO. REV. STAT. §§ 417.450 to 417.467 (1995); MONT. CODE ANN. §§ 30-14-401 to 30-14-409 (1985); R.R.S.1943, §§ 87-501 to 87-507; NEV. REV. STAT. §§ 600A.010 to 600A.100 (1987); N.H. REV. STAT. ANN. §§ 350-B:1 to 350-B:9 (1990); N.M. STAT. ANN. §§ 57-3A-1 to 57-3A-7 (1989); N.D. CENT. CODE §§ 47-25.1-01 to 47-25.1-08 (1983); OHIO REV. CODE ANN. §§ 1333.61 to 1333.69 (1994); OKL. ST. ANN. tit. 78 §§ 85 to 94 (1986); OR. REV. STAT. §§ 646.461 to 646.475 (1986); 12 PA. CONS. STAT. ANN. §§ 5301 to 5308; R.I. GEN. LAWS §§ 6-41-1 to 6-41-11 (1986); S.C. CODE ANN. §§ 39-8-10 to 39-8-130 (1992); S.D. CODIFIED LAWS §§ 37-29-1 to 37-29-11 (1988); TENN. CODE ANN. §§ 47-25-1701 to 47-25-1709; UTAH CODE ANN. §§ 13-24-1 to 13-24-9 (1989); VT. STAT. ANN. tit. 9 §§ 4601 to 4609 (1996), 12 VT. STAT. ANN. § 523; Code 1950, §§ 59.1-336 to 59.1-343; WASH. REV. CODE §§ 19.108. to 19.108.940 (1982); W. VA. CODE, §§ 47-22-1 to 47-22-10 (1986); Wis. STAT. § 134.90 (1986).

67. Unif. Trade Secrets Act §§ 1-11 (amended 1985), *archived at* <http://www.webcitation.org/5YF3PQNAX>.

68. New Jersey, New York, Texas, and Wyoming.

69. See ALA. CODE §8-27-1.

70. MASS. GEN. LAWS ch. 266, §30 (the criminal statute protects a trade secret from appropriation); *Id.* at §60A (forbids the purchase or receipt of stolen trade secrets).

Because Massachusetts trade secret law is radically different from the law in the other forty-nine states, care must be taken when adopting decisions concerning trade secrets based on the case law of other states. Those court decisions are interpreting jurisprudence that is very different from that of Massachusetts.

In evaluating a trade secret in Massachusetts, the SJC in *USM Corp. v. Marson Fastener Corp.* stated:

“There are numerous factors to be considered in determining whether an alleged trade secret will be protected. Such factors include:

(a)The expenditure of money, time, and labor in developing the trade secrets;

(b)The **novelty of the secret**;

(c)The question **whether the secret is in fact a secret**;

(d)The **conscious and continuing effort by the proprietor to maintain secrecy**, including the prevention of unauthorized disclosure by employees;

(e)The value of the secret to the proprietor’s business;

(f)The **extent to which the trade secret may be isolated by analysis** and known procedures; and

(g)The relationship between the parties having knowledge of the secret.”⁷¹

To determine whether a source code is a trade secret and may therefore not be disclosed, a Massachusetts Court must evaluate the USM factors. The “novelty” of the source code can be met because the source code only works in the machine for which it is written. Although the software from an Intoxilyzer 8000 cannot be loaded into the Draeger Alcotest, the novelty examination should go beyond the fact that the software is only useful on one hardware platform.⁷² The appropriate

71. *USM Corp. v. Marson Fastener Corp.*, 393 N.E.2d 895, 900 n.9 (Mass. 1979) (citing A.H. SIEDEL & R.L. PANITCH, WHAT THE GENERAL PRACTITIONER SHOULD KNOW ABOUT TRADE SECRETS AND EMPLOYMENT AGREEMENTS 12 (1973) (formatting and emphasis added).

72. The Draeger machine uses a Motorola 68HC11 microprocessor, and the Intoxilyzer uses an Intel based microprocessor. See *New Jersey v. Chun*, No. 58,879, 198 n.52 (February 13, 2007), archived at <http://www.webcitation.org/5YEshzqe>; Brochure for Intoxilyzer 8000, archived at <http://www.webcitation.org/5YF5dv7tF>.

inquiry is to the issue of what algorithms or techniques are unique, and if unique designs exist. How can a court accept evidence in a criminal matter that is based on techniques which are secret, not reviewed for validity, and which, in fact may be scientifically unreliable?

In considering whether the alleged trade secret is in fact a secret, a threshold inquiry into what the secrets are and the level at which they operate, not how they operate, is appropriate.⁷³ If nothing can be identified by the corporation, then no true secrets exist. Further, the software exists in the form of “machine code” within each machine in use in the state.⁷⁴ This “machine code” is in the “possession and control” of the Commonwealth.⁷⁵ When a citizen, who had no prior secrecy arrangements with the manufacturer of the breath testing machine, observes their own breath test, they observe a process that is represented by the contents of the source code. Additionally, the possession of a single unit of the machine, by a third party, destroys any claims to secrecy in the software.⁷⁶ Without any restrictions, the author has viewed and used a Draeger Alcotest 7110 MK-III C breath test machine, which was not in the possession of any governmental agency.

The requirement that the proprietor maintain secrecy is essential to preserving any trade secrets.⁷⁷ In one sense, the disclosure of the secret results in the destruction of the secret. When the source code as an entity is claimed to be secret, at least one person has seen portions of the Draeger Alcotest 7110 MK-III C source code.⁷⁸

The requirement that the secret be capable of isolation from the larger body of work has traditionally not been required when other states have considered the appropriate manner of evaluating the alleged trade secrets of various manufacturers.⁷⁹

73. See generally, *USM Corp. v. Marson Fastner Corp.*, 393 N.E.2d 895 (Mass. 1979).

74. See Wikipedia, “Machine Code”, archived at <http://www.webcitation.org/5YFgyRfO1>.

75. See *USM Corp. v. Marson Fastener Corp.*, 393 N.E.2d 895, 900 n.9 (Mass. 1979).

76. *Id.*

77. *Id.*

78. During the remand hearings in *State v. Chun*, the New Jersey hearings to evaluate the source code of the Draeger Alcotest 7110 MK-III C, the author was permitted to stand behind defense expert John Wisniewski, and view portions of the source code on the laptop screen of the witness. This viewing of portions of the source code was accomplished without any restrictions placed on the author by the Court or by Draeger. As to the destruction of the secret by disclosure without limitations, that destruction as to the Draeger source code has occurred.

79. See generally BRIAN M. MALSBERG, ET AL., *TRADE SECRETS: A STATE-BY-STATE SURVEY* (BNA Books 2005) (2003).

Finally, if the manufacturer has obtained patent protection for any portion of their invention that is represented by the software, that manufacturer has an affirmative obligation to disclose that source code, so that a person having “ordinary skill in the art” could replicate the patented invention upon expiration of the US patent.⁸⁰

The interplay between federal patent law and state trade secret law was evident in the “Prefatory Note” to the Uniform Trade Secret Act of 1985, which stated:

“A valid patent provides a legal monopoly for seventeen years in exchange for public disclosure of an invention. If, however, the courts ultimately decide that the Patent Office improperly issued a patent, an invention will have been disclosed to competitors with no corresponding benefit. In view of the substantial number of patents that are invalidated by the courts, many businesses now elect to protect commercially valuable information through reliance upon the state law of trade secret protection. *Kewanee Oil Co. v. Bicron Corp.*, 416 U.S. 470 (1974), which establishes that neither the Patent Clause of the United States Constitution nor the federal patent laws pre-empt state trade secret protection for patentable or unpatentable information, may well have increased the extent of this reliance.” Prefatory Note to the UTSA, with 1985 amendments.⁸¹

The “quid pro quo” of the patent system provides a monopoly for the owner of any intellectual property, but requires full disclosure so that the body of science is enriched upon expiration of the limited term of the monopoly.⁸²

XV. Recent Court Decisions Concerning “Source Code”

The source code is the manifestation of the software most suited to review and inspection. While it is theoretically possible to reverse engineer something that resembles source code, a reverse engineered product is devoid of context and commentary that relates to why actions

80. 35 U.S.C. § 112(1) “The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.”

81. Unif. Trade Secrets Act, *supra* note 67.

82. See *Brenner v. Manson*, 383 U.S. 519, 534-35 (1966).

are being performed. Many states have not only recognized the relevance of the source code, but have also held that under due process and confrontation constitutional principles, the source code of a machine that is used to produce evidence against a citizen must be produced.⁸³

XVI. New Jersey Litigation Concerning “Source Code”

In New Jersey, following a forty-one day *Daubert* evidentiary hearing on matters consolidated, for which prosecutions were stayed pending an evaluation of the Draeger Alcotest,⁸⁴ Special Master Patrick King reported to the New Jersey Supreme Court:

We do not think that this dispute about the source codes has any substantial relevance to our ultimate conclusion, that the Alcotest 7110 instrument is very good at measuring breath alcohol.⁸⁵

The New Jersey Supreme Court adopted virtually all of Judge King’s findings, except one; the Justices believed that the source code for the Draeger Alcotest was highly relevant, so much so that the Court remanded the matter back to Judge King for further actions consistent with their opinion.⁸⁶

The Court initially ordered the state and Defendants identify a single business to analyze the source code and report their findings to the Court.⁸⁷ Ultimately, the parties were not able to agree on a single company, and the Court issued a supplemental order.⁸⁸ The state retained Systest, the company that reviewed the Diebold voting machines in Colorado, and the Defendants hired BaseOne, a company that does software work for government and industry.⁸⁹ Evidentiary hearings were held in Trenton over a four week period, culminating in a second Special Master Report, supplemental briefs, and oral arguments

83. *But see In re Comm’r of Pub. Safety*, 735 N.W.2d 706, 709 (Minn. 2007).

84. *N.J. v. Chun*, AM53-153-05T5, N.J. Super. Ct. App. Div., Order to Stay pending OUI Cases, and to Order Daubert Hearing (December 1, 2005).

85. *See See New Jersey v. Chun*, No. 58,879, 45 (February 13, 2007), *archived at* <http://www.webcitation.org/5YEsnhzqe>.

86. *N.J. v. Chun*, No. 58,879, N.J. Sup. Ct., Remand Order for the Examination of the Draeger Alcotest 7110 Source Code (April 30, 2007), *archived at* <http://www.webcitation.org/5YFidvJzx>.

87. *Id.*

88. *N.J. v. Chun*, 58,879, N.J. Sup. Ct., Supplemental Order Setting Forth Source Code Examination Procedure (May 22, 2007).

89. *N.J. v. Chun*, 58,879, Supplemental Findings and Conclusions of Remand Court (Nov. 8, 2007), *archived at* <http://www.webcitation.org/5YFjJ6KVP>.

before the New Jersey Supreme Court on January 7, 2008. The New Jersey Supreme Court handed down their decision on March 17, 2008, finding "... the Alcotest, utilizing New Jersey Firmware version 3.11, is generally scientifically reliable, but that certain modifications are required in order to permit its results to be admissible or to allow it to be utilized to prove a per se violation of the statute."⁹⁰

XVII. Litigation in Other States Concerning "Source Code"

In Florida, the Court ordered CMI to produce the source code for the Intoxilyzer 8000.⁹¹ CMI refused, and petitioned a Kentucky Court to quash the Florida subpoena for the source code.⁹² The Kentucky Court issued an opinion that quashed the Florida subpoena.⁹³ The Florida Court entered an order finding CMI in contempt, and did not recognize the Kentucky court's jurisdiction over a Florida Court's order.⁹⁴ CMI has contested the finding of Contempt, and has posted a bond.⁹⁵

In Minnesota, the state falsely represented that they were not obligated to produce the source code because they did not have custody of the source code.⁹⁶ A freedom of information request for the procurement documents disclosed that the state had contracted for all intellectual property rights pertaining to the source code.⁹⁷ The Minnesota courts, once informed of this provision of the state's contract, ordered the production of the source code to defendant's counsel.⁹⁸

In Arizona, a Tucson trial court, on behalf of thirty one consolidated cases, following an evidentiary hearing, ordered CMI to produce the source code for the Intoxilyzer 8000 used in Arizona.⁹⁹ CMI has yet to comply.

90. N.J. v. Chun, 943 A.2d 114, 120 (2008).

91. Fla. v. Fabian, Case No. 2006 CT 9733, Order on State's Motion to Strike, Defendants' Motion to Consolidate, and Defendants' Motion in Limine (March 2, 2007), *archived at* <http://www.webcitation.org/5YFlna1Jh>.

92. Fla. v. Fabian, Case No. 2006 CT 9733, Order of Civil Contempt (Aug. 13, 2007), *archived at* <http://www.webcitation.org/5YFm4SsBD>.

93. *Id.*

94. *Id.*

95. CMI, Inc. v. Fabian, Appeal to Circuit Court of the Twelfth Judicial Circuit (March 31, 2008), *archived at* <http://www.webcitation.org/5YFmmZeHt>.

96. Underdahl v. Comm. of Pub. Safety, 735 N.W.2d 706 (July 26, 2007).

97. *Id.*

98. *Id.*

99. Arizona v. Bennett, CR 7069897, Tucson City Court, (Nov. 16, 2007).

In Louisiana, CMI was ordered to produce the source code.¹⁰⁰ CMI was ordered by a Federal Court in the District of Columbia to produce the source code.¹⁰¹

Finally, in Kentucky, CMI's home state, an appeals court ruled that CMI must produce their source code.¹⁰²

XVIII. Conclusion

Machines like the Draeger Alcotest 7110 MK III-C are computer systems that manage sensors and output systems, and include systems designed to collect and store data on tests performed. These systems can be analyzed and their reliability assessed using traditional engineering and computer science techniques. The most logical first step in this process is an analysis of data collected on the machines.

The data for all machines of the same design define the norms for the collection and can then identify machines which are not performing to those norms. Impossible conditions, or those which should not occur, can often be identified and are indicative of either design defects or of machines that are not working to specification. In both cases, the reliability of any measured results are called into question.

Many states have tried to argue that because they have no computer science expertise, such expertise must be considered irrelevant to the issues surrounding the science of the machines that test human breath. Most Courts have rejected this logic, and cite the constitutional principles of due process and confrontation in ordering the production of the source code.¹⁰³ They recognize that these machines often produce the only evidence available to the state in a DUI criminal case. Ironically, when the evidence sought is the ultimate authoritative material concerning how breath was tested for alcohol, a civil litigant has a greater access to evidence than many DUI defendants have experienced.

100. *La. v. Bates*, 0715472, 11th Judicial District, DeSoto Parish, (Nov. 28, 2008).

101. *D.C. v. Rucker*, 2007-CTF-8161, (Oct. 4, 2007).

102. *House v. Ky.*, 2007-CA-000417-DG, 2008 WL 162212, (January 18, 2008).

103. *See N.J. v. Chun*, 943 A.2d 114 (2008).