

Westlaw

943 A.2d 114
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H
State v. Chun
 N.J., 2008.

Supreme Court of New Jersey.
STATE of New Jersey, Plaintiff-Appellant,
 v.

Jane H. **CHUN**, Daria L. De Cicco, James R. Hausler, Angel Miralda, Jeffrey R. Wood, Anthony Anzano, Raj Desai, Peter Lieberwirth, Jeffrey Ling, Hussain Nawaz, Frederick Ogbutor, Peter Piasecki, Lara Slater, Christopher Salkowitz, Elina Tirado, David Walker, David Whitman and Jairo J. Yataco, Defendants-Respondents, and Mehmet Demirelli and Jeffrey Locastro, Defendant, and Draeger Safety Diagnostics, Inc., Intervenor.

Argued April 5, 2007.
 Remanded April 30, 2007.
 Master's Report filed Nov. 8, 2007.
 Re-argued Jan. 7, 2008.
 Decided March 17, 2008.

Background: Defendants who were charged with driving while intoxicated (DWI) challenged the admissibility of results from breath testing device. The Superior Court, Law Division, Middlesex County, stayed all DWI-related cases involving breath test device. State appealed, and the Appellate Division remanded for a hearing on admissibility. The Supreme Court certified the pending appeal before hearing could proceed, vacated the remand to the trial court, and remanded the case to a Special Master. The Special Master submitted findings and conclusions.

Holdings: The Supreme Court, Hoens, J., held that:

- (1) evidence was sufficient to support findings that blood/breath ratio of 2100 to one for purposes of calculating blood alcohol level continued to be scientifically valid;
- (2) lowering required breath volume for blood alcohol breath testing device from 1.5 liters to 1.2 liters for women over the age of 60 did not violate equal protection;
- (3) evidence was insufficient to support recommendation that breath temperature sensor be incorporated into device;

- (4) use of the absolute 0.01 percent blood alcohol concentration standard, coupled with use of like range of tolerance expressed as percentage deviation from mean, for breath testing device was scientifically appropriate;
- (5) use of a fuel cell drift algorithm did not render device scientifically inaccurate;
- (6) use of a weighted averaging algorithm did not render device scientifically inaccurate; and
- (7) admission of alcohol influence report generated by device did not violate confrontation clause.

Adopted as modified and remanded.

West Headnotes

[1] **Criminal Law 110** ⚡ **388.1**

110 Criminal Law
 110XVII Evidence
 110XVII(I) Competency in General
 110k388 Experiments and Tests; Scientific and Survey Evidence

110k388.1 k. In General. Most Cited Cases
 Admissibility of scientific test results in a criminal trial is permitted only when those tests are shown to be generally accepted, within the relevant scientific community, to be reliable; that is to say, the test must have a sufficient scientific basis to produce uniform and reasonably reliable results and will contribute materially to the ascertainment of the truth.

[2] **Criminal Law 110** ⚡ **388.1**

110 Criminal Law
 110XVII Evidence
 110XVII(I) Competency in General
 110k388 Experiments and Tests; Scientific and Survey Evidence

110k388.1 k. In General. Most Cited Cases
 Proof of general acceptance for purposes of admitting scientific testing evidence does not mean that there must be complete agreement in the scientific community about the techniques, methodology, or procedures that underlie the scientific evidence; even the possibility of error does not mean that a particular scientific

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device falls short of the required showing of general acceptance.

[3] Criminal Law 110 ⚡ 388.1

110 Criminal Law

110XVII Evidence

110XVII(I) Competency in General

110k388 Experiments and Tests; Scientific and Survey Evidence

110k388.1 k. In General. Most Cited Cases

Before the Supreme Court can conclude that scientific test results are admissible in evidence, the proponent of the scientific device must bear its burden to clearly establish that the device or the test meets the standard of general acceptance as the Court has defined it.

[4] Criminal Law 110 ⚡ 1134(3)

110 Criminal Law

110XXIV Review

110XXIV(L) Scope of Review in General

110k1134 Scope and Extent in General

110k1134(3) k. Questions Considered in General. Most Cited Cases

Criminal Law 110 ⚡ 1158(1)

110 Criminal Law

110XXIV Review

110XXIV(O) Questions of Fact and Findings

110k1158 In General

110k1158(1) k. In General. Most Cited Cases

In reviewing the findings and conclusions set forth by the Special Master in his report, the Supreme Court employs its ordinary standards of review, considering them in the same manner as it would the findings and conclusions of a judge sitting as a finder of fact; the Court therefore accepts the fact findings to the extent that they are supported by substantial credible evidence in the record, but it gives no particular deference to the legal conclusions of the Special Master.

[5] Automobiles 48A ⚡ 426

48A Automobiles

48AIX Evidence of Sobriety Tests

48Ak426 k. Procedure; Evidence and Fact Questions. Most Cited Cases

Evidence was sufficient to support Special Master's findings that a blood/breath ratio of 2100 to one for purposes of calculating blood alcohol level using a breath testing device continued to be valid so as to make breath test results scientifically reliable; overwhelming evidence demonstrated that use of the 2100 to one ratio tended to underestimate the actual blood alcohol level in the vast majority of persons whose breath was tested.

[6] Automobiles 48A ⚡ 349(1)

48A Automobiles

48AVII Offenses

48AVII(B) Prosecution

48Ak349 Arrest, Stop, or Inquiry; Bail or Deposit

48Ak349(1) k. In General. Most Cited Cases

Charging an arrestee with refusal to take a breath test for blood alcohol concentration remains largely within the police officer's discretion. N.J.S.A. 39:4-50.4a.

[7] Constitutional Law 92 ⚡ 3030

92 Constitutional Law

92XXVI Equal Protection

92XXVI(A) In General

92XXVI(A)5 Scope of Doctrine in General

92k3030 k. In General. Most Cited Cases

Constitutional Law 92 ⚡ 3039

92 Constitutional Law

92XXVI Equal Protection

92XXVI(A) In General

92XXVI(A)5 Scope of Doctrine in General

92k3038 Discrimination and Classification

92k3039 k. In General. Most Cited Cases

The federal equal protection analysis looks to the characteristics of the impacted protected class or the nature of the right being affected by the government action. U.S.C.A. Const.Amend. 14.

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[8] Constitutional Law 92 🔑3071

92 Constitutional Law
 92XXVI Equal Protection
 92XXVI(A) In General
 92XXVI(A)6 Levels of Scrutiny
 92k3069 Particular Classes
 92k3071 k. Age. Most Cited Cases

The federal test used to evaluate an age-based challenge is concerned with whether the age classification in question is rationally related to a legitimate state interest; the rationality commanded by the Equal Protection Clause does not require States to match age distinctions and the legitimate interests they serve with razor like precision. U.S.C.A. Const.Amend. 14.

[9] Constitutional Law 92 🔑3081

92 Constitutional Law
 92XXVI Equal Protection
 92XXVI(A) In General
 92XXVI(A)6 Levels of Scrutiny
 92k3069 Particular Classes
 92k3081 k. Sex or Gender. Most Cited Cases

If the government distinguishes between males and females, the classification is subject to a heightened scrutiny under the Equal Protection Clause. U.S.C.A. Const.Amend. 14.

[10] Constitutional Law 92 🔑3081

92 Constitutional Law
 92XXVI Equal Protection
 92XXVI(A) In General
 92XXVI(A)6 Levels of Scrutiny
 92k3069 Particular Classes
 92k3081 k. Sex or Gender. Most Cited Cases

For a gender classification to survive heightened scrutiny under the Equal Protection Clause, the government must show at least that the challenged classification serves important governmental objectives and that the discriminatory means employed are substantially related to the achievement of those objectives. U.S.C.A. Const.Amend. 14.

[11] Constitutional Law 92 🔑3006

92 Constitutional Law
 92XXVI Equal Protection
 92XXVI(A) In General
 92XXVI(A)2 Relationship to Similar Provisions
 92k3006 k. Federal/State Cognates. Most Cited Cases

Although conceptually similar, the right of equal protection under the State Constitution can in some situations be broader than the right conferred by the Equal Protection Clause. U.S.C.A. Const.Amend. 14; N.J.S.A. Const. Art. 1, par. 1.

[12] Constitutional Law 92 🔑3058

92 Constitutional Law
 92XXVI Equal Protection
 92XXVI(A) In General
 92XXVI(A)6 Levels of Scrutiny
 92k3052 Rational Basis Standard; Reasonableness
 92k3058 k. Police Power; Public Safety and Welfare. Most Cited Cases

Constitutional Law 92 🔑3902

92 Constitutional Law
 92XXVII Due Process
 92XXVII(B) Protections Provided and Deprivations Prohibited in General
 92k3902 k. Police Power, Relationship to Due Process. Most Cited Cases
 The constitutional principles of due process and equal protection demand that the exercise of police power be devoid of unreason and arbitrariness, and the means selected for the fulfillment of the policy bear a real and substantial relation to that end. N.J.S.A. Const. Art. 1, par. 1.

[13] Constitutional Law 92 🔑3081

92 Constitutional Law
 92XXVI Equal Protection
 92XXVI(A) In General
 92XXVI(A)6 Levels of Scrutiny

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92k3069 Particular Classes

92k3081 k. Sex or Gender. Most Cited

Cases

The right to equal protection does not require a court to scrutinize gender distinctions that are based on real physiological differences to the same extent it would scrutinize those distinctions when they are based on archaic, invidious stereotypes about men and women. U.S.C.A. Const.Amend. 14; N.J.S.A. Const. Art. 1, par. 1.

[14] Automobiles 48A ⚡324

48A Automobiles

48AVII Offenses

48AVII(A) In General

48Ak324 k. Offenses in General. Most Cited

Cases

Automobiles 48A ⚡422.1

48A Automobiles

48AIX Evidence of Sobriety Tests

48Ak422 Conduct and Proof of Test; Foundation or Predicate

48Ak422.1 k. In General. Most Cited Cases

Constitutional Law 92 ⚡3102

92 Constitutional Law

92XXVI Equal Protection

92XXVI(B) Particular Classes

92XXVI(B)1 Age

92k3102 k. Motor Vehicles. Most Cited

Cases

Constitutional Law 92 ⚡3407

92 Constitutional Law

92XXVI Equal Protection

92XXVI(B) Particular Classes

92XXVI(B)11 Sex or Gender

92k3407 k. Motor Vehicles. Most Cited

Cases

Lowering the required breath volume for blood alcohol breath testing device from 1.5 liters to 1.2 liters for women over the age of 60 did not violate equal protection

by either allowing women over the age of 60, who were capable of producing a greater volume of air, to provide a shallower sample with a lower blood alcohol reading or by allowing drivers under the age of 60 to be charged with refusal when they failed to provide a sample with a volume of 1.5 liters; regardless of the breath volume, the testing device would not accept a sample that failed to reach a plateau, and medical evidence indicated that it was only women over the age of 60 who were incapable of providing a sample with a volume of 1.5. U.S.C.A. Const.Amend. 14; N.J.S.A. Const. Art. 1, par. 1.

[15] Automobiles 48A ⚡355(1)

48A Automobiles

48AVII Offenses

48AVII(B) Prosecution

48Ak355 Weight and Sufficiency of Evidence

48Ak355(1) k. In General. Most Cited Cases

Automobiles 48A ⚡411

48A Automobiles

48AIX Evidence of Sobriety Tests

48Ak411 k. In General. Most Cited Cases

Automobiles 48A ⚡413

48A Automobiles

48AIX Evidence of Sobriety Tests

48Ak413 k. Refusal of Test, Admissibility. Most Cited Cases

In driving while intoxicated prosecutions based on breath test readings made prior to the Supreme Court's directive allowing for the minimum sample air volume for women over the age of 60 to be lowered to 1.2 liters, a test reading that demonstrated insufficient breath volume for a woman over age 60 could not be used as proof on a charge of refusal; however, if the test demonstrates that a woman over the age of 60 was able to provide at least one sample that was deemed to be sufficient for purposes of the 1.5 liter volume requirement, but she failed to do so on a subsequent attempt, the test demonstrating those facts could be utilized as evidence,

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albeit not conclusive proof, in support of a refusal charge. N.J.S.A. 39:4-50.4a.

[16] Automobiles 48A ⚡411

48A Automobiles

48AIX Evidence of Sobriety Tests

48Ak411 k. In General. Most Cited Cases

Evidence was insufficient to support Special Master's recommendation that a breath temperature sensor be incorporated into breath testing device for blood alcohol concentration; the generally accepted average temperature for human breath was 34 degrees Celsius, which was the temperature the breath analyzer assumed to be for the samples collected, the device incorporated two methods that accounted for any possible overestimation of blood alcohol concentration due to elevated breath temperature, and requiring the addition of a temperature sensor would result in an unreasonable maintenance burden.

[17] Automobiles 48A ⚡411

48A Automobiles

48AIX Evidence of Sobriety Tests

48Ak411 k. In General. Most Cited Cases

Continued use of the absolute 0.01 percent blood alcohol concentration (BAC) standard, coupled with the use of a like range of tolerance expressed as a percentage deviation from the mean, for breath testing device was both scientifically appropriate and consistent with the intention of the Legislature in adopting per se blood alcohol concentration limits for driving while intoxicated.

[18] Automobiles 48A ⚡411

48A Automobiles

48AIX Evidence of Sobriety Tests

48Ak411 k. In General. Most Cited Cases

In driving while intoxicated prosecutions based on breath test readings made prior to the Supreme Court's directive regarding breath test tolerance limits, breath samples that were obtained using a doubled tolerance range must be reviewed to determine whether the results meet the tolerance range of an absolute 0.01 percent blood alcohol concentration standard; any test results

that do not meet the accepted tolerance standard cannot be deemed to be sufficiently scientifically reliable to be admissible.

[19] Automobiles 48A ⚡411

48A Automobiles

48AIX Evidence of Sobriety Tests

48Ak411 k. In General. Most Cited Cases

Use of a fuel cell drift algorithm in breath testing device used to determine blood alcohol concentration, which algorithm compensated for aging fuel cell, did not render device scientifically inaccurate.

[20] Automobiles 48A ⚡411

48A Automobiles

48AIX Evidence of Sobriety Tests

48Ak411 k. In General. Most Cited Cases

Use of a weighted averaging algorithm in breath testing device used to determine blood alcohol concentration (BAC), which algorithm placed proportionately greater weight on the later measurements from the breath sample than on the earlier ones, did not render device scientifically inaccurate; the algorithm gave greater weight to breath that, inevitably, included the deepest air drawn from the lungs, and thus, it focused the analysis on the portion of breath sample that most accurately represented the subject's BAC.

[21] Automobiles 48A ⚡411

48A Automobiles

48AIX Evidence of Sobriety Tests

48Ak411 k. In General. Most Cited Cases

Each alcohol influence report generated by breath test device used to calculate blood alcohol concentration (BAC) that included three breath tests was admissible as evidence of an accurate BAC reading despite the buffer overflow error that could occur during testing, which error resulted in the device overlooking one test result, so long as formula was applied to ensure the correct calculation of the lowest possible result and reading.

[22] Automobiles 48A ⚡411

48A Automobiles

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48AIX Evidence of Sobriety Tests

48Ak411 k. In General. Most Cited Cases

Although catastrophic error detection device should not have been disabled on breath test device for calculating blood alcohol concentration, the absence of the error detection device was incapable of producing inaccurate alcohol influence reports by breath test device; expert testified that catastrophic error would likely cause testing device to enter an endless loop of non-productive analysis and become unresponsive.

[23] Automobiles 48A 411

48A Automobiles

48AIX Evidence of Sobriety Tests

48Ak411 k. In General. Most Cited Cases

Firmware used to operate breath test device for blood alcohol concentration was required to be locked so that only the manufacturer could make changes to it.

[24] Automobiles 48A 411

48A Automobiles

48AIX Evidence of Sobriety Tests

48Ak411 k. In General. Most Cited Cases

Breath test device for calculating blood alcohol concentration was required to be programmed so that all future alcohol influence report printouts contained the firmware version being utilized by the device.

[25] Automobiles 48A 411

48A Automobiles

48AIX Evidence of Sobriety Tests

48Ak411 k. In General. Most Cited Cases

State was required to provide public with notice regarding changes to firmware that operated breath test device for calculating blood alcohol concentration; the notice must be sufficiently specific to identify the proposed changes to the firmware.

[26] Automobiles 48A 411

48A Automobiles

48AIX Evidence of Sobriety Tests

48Ak411 k. In General. Most Cited Cases

Manufacturer of breath test device for calculating blood

alcohol concentration was required to make training, substantially similar to that provided to breath test device operators and coordinators, available to licensed New Jersey attorneys and their designated experts to enable them to better prepare to represent their clients.

[27] Automobiles 48A 423

48A Automobiles

48AIX Evidence of Sobriety Tests

48Ak422 Conduct and Proof of Test; Foundation or Predicate

48Ak423 k. Competency of Technician. Most Cited Cases

Criminal Law 110 662.40

110 Criminal Law

110XX Trial

110XX(C) Reception of Evidence

110k662 Right of Accused to Confront Witnesses

110k662.40 k. Use of Documentary Evidence. Most Cited Cases

Admission into evidence in trial on charges of driving while intoxicated of credentials of operator of breath test device used to calculate blood alcohol concentration did not violate confrontation clause; apart from the fact that these documents fell squarely within the traditional business records exception, they were not testimonial because they neither established an element of the offense charged nor demonstrated the truth of any fact in issue. U.S.C.A. Const.Amend. 6; N.J.S.A. 2A:84A, App. A, Rules of Evid., N.J.R.E. 803(c)(6).

[28] Automobiles 48A 424

48A Automobiles

48AIX Evidence of Sobriety Tests

48Ak422 Conduct and Proof of Test; Foundation or Predicate

48Ak424 k. Reliability of Particular Testing Devices. Most Cited Cases

Criminal Law 110 662.40

110 Criminal Law

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110XX Trial

110XX(C) Reception of Evidence

110k662 Right of Accused to Confront Witnesses

110k662.40 k. Use of Documentary Evidence. Most Cited Cases

Foundational documents, relating to the good working order of the breath test device for calculating blood alcohol concentration, were not testimonial, and thus, admission of documents did not violate confrontation clause; although some of the documents were generated by police, none of them related to or reported a past fact and none of them were generated or prepared in order to establish any fact that was an element of offense of driving while intoxicated. U.S.C.A. Const.Amend. 6.

[29] Automobiles 48A ⚡422.1

48A Automobiles

48AIX Evidence of Sobriety Tests

48Ak422 Conduct and Proof of Test; Foundation or Predicate

48Ak422.1 k. In General. Most Cited Cases

Criminal Law 110 ⚡662.40

110 Criminal Law

110XX Trial

110XX(C) Reception of Evidence

110k662 Right of Accused to Confront Witnesses

110k662.40 k. Use of Documentary Evidence. Most Cited Cases

Alcohol influence report (AIR) generated by breath test device used to calculate blood alcohol concentration (BAC) did not constitute testimonial evidence, and thus, admission of report did not violate confrontation clause; the AIR reports a present, and not a past, piece of information, although given in the presence of a police officer who operates the device, nothing the operator does could influence the AIR, and while the officer may have a purpose of establishing evidence of a BAC in excess of the permissible limit, the device had no such intent and could just as likely exonerate a test subject. U.S.C.A. Const.Amend. 6.

*118 Boris Moczula, Assistant Attorney General, argued the cause for appellant (Anne Milgram, Attorney General of New Jersey, attorney; Mr. Moczula, Jessica S. Oppenheim, Assistant Attorney General, Christine A. Hoffman and John J. Dell'Aquilo, Jr., Deputy Attorneys General, of counsel; Mr. Moczula, Ms. Oppenheim, Ms. Hoffman, Mr. Dell'Aquilo, Stephen H. Monson and Robert T. Lougy, Deputy Attorneys General, on the briefs).

Jeffrey Schreiber argued the cause for intervenor (Meister Seelig & Fein, attorneys; Mr. Schreiber and Adena S. Edwards, on the briefs).

Matthew W. Reisig, Freehold, Samuel Louis Sachs, East Windsor, Evan M. Levow, Cherry Hill and John Menzel, Point Pleasant, argued the cause for respondents (Mr. Reisig, attorney for Raj Desai, Peter Lieberwirth, Peter Piasecki and Christopher Salkowitz; Mr. Sachs, attorney for James R. Hausler and Jeffrey R. Wood; Levow and Associates and Andrew S. Maze, attorneys for Jane H. Chun; Levow and Associates, attorneys for Angel Miralda, Frederick Ogbutor, Lara Slater and Elina Tirado; Mr. Menzel, attorney for Anthony Anzano, Jeffrey Ling, Hussain Nawaz, David Walker and David Whitman; Garces & Grabler, attorneys for Angel Miralda and Jairo J. Yataco; Bartholomew Baffuto, attorney for Daria L. DeCicco; Mr. Reisig, Mr. Sachs, Mr. Levow, Mr. Menzel, Mr. Baffuto, Jonathan A. Kessous, and Christopher G. Hewitt, on the briefs).

*119 Peter H. Lederman argued the cause for amicus curiae Association of Criminal Defense Lawyers of New Jersey (Lomurro, Davison, Eastman & Munoz, attorneys; Mr. Lederman and Andrew T. McDonald, Freehold, on the brief).

Jeffrey Evan Gold, Cherry Hill, argued the cause for amicus curiae New Jersey State Bar Association (Lynn Fontaine Newsome, President, attorney; Ms. Newsome, Mr. Gold, Wayne J. Positan, Former President and Arnold N. Fishman, on the briefs).

Justice HOENS delivered the opinion of the Court.

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*120 INTRODUCTION

*64 For decades, this Court has recognized that certain breath testing devices, commonly known as breathalyzers, are scientifically reliable and accurate instruments for determining blood alcohol concentration (BAC) FN1 and that drivers whose breathalyzer test results demonstrate the requisite statutorily-imposed BAC are guilty per se of driving while intoxicated (DWI). Although the Legislature has from time to time reduced the permissible BAC limits and has altered the penalties for this offense, and although we have required foundational proofs relating to the operation of the breathalyzer device as a precondition for admission of the breathalyzer test results into evidence, the accuracy and reliability of the breathalyzer itself has remained essentially unquestioned since our decision in *Romano v. Kimmelman*, 96 N.J. 66, 474 A.2d 1 (1984).

FN1. Although the statute fixes limits in terms of BAC, violations of the statute have been proven routinely through analysis of breath and a conversion of breath alcohol concentration (BrAC) into a BAC reading. See Sections III.A. and VIII.A., *infra*.

Nevertheless, in the intervening years, the devices have

become technologically outdated, with the result that replacement parts are no longer available and the machines themselves, when they fail, cannot be repaired or replaced with like equipment. Faced with an increasingly difficult situation, the Attorney General's office began to consider alternate devices to use for breath-testing purposes. That process led to the decision by the Attorney General to select the Alcotest 7110 MKIII-C (the Alcotest).^{FN2} *65 Following its introduction into service in a pilot program in Pennsauken, the use of the Alcotest has been expanded to all but four of our counties. Its use and its capabilities, as a means to analyze breath samples with sufficient accuracy so that the results will be admissible into evidence to support a conviction, withstood an initial challenge arising from the Pennsauken program. Thereafter, the continued expansion of use of the Alcotest around the state resulted in a further challenge to its scientific reliability, which has been the essential focus of our inquiry here.

FN2. Throughout this opinion, we will refer to the Alcotest without specifying further the model number and we will generally refer to the firmware without designating the version utilized except in instances where the designation is important for clarity. We intend to make no comments about other models of the device

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or about the software used to operate any other Alcotest model.

In our effort to analyze the reliability of the Alcotest, we have not only considered the questions concerning the scientific challenges to the machine, but we have also considered the underlying constitutional questions about the permissibility of its use in the context of a per se violation of the statute based solely on the results it reports, together with such safeguards and foundational requirements that will allow its admissibility in a DWI prosecution. We have been aided enormously in this task by the efforts of the Special Master for his analysis of the voluminous record created during the extended proceedings on remand.

In summary, we conclude that 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. Some of these conditions upon admissibility we impose as a matter of constitutional *121 imperative, others as a matter of addressing certain of the device's mechanical and technical shortcomings that were revealed during the proceedings on remand. Within the framework for admissibility that we here establish, pending prosecutions should be able to proceed in an orderly and uniform fashion.

*66 I. Facts and Procedural History

The matters that we have been called upon to consider are both many and varied; even among those issues on which the parties agree, we are required to create mechanisms for addressing the uses of Alcotest results generated in prosecutions undertaken prior to this analysis.

The Alcotest is a breath-testing device,^{FN3} manufactured and marketed by Draeger Safety Diagnostics Inc. (Draeger), which was first utilized in New Jersey as part of a pilot project in Pennsauken. The admissibility of the results derived from breath testing by this device was first challenged in 2003. See *State v. Foley*, 370 N.J.Super. 341, 851 A.2d 123 (Law Div.2003). In a pub-

lished decision addressing that challenge, the Law Division judge concluded that the device was generally scientifically reliable and that the BAC readings it generates are therefore admissible as proof of a per se violation of the drunk driving statute. *Id.* at 345, 851 A.2d 123.

FN3. To the extent that the technical manner in which the device operates is germane to our analysis, we set it forth in Section III.B., *infra*.

Following the decision in *Foley*, the State expanded the use of the device to other municipalities, including county-wide utilization in Middlesex County. At the same time, in cooperation with State Police personnel charged with overseeing the device's implementation, see N.J.A.C. 13:51-3.2, the manufacturer created revised software for use in the device.^{FN4}

FN4. The technical alterations in the software, referred to as firmware, some of which are significant to our evaluation of the device, are explained in Section VIII.D.1, *infra*.

A. Certification to this Court

Defendants are twenty individuals who were arrested in various municipalities in Middlesex County and were charged with driving while intoxicated, see N.J.S.A. 39:4-50. Each of these defendants challenged the admissibility of results from the Alcotest in their *67 respective proceedings. The Law Division consolidated all of these matters for consideration of the challenge to the Alcotest. In response, the State filed a motion seeking to have the court recognize the *Foley* opinion as binding authority and apply its findings about the scientific reliability of the device to all pending prosecutions. The Law Division denied that motion and stayed all DWI-related cases involving the Alcotest that were then pending in Middlesex County.

The Appellate Division granted the State's motion for leave to appeal and remanded the matter to the Law Division for a hearing regarding the admissibility of Alcotest results. Before that hearing could proceed, this Court certified the pending appeal pursuant to *Rule*

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2:12-1, vacated the remand to the trial court, and instead remanded the case to a Special Master, retired Appellate Division Presiding Judge Michael Patrick King. The Court ordered the Special Master to:

1. Conduct a plenary hearing on the reliability of Alcotest breath test instruments, including consideration of the pertinent portions of the record in *State v. Foley*, 370 N.J.Super. 341 [851 A.2d 123] (Law Div.2003), and the within matters in the Superior Court, Law Division, Middlesex County, together with such additional expert testimony and arguments*122 as may be presented by the parties;

2. Determine whether the testimony presented by the parties should be supplemented by that of independent experts selected by the Special Master;

3. Grant, in the Special Master's discretion, motions by appropriate entities seeking to participate as *amici curiae*, said motions to be filed with the Special Master within ten days of the filing date of this Order;

4. Invite, in the Special Master's discretion, the participation of entities or persons as *amici curiae* or, to the extent necessary in the interests of justice, as intervenors to assist the Special Master in the resolution of the issues before him; and

5. Within thirty days of the completion of the plenary hearing, file findings and conclusions with the Clerk of the Court and contemporaneously serve a copy on the parties and *amici curiae*, which service may be effectuated by the posting of the report on the Judiciary's website.

Although we also vacated the Law Division's stay of all drunk driving cases then pending in Middlesex County, we subsequently created a distinction among pending prosecutions based upon the proofs and the status of the charged individuals. Our January 10, 2006 Order therefore directed that all drunk driving prosecutions, *68 see N.J.S.A. 39:4-50, that did not involve an Alcotest, and all cases of repeat offenders, should proceed normally. As to repeat offenders who were thereafter found guilty, we directed that the sentences to be imposed on

those defendants would be stayed only if the conviction were based on the Alcotest results alone. We ordered that first-offender cases involving the Alcotest be tried "based on clinical evidence when available, including but not limited to objective observational evidence, as well as the relevant Alcotest readings." We further ordered that if a court found that a first offender was guilty, it was required to articulate, if possible, the alternate bases for the finding. We stayed the execution of all first offenders' sentences pending resolution of this matter, except where public interest required otherwise, and stayed all further requests for Alcotest reliability hearings. Finally, we reiterated our earlier Order authorizing conditional guilty pleas, see R. 7:6-2(c), with a reservation of the right to appeal in the event that we concluded that the Alcotest is not reliable.

The Association of Criminal Defense Lawyers of New Jersey (ACDL) and the New Jersey State Bar Association (NJSBA) were subsequently permitted to participate as *amici curiae* in all of the remand and appellate proceedings.

B. Remand Hearings

Shortly after being appointed to serve, the Special Master issued a discovery order directing the State to provide defendants with certain technical information concerning the operation of the Alcotest device, followed by an order directing the State to make several Alcotest machines available to defendants and the NJSBA. In large part, the ensuing dispute about the disclosure of the software used to operate the device, called firmware, and the source codes needed for an analysis of that software, caused significant disruption in the orderly completion of the proceedings and eventually led to our further remand for additional proceedings.

In short, however, the Special Master was advised that Draeger considered the software and the source code to be proprietary *69 information and would not disclose it. He proposed that counsel enter into a standard protective order and invited Draeger, which was not then a party, to *123 intervene in the proceedings. Draeger declined the Special Master's invitation to intervene. At

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the same time, Draeger refused to permit the parties to review the software except under extremely limited conditions and refused to disclose the source code under any circumstances. As a result of this impasse, the Special Master concluded that he could utilize an adverse inference as to the reliability of the device, but he proceeded with the hearings in the absence of any participation by Draeger. Near the end of the initial hearings, defendants and Draeger entered into a letter agreement, which would have permitted defendants to evaluate future changes to the software in the event that the Alcotest was found to be scientifically reliable.^{FN5}

FN5. In some respects, the parties disagree about the continued need for and viability of the agreement, which they referred to as Addendum A. We address future testing of software revisions further below, *see* Section X, *infra*.

Following hearings that spanned four months, the Special Master issued his findings and conclusions, embodied in a report to this Court dated February 13, 2007. In that report, the details of which we address in Section IV.A., *infra*, the Special Master concluded that the Alcotest is generally scientifically reliable, but he recommended that several changes be incorporated both prospectively and with respect to pending matters. Thereafter, but prior to the time when we received briefs on the merits and entertained oral argument, Draeger moved for leave to intervene before this Court, which motion we granted.

After the initial oral arguments on April 5, 2007, including those offered by Draeger, we remanded the matter to the Special Master again to allow defendants an opportunity to conduct the analysis of the source code that they had contended was essential to an accurate determination of the reliability of the device. *State v. Chun*, 191 N.J. 308, 309, 923 A.2d 226 (2007). In doing so, we directed that the review be undertaken by an independent software*70 house, to be agreed upon by Draeger and defendants, in order to preserve Draeger's proprietary interests. *Id.* at 309-10, 923 A.2d 226.

The parties, however, were unable to agree on an inde-

pendent software house that would conduct the source code analysis. Although our order authorized the Special Master in that event to make the selection, he believed he was not well equipped to choose and he so advised us. Therefore, this Court issued a supplemental order allowing each of the parties, at its own expense, to designate an independent software house to review the source code. The supplemental order also provided that the Special Master, at his discretion, could conduct further hearings following his receipt and review of the expert reports.

Draeger and defendants each designated a software house to analyze the source code and report on its reliability. Because the reports reached different conclusions, the Special Master scheduled further hearings. After ten additional days of testimony and two days devoted to summations, the hearings were completed on October 24, 2007. The Special Master submitted his Supplemental Findings and Conclusions to this Court on November 8, 2007. He concluded, in summary, that the source code analysis did not alter his original opinion that the Alcotest is scientifically reliable, as to both its hardware and software elements. However, he conditioned this conclusion on additional recommendations, which supplemented those contained in the initial report.

II. Legislative Framework

Our analysis of the issues surrounding the scientific reliability of the Alcotest device*124 and our consideration of the Special Master's recommendations must begin with an understanding of the legislative framework that bears upon drunk driving prosecutions. We turn, then, to an explanation of the statutes governing the offenses that we generally refer to as drunk driving, together with an analysis of the relevant legislative history that bears on the issues before us.

*71 The Legislature has established that an individual is guilty of driving while intoxicated if he or she "operates a motor vehicle with a blood alcohol concentration of [0].08 [percent] or more by weight of alcohol in [his or her] blood." N.J.S.A. 39:4-50(a). For first offenders who

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have a BAC that is 0.10 percent or greater, harsher penalties and higher fines apply. *See N.J.S.A. 39:4-50(a)(1)*. Subsequent offenses, as measured by the 0.08 percent standard, are treated with increasingly harsh penalties, including not only longer periods of license suspension, but incarceration as well. *See N.J.S.A. 39:4-50(a)(2), -50(a)(3)*.

As we have previously found, the primary purpose behind our drunk driving laws is to remove intoxicated drivers from our roadways and thereby "to curb the senseless havoc and destruction" caused by them. *State v. Tischio*, 107 N.J. 504, 512, 527 A.2d 388 (1987). We have consistently construed these laws both broadly and pragmatically to ensure that the Legislature's intent is effectuated. *See id.* at 513, 527 A.2d 388; *State v. Mulcahy*, 107 N.J. 467, 479, 527 A.2d 368 (1987) (concluding that turning on ignition is not required for finding that person behind the wheel was in control of and intended to operate vehicle); *State v. Wright*, 107 N.J. 488, 497, 527 A.2d 379 (1987) (concluding that predicate of actual operation of vehicle is not required for request that individual undergo breathalyzer testing).

As part of the effort to rid our roads of drunk drivers, the Legislature has sought over time to streamline the process by which those charged with DWI offenses are efficiently and successfully prosecuted. *See Tischio*, *supra*, 107 N.J. at 514, 527 A.2d 388. Our current laws, as a result, can only be interpreted correctly if they are viewed in the context of this continuing evolution.

Our analysis begins in 1951, when, in order to address growing difficulties and confusion surrounding the evidentiary burden for establishing operation of a vehicle "under the influence," the Legislature enacted *N.J.S.A. 39:4-50.1*. *72 *Tischio*, *supra*, 107 N.J. at 514-15, 527 A.2d 388; *see also State v. Protokowicz*, 55 N.J. Super. 598, 603, 151 A.2d 396 (App.Div.1959). This statute provided that a 0.15 percent blood-alcohol level gave rise to a presumption of intoxication for purposes of a driving under the influence prosecution. *Tischio*, *supra*, 107 N.J. at 515, 527 A.2d 388. A blood-alcohol level below 0.05 percent gave rise to a presumption of non-intoxication, and a level between the two gave rise to no presumption. *Id.* at 515 n. 3, 527 A.2d

388. These legislative presumptions were targeted at reducing the evidence, specifically expert and other testimony, which was otherwise needed to prove intoxication and convict a drunk driver. *Id.* at 515, 527 A.2d 388.

At that time, New Jersey's 0.15 percent standard was the most permissive in the country, *see id.* at 515-16, 527 A.2d 388 (citing Motor Vehicle Study Commission, Report to the Senate and the General Assembly of 1975 (hereinafter "Report"), at 135), although the penalties imposed were "among the most stringent." *Id.* at 515, 515 n. 4, 527 A.2d 388. Nevertheless, studies revealed that most drivers were impaired at BAC levels significantly lower than the statutory presumption employed *125 in the 1951 statute. *Id.* at 516, 527 A.2d 388 (citing Report, *supra*, at 141-42). As a result, the Legislature amended *N.J.S.A. 39:4-50.1*, in 1977, *see L. 1977, c. 29*, to lower the presumptive BAC for intoxication purposes from 0.15 to 0.10 percent. *Tischio*, *supra*, 107 N.J. at 516, 527 A.2d 388.

In 1983, the Legislature again amended the drunk driving statutes to take into account "mounting scientific findings," to the effect that almost all drivers suffered reduced driving ability at a BAC of 0.10 percent. *Ibid.* At the same time, the amended statute brought the state into compliance with minimum federal grant standards. *L. 1983, c. 129*; Assembly Judiciary, Law, Public Safety & Defense Committee, *Statement to Assembly Committee Substitute for Senate Bill No. 1833* (Feb. 14, 1983). Significantly, the amended version of *N.J.S.A. 39:4-50* provided that a 0.10 percent BAC level constituted a *per se* offense, instead of *73 simply giving rise to a presumption.^{FN6}

FN6. This change essentially engulfed the rule provided in *N.J.S.A. 39:4-50.1*, which nonetheless remained in the statutes until 1990, when it was repealed by *L. 1990, c. 103, § 38*.

In 1990, the New Jersey Commercial Driver License Act was enacted. *L. 1990, c. 103*. It created an even more stringent standard to be applied to drivers of commercial vehicles. It provides a penalty, in addition to any other applicable penalties, of a one to three-year

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commercial license suspension for commercial drivers caught driving with a BAC level of 0.04 percent or greater. *N.J.S.A.* 39:3-10.13, -10.20(a)(1). The 0.04 percent BAC standard for commercial drivers was enacted both to comply with the federal standard in the Commercial Motor Vehicle Safety Act of 1986, Pub.L. No. 99-570, 100 Stat. 3207 (1986) (codified at 49 U.S.C.A. § 31310), and in recognition of the fact that significant impairment occurred well below the otherwise applicable 0.10 percent BAC levels. See *L.* 1990, c. 103; Assembly Appropriations Committee, *Statement to Assembly Bill No. 3258*, at 23 (Oct. 1, 1990).

In 1992, the Legislature enacted an additional drunk driving prohibition by creating a new per se offense, which applies to drivers who are under the legal drinking age. *L.* 1992, c. 189. This most recently-added tier provides that any person under the age of twenty-one who is caught driving with a BAC level above 0.01 percent faces a thirty to ninety-day license suspension, in addition to community service requirements. See *N.J.S.A.* 39:4-50.14. The statement attached to the legislation explained that the bill was intended to establish penalties for any driver under the age of twenty-one who is "found to have consumed an alcoholic beverage." *L.* 1992, c. 189; Assembly Judiciary, Law & Public Safety Committee, *Statement to Assembly Committee Substitute for Assembly Nos. 1447 & 1426* (June 1, 1992). The purpose of the enactment was two-fold: "to deter younger drivers from drinking and driving, and to establish an early detection and *74 treatment program for young people...." Anthony Impreveduto, et al., *Statement to Assembly No. 1426* (May 14, 1992).

In 2003, the per se violation set forth in the statute was further reduced. In order to comply with federal highway funding requirements, the statutory standard of 0.10 percent BAC was reduced to 0.08 percent BAC. *L.* 2003, c. 314. At the same time, the amendment created two separate, graduated penalties relevant to prosecution for a first offense. As a result of this legislative enactment, first time offenders with a BAC level between 0.08 percent and 0.10 percent are subject to a three-month license suspension, but first time offenders with a BAC level of 0.10 *126 percent or greater are subject

to a seven to twelve-month license suspension. *Ibid.*

In addition, throughout this time, penalties for second and third offenders have become increasingly harsh. See, e.g., *L.* 1995, c. 286 (registration revocation); *L.* 1999, c. 417 (ignition interlock device installation); *L.* 2003, c. 315 (Michael's Law; imposing mandatory jail time or inpatient rehabilitation program time for a third or subsequent violation); *L.* 2004, c. 8 (increasing penalties for refusal to submit to breath test).

Although when considered together, these statutory enactments make plain the Legislature's view that drunk driving is not to be tolerated, the relationship between this increasingly restrictive legislative scheme and the new technology of the Alcotest, as compared to the breathalyzer, requires us to re-examine much of our earlier jurisprudence as part of our consideration of the issues raised in this appeal.

In virtually all of these statutes, the Legislature has utilized blood alcohol concentration, not breath alcohol concentration, as its standard measure.^{FN7} Both the breathalyzer and the Alcotest, however, test breath samples and convert that analysis by *75 mathematical calculations to an expression of the subject's presumed blood alcohol concentration. The principle question, then, is whether the Alcotest does so with sufficient accuracy and reliability to permit the results to be admitted in evidence in a DWI prosecution, or used as the basis for a per se violation of the statute and, therefore, a conviction.

FN7. Although the commercial driving statute defines "alcohol concentration" in terms of both blood and breath, see *N.J.S.A.* 39:3-10.11, our focus here will be on the more commonly applied articulation of blood alcohol.

III. How the Alcotest Works

The State seeks in this proceeding to establish that the Alcotest is scientifically reliable to measure defendants' blood alcohol levels. We turn, then, to a discussion of the physiological effects of alcohol on the body, how the Alcotest measures the concentration of alcohol in

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the breath and converts it to a measure of blood alcohol levels, and the State's proposed procedures to ensure that the Alcotest functions properly.

A. Scientific and Physiological Framework

Much of the scientific evidence in the record before the Court is undisputed. In fact, the basic physiological mechanisms on which all breath testing devices rely are not themselves controversial. We set these scientific propositions forth here, however, to provide the basis for our analysis of the scientific matters that are in dispute.

1. Alcohol and Blood^{FN8}

FN8. We draw these scientific descriptions from the testimony in the record offered by Barry Logan, a board-certified forensic toxicologist, and Patrick Harding, a biochemist who has also previously testified in proceedings involving breath testing devices. *See State v. Downie*, 117 N.J. 450, 454, 569 A.2d 242 (1990).

Alcohol is ordinarily ingested orally and enters the stomach where it is absorbed through the stomach's walls and intestines and is thereafter carried by the blood through the liver to the heart. The heart pumps the blood and, along with it, the alcohol, through the body, including carrying it to the brain and the lungs. Alcohol exerts its effects on an individual when the blood containing the alcohol reaches the brain.

*76 Absorption begins immediately once a person starts drinking. The rate of absorption varies greatly from one person to *127 the next and can even vary in the same person at different times. It depends on a wide variety of factors including general health, recent food consumption, physical makeup, amount of alcohol consumed, weight, and gender.

Elimination of alcohol also starts as soon as a person begins to drink. Alcohol is eliminated through excretion

and metabolization, which occur when alcohol passes through the liver and is broken down by enzymes and dehydrogenates. When a person's body is absorbing alcohol faster than he or she is eliminating it, the concentration of alcohol in the blood will continue to rise. This period of time is ordinarily referred to as the absorptive phase. The concentration will reach its peak, and it will achieve a plateau, at the time when elimination and absorption are occurring at about the same rate.

When the person stops ingesting alcohol, or slows down ingestion to the point where the body is eliminating alcohol more quickly than absorbing it, the body enters what has generally been referred to as the post-absorptive phase. During this period of time, the concentration of alcohol in the blood decreases.

2. Alcohol and Breath

The reported concentration of alcohol in any particular person varies depending upon the source of the test sample. An understanding of the relationship of these potential test sample sources to BAC is important to our analysis. Alcohol passes into the lungs, through the walls of the air sacs, called alveoli. As it does so, it mixes with the air that the person has inhaled. When the person exhales, alcohol passes out of the body as part of the breath.

An individual's breathing pattern can influence the amount of alcohol that appears in any particular breath. In addition, the amount of alcohol in the breath sample represented by a single act of exhalation will vary from the beginning to the end. This is because the breath actually comes from different parts of the *77 body, from the mouth to the deepest part of the lungs. Except for the possible interference that would occur if the test subject had ingested alcohol so recently that residual mouth alcohol were captured, the first part of the breath comes from the mouth and throat where there is little contact with the alcohol passing through the alveoli. However, as the person continues to exhale, the expelled air comes from deeper in the respiratory system, where it contains alcohol that more closely represents the amount passing through the lungs from the circulat-

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ing blood.

3. Differences Between Blood and Breath Tests

Our statute establishes the violation in terms of blood, and not breath alcohol concentration. Although testing an individual's blood would presumably provide more direct evidence of that person's BAC, there are obvious practical and logistical problems associated with attempting to collect blood samples from suspected drunk drivers routinely.

As a result, although because of our statute New Jersey is considered to be a "blood state," we have long permitted BAC to be established through breath testing, in which breath samples are tested and converted to determine blood alcohol levels. Breath testing therefore uses an indirect measure of BAC by calculating the alcohol concentration in the breath (breath alcohol concentration, or BrAC) and extrapolating to derive the BAC using a blood/breath ratio. Breath testing has become the preferred method for field testing because it can be performed easily, is highly automated, does not require scientific skill, and produces an immediate result.

*128 B. Operation of the Alcotest

In light of the fact that breath testing always relies on the extrapolation of BAC through testing of breath, the precision with which any device evaluates BAC through this method is critical to our consideration of the admissibility of the device's results. We turn then to a description of the manner in which the Alcotest operates.

*78 The Alcotest, which is currently in use in seventeen of our twenty-one counties,^{FN9} as well as in other states, including Alabama and parts of New York, is a device that purports to accurately measure the concentration of alcohol from a human subject through breath testing. The Alcotest is an embedded system, meaning that it is a device with a specific purpose, and it relies on pre-loaded software that the manufacturer refers to as firmware.

FN9. Only Bergen, Essex, Monmouth, and Hudson counties do not currently use it.

The Alcotest uses both infrared (IR) technology and electric chemical (EC) oxidation in a fuel cell to measure breath alcohol concentration. The device therefore produces two test results for each breath sample, one derived from an IR reading and the other, by and large, from an EC reading.

Although the precise mechanism by which these tests are accomplished is not relevant to the issues before us, the IR chamber, also called a cuvette, captures the breath sample and uses infrared energy to calculate absorption of the energy by the alcohol concentrated in the chamber. IR technology has been available since the 1970's or early 1980's and scientists have concluded that it is reliable. See, e.g., *Foley, supra*, 370 N.J. Super. at 350, 851 A.2d 123.

The EC, or fuel cell technology, uses a catalyst to absorb alcohol and provide a second measurement^{FN10} of breath alcohol concentration from a small sample captured from the cuvette. In the EC chamber, voltage is applied to cause the catalytic reaction, which causes any alcohol that is present to oxidize. As that occurs, the oxidation process creates electricity, which is then measured to determine the amount of alcohol interacting with the fuel cell.

FN10. Draeger has consistently represented that the IR and EC tests are "completely independent" as a basis for its claim that the device is reliable. As our discussion of the fuel cell drift algorithm, see Section IX.A., *infra*, explains, however, the reported results of the two tests are not always independent.

*79 C. Test Administration and the Alcohol Influence Report

The Alcotest reports the IR and EC readings on a printout from the machine, referred to as the Alcohol Influence Report (AIR).^{FN11} One of the claimed advantages of the Alcotest, as compared to the breathalyzer, is that it is not operator-dependent, but performs its analysis in

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accordance with a sequence through a computerized program that gives visual prompts to the operator. We turn, then, to a description of the manner in which the device operates in practice in performing these functions.

FN11. To the extent relevant to our analysis, we describe the specific details of the information reported on each AIR further, *see infra*.

The actual administration of the test is performed by one of the more than 5000 certified Alcotest operators in New Jersey. When a person has been arrested, based on probable cause that the person has been driving while intoxicated, he or she is transported to the police station to provide a sample for the Alcotest. The Alcotest, consisting of a keyboard, an external printer, and the testing device itself, is positioned*129 on a table near where the test subject is seated.

Operators must wait twenty minutes before collecting a sample to avoid overestimated readings due to residual effects of mouth alcohol. The software is programmed to prohibit operation of the device before the passage of twenty minutes from the time entered as the time of the arrest. Moreover, the operator must observe the test subject for the required twenty-minute period of time to ensure that no alcohol has entered the person's mouth while he or she is awaiting the start of the testing sequence. In addition, if the arrestee swallows anything or regurgitates, or if the operator notices chewing gum or tobacco in the person's mouth, the operator is required to begin counting the twenty-minute period anew.

The Alcotest that is the focus of this matter utilizes software developed in collaboration with the New Jersey State Police and *80 known as New Jersey Firmware version 3.11.^{FN12} This software prompts the operator through a specific testing sequence on each arrestee. Essentially, the process begins when the operator has typed identifying information into the machine through a series of questions and prompts. The device then starts and automatically samples the room air to determine if there are chemical interferents in the room. This is known as a blank air test. Assuming that there are none, the machine then uses its attached wet bath simulator to

heat a solution and produce a vapor sample from a control test solution ^{FN13} with a known alcohol concentration of 0.10, which is then measured using IR and EC technology. In order to be valid, the control test, in accordance with currently-programmed firmware, must produce results between 0.095 and 0.105. If the results do not identify the known sample within the defined parameters, the device is programmed so that the test cannot proceed. If the machine is working properly as demonstrated by the control test, then the instrument performs a second blank air test, again using room air to purge the test sample out of the chamber.

FN12. The Alcotest that was the subject of the Law Division's findings and conclusions in *Foley*, *supra*, utilized an earlier version of the software known as New Jersey Firmware version 3.8. A number of changes made to the software following the court's decision in *Foley* have become important to our analysis as we will detail.

FN13. The record reflects that the control solution must be changed after approximately twenty-five test sequences or thirty days. The device prompts the operator when the solution needs to be changed and generates a separate report evidencing the results of control testing after each change in the solution.

Assuming that the results of the control test are within the established parameters, the instrument prompts the operator through a message on the LED screen to collect a breath sample. The operator then attaches a new, disposable mouthpiece and removes cell phones and portable electronic devices from the testing area. The operator is required to read the following instruction to the test subject: "I want you to take a deep breath and blow into the mouthpiece with one long, continuous breath. *81 Continue to blow until I tell you to stop. Do you understand these instructions?" The arrestee then provides the first breath sample, which is measured in the IR and EC chambers.

Lights on the LED screen and an audible sound alert the operator when a breath sample which meets the minim-

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um fixed standards, comprised of four criteria, has been provided. The operator then tells the subject to stop and the instrument performs a third blank test to purge the first breath sample. After a two-minute *130 lock-out period during which the device will not permit another test, the instrument prompts the operator to read the instruction again to the arrestee and collect the second breath sample. The second sample is also measured using the IR and EC technology. The second sample is purged from the machine and the device performs a fourth blank test using room air.

If the measurements for the first breath test are out of the accepted range of tolerance with the measurements for the second breath test, the machine prompts the operator to conduct a third breath test. Depending on the relationship among the three tests, the results are reported. The instrument then performs a second control test with the known solution from the simulator. Finally, the air is purged again and a final blank test is performed.

The device gives the operator three minutes to collect each sample. If that time expires without a sample, the device will present the operator with three options. The options are to terminate the test, report that the person refused the test, or continue with the test. If the officer opts to continue the test, the device will purge itself and then prompt the operator to collect another sample. The operator has a maximum of eleven attempts to collect two breath samples. After the eleventh failed test, the only two options permitted by the device are to terminate testing or report refusal.^{FN14}

FN14. Even if the officer types in the code for a refusal, he is not required to issue a summons for refusal. Instead, the officer may opt to start the test again and give the arrestee eleven more attempts. Alternatively, the officer may decide to terminate testing, without charging the test subject with refusal. An operator will generally select this option if he or she concludes that the subject has in fact attempted to comply but is not capable of providing a sample that meets the minimum test criteria.

*82 As currently configured by New Jersey Firmware

version 3.11, the software now being utilized, the device will accept a sample only if it meets certain minimum criteria that have been devised by the State.^{FN15} Once the subject has provided an acceptable breath sample, the machine prompts the operator, through a system of lights on the LED screen and an audible beep, to tell the subject that he or she may stop. If any of these minimum test criteria has not been met, the machine will generate an error message and a report of how much air was submitted. The machine then offers the operator the option of giving the person another attempt or asserting refusal.

FN15. The legitimacy of some of these criteria are in issue in this dispute. We need not explain them in detail here but will do so in the context of our analysis of those criteria that have given rise to a debate. *See infra*, Section VIII.B.

The results of the test sequence are printed out from the device in a sequentially numbered document referred to as an AIR. The AIR contains the test subject's identifying information, date, time, and test results for each stage of the procedure. Each AIR includes a variety of other information relevant to the test, including the serial number of the device used in the test, dates of and file numbers for calibration and linearity checks, and solution control lot and bottle numbers. The operator must retain a copy of the AIR and give a copy to the arrestee.

In the event that the administration of the test resulted in errors because of, for example, insufficient breath volume or duration, the AIR will report those errors and will not attempt to calculate the BAC from an inadequate sample. Similarly, if *131 the results of the control test do not fall within the acceptable tolerance, the device will produce an AIR that reports that the test could not be accomplished because of an invalid control test.

*83 If the results are within the acceptable tolerance, the AIR shows the BAC values for each IR and EC reading for each of the tests to three decimal places. The AIR then reports the final BAC test result, which will be the lowest of the four acceptable readings, that is,

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readings within acceptable tolerance, which the device is programmed to truncate to two decimal places. Truncating, as opposed to rounding, involves simply reporting the first and second decimal places and dropping the third. For example, by truncating, a reading of 0.079 percent BAC would be reported as 0.07 and a reading of 0.089 percent BAC would be reported as 0.08. The effect of truncating, as opposed to rounding, is to under-report the concentration, to the benefit of the arrestee.

By statute, the Legislature has designated the Attorney General to create and implement a breath testing program. *See N.J.S.A. 39:4-50.3*. The Attorney General, in turn, has vested responsibility for carrying out this command in the State Police. *See N.J.A.C. 13:51-3.2*. The Alcotest program was designed and is overseen by the Office of Forensic Sciences, a Division of the New Jersey State Police. The director of the forensic laboratory, Dr. Thomas Brettell, together with other forensic scientists in the Office assigned to the alcohol/drug testing unit, conducted tests on a variety of breath testing devices in an effort to select a successor to the breathalyzer.

After the Alcotest was chosen, Brettell assisted in the creation of the test criteria and provided other input into the original programming and the updates to the software that now is utilized in operating the device. His office has collaborated with municipalities to train Alcotest operators and to oversee certain aspects of the program. State Police Sergeant Kevin Flanagan is the field supervisor for five State Police coordinators, each of whom monitors a geographic area. The coordinators receive factory and classroom training from Draeger and they, in turn, train the operators. Coordinators do not perform any repairs, but they perform "black key" functions, such as calibration and software uploads, which are not done by other police personnel.

***84** Calibration of the machines involves attaching the machine to an external simulator which uses a variety of solutions of known alcohol concentrations to create vapors that approximate human breath. By exposing the IR and EC mechanisms to these differing concentrations, and by analyzing the device's ability to identify accurately each of those samples within the acceptable

range of tolerance, referred to as a linearity test, the coordinator is able to ensure that the machine is correctly calibrated. When coordinators undertake to perform this calibration, currently on an annual basis, and other routine inspections, they also download the device's test information onto two compact discs.^{FN16} In accordance with current State Police protocol, one of these discs is kept in the local police department's evidence file and the other is held by the coordinator.^{FN17}

FN16. The record reflects that each device is capable of storing the data from 1000 test results. Current State Police protocol, however, requires the coordinators to download data from each device before it exceeds 500 tests.

FN17. *See* Part IV, *infra* (Special Master's Finding 7, recommending creation of centralized database).

***132 IV. Findings of the Special Master**

Following hearings that spanned four months and included testimony from eleven fact and expert witnesses called by the State and two experts offered by defendants, the Special Master issued his first report on February 13, 2007. Although there are some aspects of that report and certain of the Special Master's recommendations that are not disputed by any of the parties, much of the report and many of the recommendations are challenged in this proceeding. As a result, we briefly summarize the report and its findings and recommendations before turning to our analysis of the matters in dispute.

A. Initial Report

In short, the Special Master concluded that the Alcotest in general is scientifically reliable, that it is superior to the breathalyzer because it relies less on operator influence, and that the AIR ***85** it generates, therefore, meets the test for admissibility in drunk driving prosecutions in general. Notwithstanding that conclusion, however, the Special Master offered a large number of suggestions for modifications both as to the future operation of the device and as to the use of the extant AIRs as evidence in pending prosecutions.

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In his first report, the Special Master offered all of the following specific findings and recommendations.^{FN18} He found that the use of the 2100 to 1 blood/breath ratio is scientifically reliable (Special Master's Finding 1(b)); he recommended that the AIR, solution change report and calibration documents be amended to include a listing of the temperature probe serial number and value (Special Master's Finding 2(a)); he recommended that the State be required to publish future firmware revisions (Special Master's Finding 2(b)); he recommended that the State continue to lock the firmware so that only Draeger and the coordinators would be able to make changes to that software (Special Master's Finding 2(c)); he found that the AIR, which reports all of the breath test results, rather than only the final reported lowest result, should be admissible in evidence (Special Master's Finding 2(d)); he recommended that the AIR be revised to identify the reason that a particular defendant did not achieve a reportable result (Special Master's Finding 2(e)); he found that Firmware version 3.11 is itself scientifically reliable and that future changes would not undermine its current reliability (Special Master's Finding 2(f)); he concluded that the Alcotest is not operator dependent, (Special Master's Finding 2(g)), and that it is therefore superior to the breathalyzer (Special Master's Finding 8); he recommended that all defendants have access to centrally collected data on their matters as well as to redacted versions of information relating to breath tests performed on other arrestees (Special Master's Finding 2(h)); he recommended that the calibration, certification and *86 linearity reports be amended to include the serial number of the digital temperature measuring system utilized (Special Master's Finding 2(i)); he found that the State should be required to provide training for defense counsel and their experts similar to that provided to the certified operators (Special Master's Finding 2(j)); he found that the agreement between Draeger and defendants regarding future testing of firmware revisions should be enforced (Special Master's Finding 3); he concluded that the Alcotest is well shielded against radio frequency interference (RFI) (Special Master's *133 Finding 4); he recommended that operators be required to testify about their qualifications and the testing procedures utilized in any proceeding relying on Alcotest res-

ults (Special Master's Finding 5(a)); he identified twelve foundational documents that the State must provide in discovery, which may be admitted into evidence without further formal proofs, and reasoned that they must be admitted into evidence in cases in which the defendant is not represented by counsel (Special Master's Finding 5(b)); he concluded that the technical criteria for a minimum breath sample utilized by the Alcotest are appropriate, with the exception of the minimum breath volume as it relates to women over sixty years of age (Special Master's Finding 6); he recommended that the State create and maintain a centralized database of the digitally recorded data (Special Master's Finding 7); he concluded that the State must commence use of the Draeger breath temperature sensor and apply a mathematical formula to account for the effect of temperature to pending reported results (Special Master's Finding 9); and he recommended that the State must reduce the acceptable tolerance for breath results to a total range of ten percent in place of the currently utilized calculation of a range of plus or minus ten percent for future use of the device (Special Master's Finding 10).

FN18. We have elected to adopt, only for the sake of simplicity and clarity, the numbering of the recommendations utilized by the Special Master rather than to proceed with a sequential enumeration.

B. Draeger's Role in the Proceedings

During the first oral argument before this Court following the Special Master's release of his report and recommendations, defendants argued that the entire proceedings were tainted by the manner in which defendants were required to proceed. They *87 argued that because Draeger had refused to make its source code available for their inspection and for analysis by their experts, the Court could have no confidence in the reliability or accuracy of the device from a scientific perspective. In short, they argued that the manufacturer's intransigence forced the Special Master and, by extension, this Court, to rely on "black box" testing,^{FN19} when only a complete and thorough analysis of the source code used to operate the device would suffice for constitutional purposes.

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FN19. "Black box" testing refers in this context to a method of evaluating the reliability of the device by using known concentrations to test whether the device accurately detects those concentrations. It refers to testing that does not also consider whether the mechanism by which the result is achieved might be flawed.

Indeed, the refusal of Draeger to intervene precluded the Special Master from permitting any testing of the manner in which the device operates, and required him to rely on tests that at best could only demonstrate that the machine reliably appeared to be able to identify correctly, or at least acceptably within the established parameters, the alcohol concentration of a known test sample. There is some logic to that method of proceeding: If a breath testing device can, reliably and consistently over time, correctly analyze a sample of known alcohol concentration, one might argue that it matters little how the device is able to do so. Notwithstanding the rather considerable force of that logic, we were persuaded that, in light of the constitutional dimension of the issues before us, Draeger's eventual election to intervene in this matter afforded us the opportunity to permit defendants to engage in the technical analysis of the source code that they had asserted was so necessary to the adequate protection of their rights.

C. Source Code Remand

Following our order remanding the matter for further analysis of the issues by means of the source code evaluation by the *134 two independent testing entities, *see Chun, supra*, 191 N.J. at 309-10, 923 A.2d 226, the Special Master entertained further testimony on the issues. His supplemental report, dated November 8, 2007, *88 included several additional recommendations, but continued to adhere to his initial conclusion that the device is scientifically reliable for use in pending and, with modifications, future proceedings.

In summary, the Special Master found that a mathematical algorithm that corrects for fuel cell drift did not undermine the reliability of the results, but he recommended that the machines be recalibrated every six months

rather than annually to afford more regular opportunities to replace aging fuel cells; he found that a specific buffer overflow error should be corrected in future versions of the software and recommended that in all pending matters in which a third test was performed, that the AIR be excluded or recalculated according to a corrective formula, described in the record as the Shaffer formula; he recommended that catastrophic error detection be re-enabled to stop and restart the machine in the event that such an error occurs; he recommended that the AIR should be inadmissible in any case in which there is data missing from it; he revised his initial finding 5(b) to recommend that the twelve foundational documents be produced in discovery and be admissible in all cases, without regard to whether a particular defendant is represented by counsel or not; he suggested that notice of any and all proposed software revisions be provided to the NJSBA; he recommended generally that defendants' expert's suggestions for reorganizing and simplifying the source code be considered for implementation, but declined to mandate adherence to any specific design standard for future software revisions; he concluded that a weighted averaging algorithm in the code was an accurate methodology that fairly aids in the measurement of breath samples in a test subject; and he accepted the testing method employed by the State's expert and rejected the hypothetical probability analysis raised by defendants as being unnecessarily speculative.

V. Uncontested Issues

We begin our analysis with the observation that some of the Special Master's findings and recommendations have not been contested by any of the parties. We will therefore limit our *89 review of those findings and recommendations to a consideration of whether they are supported by sufficient credible evidence in the record, *see State v. Locurto*, 157 N.J. 463, 472, 724 A.2d 234 (1999); *State v. Johnson*, 42 N.J. 146, 158-59, 199 A.2d 809 (1964), and, by extension, whether we will adopt them as our own. With this standard to guide us, we need only briefly address each of them. We do not, however, by the relative brevity of the attention we here accord to these findings and recommendations, intend to suggest that any of them is unimportant to our overall

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evaluation of the support in the record for the ultimate determination of the scientific reliability of the device.

Certainly, there is adequate support in the record for the Special Master's finding that the Alcotest is not as operator-dependent as was the breathalyzer. (Special Master's Findings 2(g), 8). Indeed, the testing sequence we have described is almost entirely controlled and prompted by the device and, with only a very few exceptions, the operator is not able to influence the manner in which the test is administered. Similarly, there is ample support for the finding that the Alcotest is well-shielded from the impact of any potential RFI that might otherwise affect the reported results or limit our confidence in *135 the accuracy of the test results. (Special Master's Finding 4).

The parties agree, as well, about certain of the Special Master's recommendations for future revisions in the firmware that will provide additional information on the reported results that the device generates. For example, the parties agree that the firmware should be rewritten so that the AIR, solution change report, and calibration documents include the temperature probe serial number and probe value (Special Master's Finding 2(a)); that if the particular test subject has not received a reportable result, the AIR must include a statement identifying why that occurred (Special Master's Finding 2(e)); and that future calibration, certification and linearity reports should include the serial number of the Ertco-Hart digital temperature measuring system utilized in performing those testing and maintenance operations (Special Master's Finding 2(i)).

*90 As to each of these recommendations, there is sufficient evidence in the record to support the conclusion that the addition of this information for future firmware revisions might be of some assistance to future defendants. Notwithstanding our agreement that these proposed alterations, to which the State has acceded, might be beneficial, we discern no basis in the record that suggests that any previously-generated report that lacks these additional details is therefore insufficient as a matter of proof of a per se violation. Rather, we agree with the Special Master that updating the firmware to provide this information in addition to that which it

already provides would merely be beneficial.

Similarly, the Special Master recommended, and the parties by and large agree, that the State should create and maintain a centralized database of information regularly uploaded through modem (Special Master's Finding 7), and that defendants should have access to centrally collected and maintained data on their own cases, as well as to the compiled scientific data on matters involving others that has been redacted to shield the personal information related to those other individuals as appropriate (Special Master's Finding 2(h)).^{FN20} Our review of the record satisfies us that there is substantial, credible evidence that supports the Special Master's recommendation concerning the creation and maintenance of a regularly-updated database, as well as his recommendation relating to providing access to that data to defendants.

FN20. The amicus NJSBA suggests that defendants should have access to previously downloaded, centrally collected data. We do not perceive this to be different from the Special Master's recommendation in this regard and the extent of the access to be afforded to any litigant does not appear to be a matter in dispute. In the absence of any suggestion in the record that there is a genuine difference of agreement among the parties on this matter, we see no need to address it further.

VI. Standards of Review

We turn, then, to the matters as to which the parties are deeply divided. In part, our task is made more complicated by the fact *91 that some of the shortcomings in the operation of the device can only be corrected with respect to future uses of the machine, leaving, potentially, doubt as to the validity of the previously-generated AIRs which form the basis for prosecutions stayed pending the outcome of these proceedings. Moreover, our task has become further complicated by the questions raised by the United States Supreme Court's recent Confrontation Clause ^{FN21}*136 cases, see *Crawford v. Washington*, 541 U.S. 36, 124 S.Ct. 1354, 158 L.Ed.2d 177 (2004); *Davis v. Washington*, 547 U.S. 813, 126

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S.Ct. 2266, 165 *L.Ed.2d* 224 (2006); *cf. Whorton v. Bockting*, --- *U.S.* ---, 127 *S.Ct.* 1173, 167 *L.Ed.2d* 1 (2007), as to which we must proceed with great care when the only “witness” confronting a defendant is a machine.

FN21. Because the *Crawford* implications were not thoroughly briefed in connection with our consideration of the Special Master's Initial or Supplemental Reports, we invited the parties to submit additional briefs directed to these issues, which we have considered.

[1] We begin, as we must, with a brief review of the applicable principles of law governing admissibility of novel scientific evidence. Admissibility of scientific test results in a criminal trial is permitted only when those tests are shown to be generally accepted, within the relevant scientific community, to be reliable. *See State v. Harvey*, 151 *N.J.* 117, 169-70, 699 *A.2d* 596 (1997) (citing *Frye v. United States*, 293 *F.* 1013, 1014 (D.C.Cir.1923)); *Romano*, *supra*, 96 *N.J.* at 80, 474 *A.2d* 1; *Johnson*, *supra*, 42 *N.J.* at 170-71, 199 *A.2d* 809. That is to say, the test must have a “sufficient scientific basis to produce uniform and reasonably reliable results and will contribute materially to the ascertainment of the truth.” *State v. Hurd*, 86 *N.J.* 525, 536, 432 *A.2d* 86 (1981) (quoting *State v. Cary*, 49 *N.J.* 343, 352, 230 *A.2d* 384 (1967)). As we have previously commented, however, proof of general acceptance is often “elusive.” *Harvey*, *supra*, 151 *N.J.* at 171, 699 *A.2d* 596.

[2] Proof of general acceptance does not mean that there must be complete agreement in the scientific community about the *92 techniques, methodology, or procedures that underlie the scientific evidence. *See Romano*, *supra*, 96 *N.J.* at 80, 474 *A.2d* 1. Even “the possibility of error” does not mean that a particular scientific device falls short of the required showing of general acceptance. *Ibid.* As we long ago recognized, “[p]ractically every new scientific discovery has its detractors and unbelievers, but neither unanimity of opinion nor universal infallibility is required for judicial acceptance of generally recognized matters.” *Johnson*, *supra*, 42 *N.J.* at 171, 199 *A.2d* 809. Neither “complete

agreement over the accuracy of the test [nor] the exclusion of the possibility of error” is required. *Harvey*, *supra*, 151 *N.J.* at 171, 699 *A.2d* 596.

[3] Nevertheless, before we can conclude that scientific test results are admissible in evidence, the proponent of the scientific device must bear its burden to “clearly establish” that the device or the test meets the standard of general acceptance as we have defined it. *Id.* at 170, 699 *A.2d* 596; *see State v. Kelly*, 97 *N.J.* 178, 209-11, 478 *A.2d* 364 (1984); *State v. Cavallo*, 88 *N.J.* 508, 521, 443 *A.2d* 1020 (1982).

VII. Defendants' Challenges to Scientific Reliability

Defendants raise three distinct sets of challenges to the basic scientific reliability of the Alcotest. First, they attack it on numerous traditional grounds relating to scientific acceptance, not unlike the challenges raised in *Romano* with regard to two breathalyzer models, by contesting many of the Special Master's findings and recommendations. Second, defendants separately attack the source code utilized to operate the device as being so inherently flawed as to be independently lacking in scientific reliability. Third, following the United States Supreme Court's lead in *Crawford*, defendants attack the admissibility of documents generated by or in connection with the device, which the Special Master suggested be routinely admitted into evidence, as violating their constitutional*137 rights under the Confrontation Clause.

In addition, the State, although urging us to adopt the Special Master's conclusion about the general scientific reliability of the *93 device, argues that many of his recommendations are unnecessary and that none of them undermines the accuracy of any of the previously-reported BAC results for any defendant. The State therefore contends that the majority of the Special Master's recommendations are merely precatory, that is, suggestions that the State may or may not elect to adopt. Finally, the NJSBA, although in large part agreeing with the Special Master's findings and conclusions, suggested a refinement to his recommendation relating to minimum breath sample criteria.

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[4] In reviewing the findings and conclusions set forth by the Special Master in his report, we employ our ordinary standards of review, considering them in the same manner as we would the findings and conclusions of a judge sitting as a finder of fact. We therefore accept the fact findings to the extent that they are supported by substantial credible evidence in the record, *see Locurto, supra*, 157 N.J. at 472, 724 A.2d 234, but we owe no particular deference to the legal conclusions of the Special Master, *see Manalapan Realty, L.P. v. Twp. Comm. of Manalapan*, 140 N.J. 366, 378, 658 A.2d 1230 (1995). With these standards in mind, we turn to our analysis of the issues in dispute.

VIII. Disputed Findings and Recommendations

We begin our discussion by more specifically identifying the three categories of disputed findings and recommendations. First, there are a number of disputes about the criteria employed by the Alcotest to identify an acceptable breath sample and convert the measurement data into a reported result. This category includes the Special Master's recommendations on each of the following matters: (a) the utilization of the 2100 to 1 blood/breath ratio (Special Master's Finding 1(b)); (b) the minimum breath sample criteria (Special Master's Finding 6); (c) the requirement for the addition of a breath temperature sensor (Special Master's Finding 9); and (d) the acceptable tolerance among test results (Special Master's Finding 10).

*94 Second, there are a number of disputes arising from the supplemental remand that relate to the firmware and source code analysis. This category includes the Special Master's recommendations about each of the following matters: (a) the fuel cell drift algorithm; (b) the weighted averaging sequence; and (c) the adequacy of the overall software design. In addition, although the parties agree on the need to revise the firmware to address two shortcomings identified through the source code analysis, namely, the buffer overflow error and the disabling of the catastrophic error detector, to the extent that these conceded errors may have an impact on the reliability of AIR results pending modification of the firmware, we are compelled to address them as well.

Finally, there are a number of issues that arise as a result of the Special Master's findings and recommendations concerning foundational evidence (Special Master's Findings 5(a), 5(b)). This category includes all of the following recommendations: (a) the requirement for disclosure of foundational documents as a prerequisite for admissibility of any Alcotest results; (b) the required foundational documentary proofs at trial; (c) the admissibility or uses of incomplete reports; and (d) the constitutionally-required testimonial proofs.

*138 We begin, then, with the disputed findings and recommendations as they relate to the criteria employed by the Alcotest for the collection of an adequate breath sample and the creation of an acceptable and reportable result.

A. Blood/Breath Ratio

As we have previously noted, the drunk driving statutes in New Jersey define the offense in terms of BAC. In the majority of cases involving individuals charged with these offenses, however, the particular defendant has not undergone a blood test but instead has submitted to a breath test. Modern breath testing devices include an internal mechanism that collects an acceptable breath sample and converts the alcohol detected in the breath (BrAC) into a measure of the person's BAC.

*95 Historically, breath testing devices convert from BrAC to BAC by using a mathematical calculation based upon a scientifically accepted, judicially established blood/breath ratio. The Alcotest utilizes a blood/breath ratio of 2100 to 1, a ratio that this Court has previously considered as a part of a challenge to the breathalyzer. *See Downie, supra*, 117 N.J. at 460-63, 569 A.2d 242.

The Special Master concluded that the 2100 to 1 blood/breath ratio adopted by this Court in *Downie* and utilized by the Alcotest remains a valid measuring mechanism. He based this conclusion on the opinions of three of the State's experts and on a number of published studies here and abroad relating to the average, or mean, blood/breath ratio that he found to be

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FN22 At the same time, the Special Master rejected the opinions offered by two of the experts who testified on behalf of the defendants. He found that the analysis of one of these experts was filled with so many errors that it could not be reliable, and he rejected as flawed the assertion of the other defense expert that the Alcotest actually does not test alveolar air. Defendants nonetheless assert that the continued use of the 2100 to 1 ratio is not scientifically supported and they urge us to reject any use of the Alcotest on this basis.

FN22. See, e.g., Allan R. Gainsford, et al., *A Large-Scale Study of the Relationship Between Blood and Breath Alcohol Concentrations in New Zealand Drinking Drivers*, 51 *J. Forensic Sci.* 173 (2006); Alan Wayne Jones & Lars Andersson, *Variability of the Blood/Breath Alcohol Ratio in Drinking Drivers*, 41 *J. Forensic Sci.* 916 (1996). These studies appeared in the *Journal of Forensic Sciences*, which our Appellate Division has noted is an authoritative publication in the field of forensic science. See *State v. Miller*, 64 N.J.Super. 262, 268-69, 165 A.2d 829 (App.Div.1960) (citing *Journal of Forensic Sciences* to support reliability of breath test).

[5] The true focus of our analysis on this issue must be on whether there has been any development in the scientific community in the time since we decided *Downie* that undermines our continued confidence in the accuracy and validity of the conclusion we drew there about the 2100 to 1 blood/breath ratio. Simply put, there is not. Our review of the record demonstrates that the arguments that we considered and rejected in *Downie* have been *96 raised anew, but there is no basis on which to conclude that the continued utilization of this ratio is in any way in error.

We reach this result for reasons similar to those that we relied upon in *Downie*. First, we defer to the findings of the Special Master concerning the credibility of the expert witnesses who testified. See *Locurto*, *supra*, 157 N.J. at 471, 724 A.2d 234. In part, his credibility analysis reflects the fact that one of defendants' experts candidly conceded that the use of this ratio generally tends

to underestimate *139 blood alcohol, to the benefit of the test subject.

Second, although there is some evidence that there is a percentage of the population for whom the 2100 to 1 blood/breath ratio may actually overstate the presence of blood alcohol, this evidence is not significantly different from the record considered in *Downie*, *supra*, 117 N.J. at 460, 569 A.2d 242. Scientific studies comparing actual blood alcohol content to breath-tested alcohol content found only a minute number of individuals for whom this ratio would have incorrectly reported a result over the established legal limit for driving while intoxicated. The percentage of individuals for whom there may be an overestimation by use of this ratio remains "extraordinarily small." *Id.* at 469, 569 A.2d 242.

Finally, defendants' experts on this issue did not produce any evidence to the effect that the ratio is regarded by authorities in the field with even the slightest suspicion or is otherwise subject to any significant scientific challenge. Indeed, the overwhelming evidence demonstrates that use of this ratio tends to underestimate the actual BAC in the vast majority of persons whose breath is tested. Although, as in *Downie*, there may be a small number of individuals who are disadvantaged by a device that uses the 2100 to 1 blood/breath ratio, there is sound scientific support for its continued utilization.

We are confident, based on our review of the record and our evaluation of the Special Master's findings, that there is sufficient credible evidence to support his findings as to the continued validity of the 2100 to 1 blood/breath ratio. We therefore reject *97 defendants' challenge to its use and we adopt the Special Master's recommendation that it continue to be utilized in the Alcotest.

B. Minimum Test Sample Criteria

As we have explained, the Alcotest is programmed to require that a test subject produce a breath sample that meets four minimum criteria before the sample is considered to be sufficient for purposes of deriving an accurate test result. The Special Master recommended ap-

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proval, in general, of four minimum criteria for a breath sample, which are: (1) minimum volume of 1.5 liters; (2) minimum blowing time of 4.5 seconds; (3) minimum flow rate of 2.5 liters per minute; and (4) that the IR measurement reading achieves a plateau (i.e., the breath alcohol does not differ by more than one percent in 0.25 seconds). However, the Special Master also found that there was credible evidence to support lowering the minimum breath volume from 1.5 to 1.2 liters for women over the age of sixty. He recommended that the State reprogram the device to reflect that finding, but found no need to lower the minimum volume for the general population.

Although both defendants and the State agreed with these recommendations, the amicus NJSBA suggested that the minimum breath volume be reduced to 1.2 liters for all persons, so as to avoid a potential equal protection challenge to the tests. Because no party has raised a challenge to any of these criteria other than the minimum required volume and because the Special Master's findings as to the other minimum criteria are based on substantial credible evidence, we consider only the minimum breath volume issue.

1. Scientific Data Concerning Breath Volume

Breath alcohol concentration increases, in general, as exhalation continues and deep alveolar air is expelled. The rate of increase in alcohol concentration declines as a person exhales, but the breath alcohol *140 concentration itself continues to increase until exhalation ends. The record reflects that the minimum breath volume for the Alcotest in New Jersey was fixed at 1.5 liters because the State's experts believe that this volume will exceed *98 the point after which most of the relatively rapid rise in concentration has occurred and the average person is in a fairly level part of the exhalation curve. In addition, the State's experts contend that 1.5 liters is the minimum volume necessary for an accurate BAC calculation because samples of lesser volume, in general, do not include deep lung air.

At present, the most commonly used minimum breath sample among the states is 1.5 liters. That requirement,

however, is not universal. For example, Alabama, where the Alcotest is currently in use, has adopted a minimum sample requirement of 1.3 liters for all test subjects. Moreover, although the experts generally agreed that 1.5 liters is the optimal minimum, some people may be incapable of providing that sample.

In particular, the record demonstrates that as women age, they have an increasingly difficult time producing a 1.5 liter breath sample. Data from Alabama introduced during the proceedings shows that women aged sixty to sixty-nine have more difficulty producing the 1.5 liter minimum requirement than their younger counterparts. One of the State's experts cited a study from Germany FN23 that demonstrated that women from age sixty- to sixty-nine have an average breath volume of 1.4 liters, women seventy and over have an average of 1.3 liters, and women eighty and over have an average volume of 1.2 liters. The German study included data that demonstrates that men, regardless of age, were capable of producing a sample of 1.5 liters. Indeed, Brettell also conceded that his own study data confirmed the accuracy of the assertion that older women were the only ones unable to produce a sample of 1.5 liters.

FN23. Although it is not entirely clear, it appears that the study, a copy of which was marked in evidence, is only available as an unpublished manuscript. See G. Schoknecht & B. Stock, *The Technical Concept for Evidential Breath Testing in Germany* 1 (1995)(unpublished manuscript, Institute of Biophysics).

Based on this data and the expert opinions offered during the hearing, the Special Master recommended that the minimum *99 breath sample be fixed at 1.5 liters for all test subjects except for women over the age of sixty. He suggested that the device be reprogrammed to require women over the age of sixty to provide a 1.2 liter minimum sample for a valid test result. Although defendants and the State agreed with these recommendations, the NJSBA suggests that this Court should instead require that the minimum required sample volume for all subjects be reduced from 1.5 to 1.2 liters in order to avoid a future potential equal protection challenge.

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There is substantial credible evidence in the record to support the Special Master's findings and recommendations concerning the required minimum breath sample volume. The assertion by the NJSBA that adopting a different standard for women over the age of sixty than we apply to all other test subjects might give rise to an equal protection challenge, however, requires our careful consideration.

[6] The minimum breath volume is significant, in and of itself, because the Alcotest is programmed to determine whether the four minimum criteria have been met in a precise order, the first of which is the volume analysis. A sample that falls short of the currently required 1.5 liter volume measurement will be found to be unacceptable.*141 In that event, the Alcotest will report the amount of air delivered and will display an error message which reads: "minimum volume not achieved." The Alcotest permits up to eleven attempts to collect two breath samples, after which, the only options that the device offers are "terminate" or "refusal." If the operator chooses terminate, the Alcotest will reset and the subject can then be given the opportunity for eleven more attempts. If the operator chooses "refusal," the test sequence ends, but the operator is not required to issue a summons for refusal. *N.J.S.A.* 39:4-50.4a. Charging an arrestee with refusal remains largely within the officer's discretion. See generally *State v. Widmaier*, 157 N.J. 475, 724 A.2d 241 (1999).

Although an Alcotest operator has several options if the device reports that the test sample is inadequate, the fact remains that *100 one of them, refusal, carries with it the possibility of severe sanctions. See *N.J.S.A.* 39:4-50.4a. In the face of abundant evidence in the record that there is an identifiable group in the test population who may be physiologically incapable of complying, the risk of permitting the device to reject samples from members of that group and, by extension, authorizing the issuance of a summons for refusal, is unjust.

By the same token, however, if the machine were reprogrammed to accept the lowered volume from a woman of the appropriate age, even if she could produce the ordinarily required higher volume but attempted to limit her breath output to avoid producing the deep lung air

needed for the most accurate analysis, the machine would reject the sample because it would not achieve the plateau. It is therefore clear that lowering the volume for this identifiable group of test subjects will not, in reality, afford them any advantage over others. The constitutional question raised by the NJSBA, however, also requires us to consider whether it will disadvantage the other individuals required to take the test.

2. Equal Protection and Lowered Breath Volume Requirement

Lowering the minimum breath volume for women over sixty implicates both age and gender classifications and requires us to consider a potential challenge brought pursuant to both the federal and state constitutions. Because these standards are different and because the decision-making paradigm is different in the federal and state courts, we address them in turn.

[7] The Equal Protection Clause of the United States Constitution mandates that no state shall "deny to any person within its jurisdiction the equal protection of the laws." *U.S. Const.* amend. XIV, § 1. The Equal Protection Clause "is essentially a direction that all persons similarly situated should be treated alike." *City of Cleburne v. Cleburne Living Ctr., Inc.*, 473 U.S. 432, 439, 105 S.Ct. 3249, 3254, 87 L.Ed.2d 313, 320 (1985). The federal equal protection analysis looks to the characteristics of the impacted protected class or the nature of the right being affected by the government action.

*101 [8][9][10] The federal test used to evaluate an age-based challenge is concerned with whether "the age classification in question is rationally related to a legitimate state interest. The rationality commanded by the Equal Protection Clause does not require States to match age distinctions and the legitimate interests they serve with razorlike precision." *Kimel v. Fla. Bd. of Regents*, 528 U.S. 62, 83, 120 S.Ct. 631, 646, 145 L.Ed.2d 522, 542 (2000). On the other hand, if the government distinguishes between males and females, the classification is subject to a heightened *142 scrutiny. *Nev. Dep't of Human Res. v. Hibbs*, 538 U.S. 721, 728, 123 S.Ct.

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1972, 1978, 155 L.Ed.2d 953, 963 (2003). For a gender classification to survive this scrutiny, the government "must show 'at least that the [challenged] classification serves 'important governmental objectives and that the discriminatory means employed' are 'substantially related to the achievement of those objectives.'" *United States v. Virginia*, 518 U.S. 515, 533, 116 S.Ct. 2264, 2275, 135 L.Ed.2d 735, 751 (1996) (alteration in original) (quoting *Miss. Univ. for Women v. Hogan*, 458 U.S. 718, 724, 102 S.Ct. 3331, 3336, 73 L.Ed.2d 1090, 1098 (1982) (quoting *Wengler v. Druggists Mut. Ins. Co.*, 446 U.S. 142, 150, 100 S.Ct. 1540, 1545, 64 L.Ed.2d 107, 114 (1980))).

Unlike its federal counterpart, the New Jersey Constitution does not contain an equal protection clause. Instead, we have found that "[a] concept of equal protection is implicit in Art. I, par. 1 of the 1947 New Jersey Constitution...." *McKenney v. Byrne*, 82 N.J. 304, 316, 412 A.2d 1041 (1980). Therefore, even though Article I, paragraph 1 of our Constitution does not include the phrase "equal protection," "it is well settled law that the expansive language of that provision is the source for [this] fundamental constitutional guarantee []." *Sojourner A. v. N.J. Dep't of Human Servs.*, 177 N.J. 318, 332, 828 A.2d 306 (2003).

[11] "Although conceptually similar, the right under the State Constitution can in some situations be broader than the right conferred by the Equal Protection Clause." *Doe v. Poritz*, 142 N.J. 1, 94, 662 A.2d 367 (1995). Indeed, we have held that our *102 Constitution provides "analogous or superior protections to our citizens" in the context of equal protection. *Peper v. Princeton Univ. Bd. of Trs.*, 77 N.J. 55, 79, 389 A.2d 465 (1978).

[W]here an important personal right is affected by governmental action, this Court often requires the public authority to demonstrate a greater "public need" than is traditionally required in construing the federal constitution. Specifically, it must be shown that there is an "appropriate governmental interest suitably furthered by the differential treatment."

[*Taxpayers Ass'n of Weymouth Twp. v. Weymouth*

Twp., 80 N.J. 6, 43, 364 A.2d 1016 (1976) (citing *Collingswood v. Ringgold*, 66 N.J. 350, 370, 331 A.2d 262 (1975)).]

In considering equal protection-based challenges, we have not followed the traditional equal protection paradigm of the federal courts, which focuses rigidly on the status of a particular protected class or the fundamental nature of the implicated right. Instead, when analyzing equal protection challenges under New Jersey's Constitution, we have applied a balancing test that weighs the "nature of the affected right, the extent to which the governmental restriction intrudes upon it, and the public need for the restriction." *Caviglia v. Royal Tours of Am.*, 178 N.J. 460, 473, 842 A.2d 125 (2004) (quoting *Greenberg v. Kimmelman*, 99 N.J. 552, 567, 494 A.2d 294 (1985)).

[12] Finally, in addressing equal protection challenges raised in the context of the exercise of police power, we have held that "[t]he constitutional principles of due process and equal protection demand that the exercise of the power be devoid of unreason and arbitrariness, and the means selected for the fulfillment of the policy bear a real and substantial relation to that end." *Katobimar Realty Co. v. Webster*, 20 N.J. 114, 123, 118 A.2d 824 (1955).

There are, in theory, two potential equal protection challenges to the adoption of a *143 different minimum volume standard for women over the age of sixty. First, one could argue that the lowered volume allows testing of a smaller sample of shallower depth and therefore results in a lower BAC reading. As to this challenge, it is undisputed that the device will not accept a sample that has not reached a plateau. An older woman who is capable of *103 producing a greater volume of air but does not do so can be identified by her failure to meet the plateau. Therefore, we can be certain that all test subjects, regardless of age or gender, will only achieve a valid sample when the deeper lung air is included.

Second, one could argue that the differentiation permits older women who produce a sample with a volume between 1.2 and 1.5 liters to avoid being charged with refusal but exposes both younger women and all men

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who provide samples of the same volume to be prosecuted with that offense. The record on which the differentiation between the test groups is based, however, demonstrates that the older women, and only the older women, may be physically incapable of producing the larger sample.

[13] The right to equal protection does not require us to scrutinize gender distinctions that are based on real physiological differences to the same extent we would scrutinize those distinctions when they are based on archaic, invidious stereotypes about men and women. See *State v. Vogt*, 341 N.J.Super. 407, 418, 775 A.2d 551 (App.Div.2001) (recognizing that "[t]he Equal Protection Clause ... does not demand that things that are different in fact be treated the same in law, nor that a state pretend that there are no physiological differences between men and women"). Similarly, the federal courts have recognized that not all sex-based differentiations are actionable. For example, in the employment context some "standards that appropriately differentiate between the genders are not facially discriminatory." *Jespersen v. Harrah's Operating Co.*, 444 F.3d 1104, 1109-10 (9th Cir.2006); see *Healey v. Southwood Psychiatric Hosp.*, 78 F.3d 128, 132 (3d Cir.1996) (recognizing that gender may, in certain defined circumstances, be a bona fide occupational qualification for employment).

[14] Applying the principles we have derived from both the federal and state constitutional analyses, we discern no meritorious ground for an equal protection challenge to the proposed two-tiered approach for minimum breath sample volume, regardless of which level of scrutiny we apply. Viewed against our flexible approach to equal protection challenges as derived from Article I, *104 paragraph 1 of our Constitution, the system survives the constitutional challenge. The governmental policy of achieving accurate breath samples as part of law enforcement's role in ridding our roads of drunk drivers is appropriately coupled with the authority to prosecute for refusal. The proposed two-tiered system for minimum breath volume, however, is neither unreasonable nor arbitrary for it advances these goals without holding the identified class, older women, to a standard

that they cannot meet. In this manner, the policy goals are fulfilled through "means ... [that] bear a real and substantial relation to that end." *Katobimar, supra*, 20 N.J. at 123, 118 A.2d 824.

Similarly, under either the rational relationship test applicable to age-based classifications, or the heightened level of scrutiny applied to gender-based classifications under the federal constitution, the lowered requirement for women over sixty passes constitutional muster. The policy goals we have identified for our state constitutional analysis are, in federal parlance, "important governmental objectives," see *144 *Hibbs, supra*, 538 U.S. at 728-29, 123 S.Ct. at 1978, 155 L.Ed.2d at 963. The selection of the two tiers for this aspect of the test requirements is both rationally related to those goals and "substantially related" to their achievement. *Ibid.*

Notwithstanding the concern voiced by the NJSBA, there is no scientific or other ground in the record to direct that the minimum volume be lowered for all test subjects. On the contrary, there is ample support for the Special Master's two-tiered approach and we discern no equal protection violation in lowering the required breath volume to 1.2 liters for women over the age of sixty.

3. Application to Pending Prosecutions

Our conclusion that the firmware must be revised to accept a minimum breath volume sample of 1.2 liters from women over the age of sixty requires us to consider the impact of this directive for pending prosecutions. We presume that there may be women who meet this criteria and whose prosecutions have been stayed pending our decision on these issues. For the sake of completeness of our analysis, we address briefly the possible factual *105 scenarios relevant to these defendants. First, there may be defendants who attempted but failed to achieve a sufficient volume for an acceptable sample. These individuals will be readily identified by an AIR with a breath volume error message. Obviously, proof of the charge of drunk driving for these women can only be based on observational proofs because there will be no reportable BAC results in an AIR.

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[15] The significance of the lowered breath sample volume, however, rests less in the evidence utilized to support a charge of drunk driving and more in its relationship to a charge of refusal. In light of the scientific evidence that we have found to be persuasive, in the absence of some other evidence that supports the conclusion that any such individual was capable of providing an appropriate sample, by volume, we must assume that she was unable to do so. For these individuals, then, an AIR demonstrating insufficient breath volume may not be used as proof on a charge of refusal. On the other hand, if the AIR demonstrates that a woman over the age of sixty was able to provide at least one sample that was deemed to be sufficient for purposes of the 1.5 liter volume requirement, but she failed to do so on a subsequent attempt, the AIR demonstrating those facts may be utilized as evidence, albeit not conclusive proof, in support of a refusal charge.

C. Breath Temperature Sensor

The Special Master also recommended that in the future the State acquire and utilize a breath temperature sensor device separately marketed by Draeger,^{FN24} and that, in the interim, all *106 previously reported results be reduced by 6.58 percent to account for breath variations in individuals tested. (Special Master's Finding 9). This recommendation was based on the Special Master's factual findings about breath temperature.

FN24. There are several temperature devices related to the Alcotest. One, which is an integral part of each device, and the report of which is included on the AIR, heats the simulator solution in the control test both in the device and, by extension, in the calibration process. Another heats the breath tube, but not the subject's actual breath sample, to prevent condensation. The device that is the focus of this recommendation, is an optional device that tests the temperature of the actual breath sample and reports it.

[16] We are compelled to reject this recommendation because there is insufficient support in the record for

the factual *145 findings on which it is based. In particular, the Special Master found that "[m]ost breath analyzers used in the United States operate on the assumption that the temperature of an expired breath sample is 34 degrees C[elsius]," but that "[r]ecent scientific research supports the proposition that the temperature of an expired breath sample is actually almost 35 degrees C[elsius]." He then found that BrAC increases by 6.58 percent for each degree above thirty-four degrees Celsius, and reasoned that all BAC results should be reduced by 6.58 percent to ensure their accuracy and that the optional breath temperature sensor should be used in the future. He noted, in support of his recommendation, that the State of Alabama requires reduction of all breath results from the Alcotest by this percentage.

Although defendants and the NJSBA urge this Court to adopt this finding and recommendation, in part based on the assertion that the most relevant scientific community is Alabama, the State argues that Alabama's program is an aberration and that this recommendation is both unsupported and unsound.

We are persuaded to agree with the State for both evidentiary and practical reasons.^{FN25} First, the record reflects that the generally accepted average temperature for human breath is 34 degrees Celsius. Only one study, performed in Alabama and therefore *107 relevant for that jurisdiction's purposes, concluded that the average breath temperature is closer to 35 degrees Celsius. At best, then, there is a debate about average breath temperature. In fact, however, there is no support in the record for the Special Master's assumption that a rise in breath temperature increases BrAC.

FN25. We reject, however, the State's suggestion that a measuring device that might more accurately determine BAC and serve as a basis for a per se prosecution is an "option" that falls within the sole discretion of the State in performing its prosecutorial function. Rather, to the extent that the State seeks to utilize a device, like the Alcotest, to prove a per se violation of the statute, we think it abundantly plain that the decision as to the accuracy of any innovation for proof purposes, consistent with

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our Constitution, is ours to make.

Notwithstanding that, some of the experts conceded that a one-degree Celsius increase in breath temperature could theoretically produce a 5.5 to 6.8 percent increase in BrAC, assuming that all other variables remained constant. Accordingly, a one-degree Fahrenheit increase in breath temperature could theoretically cause the BrAC to rise by 3.8 percent. There is, however, no evidence in the record that this theoretical increase translates into an inaccurately elevated BAC result.

Moreover, all of the experts agreed that even a theoretical possibility of a link would not alter the reported BAC readings in practice. That is, if a person with a normal temperature submitted a breath sample with a 0.07 percent BAC, that person's breath test would be read as being over 0.08 percent BAC only if he had a 2.5 degree-Celsius or 4.5 degree-Fahrenheit increase in body temperature. There is no evidence in the record from which we can conclude that there is any risk that any individuals with such an elevated temperature are even being tested. There is also no evidence in the record to support the finding that the average breath temperature exceeds 34 Celsius or that an elevation of the breath temperature, in and of itself, results in an elevated BAC reading.

Second, to the extent that there might be a relationship between the breath temperature of the subject submitting the sample and BAC, there is significant evidence in the record to support the finding that an independent device to measure that temperature*146 or to reduce the results to account for it ^{FN26} would be redundant. *108 The device as currently configured incorporates two methods that account for any possible overestimation of the BAC reading that an elevated breath temperature might theoretically cause, and they operate to the benefit of the person being tested. Both the truncation of results and the use of the 2100 to 1 blood/breath ratio, a ratio that in part takes temperature into account, effectively underestimate the calculation to the advantage of the test subject.

FN26. The record reflects that the Alcotest with the added breath temperature device does

not actually recalculate BAC to account for elevations in breath temperature. Instead, in Alabama, the sensor reports breath temperature and if it is shown to be elevated above 34 degrees Celsius, the court reduces the reported BAC results by a factor of 6.58 percent for every degree.

The debate about the effect of temperature is not new. It was presented specifically in *Foley, supra*, and in part in *Downie, supra*. The trial court in *Foley, supra*, analyzing virtually the same factual assertions as are included in this record, concluded that, apart from a test subject suffering from a very high fever, the natural variation of temperature was subsumed within the variability of the blood/breath ratio. 370 N.J. Super. at 355, 851 A.2d 123. As that court recognized:

The factor of 2100 to 1 was developed by doing studies on persons in the field including both arrested subjects and research subjects. The breath temperature of all these subjects varied. Therefore, the 2100 to 1 ratio already subsumes within it the variation in breath temperature of the general population.

[*Ibid.*]

We, too, have previously considered the relationship, in general, between temperature and the blood/breath ratio, see *Downie, supra*, 117 N.J. at 462-63, 569 A.2d 242. We there concluded that the utilization of the 2100 to 1 ratio adequately accounts for any small impact that a particular subject's elevated temperature might potentially have on the result.

Our review of the record convinces us that the Alcotest BAC reading would not be made more accurate by the addition of the breath temperature sensor or by the across-the-board reduction of all values by 6.58 percent to account for the theoretical temperature factor as suggested by the Special Master. More to the *109 point, perhaps, we reach our conclusion for practical reasons as well. The un rebutted evidence in the record convincingly demonstrates that requiring the addition of the breath temperature sensors would result in an unreasonable maintenance burden to the program. In fact, the re-

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cord includes detailed descriptions of the added steps, equipment, time and personnel that are necessary simply to maintain and calibrate the temperature sensors.^{FN27} That added practical and logistical burden on the State and the municipalities in New Jersey, while perhaps not prohibitive, is unreasonable in light of the scant basis in the record that might support requiring the sensor.

FN27. Because of the equipment needed to do so, the temperature sensors cannot be maintained or calibrated on-site. Instead, the equipment must be taken out of service and moved to a central location for these purposes, resulting in the need for arrestees to be transported to an adjoining municipality for testing while the equipment is undergoing routine maintenance.

Our evaluation of the evidence therefore leads us to reject the Special Master's recommendation concerning utilization of a *147 breath temperature sensor or reduction in BAC results by a 6.58 percent factor as unsupported by the factual record and unnecessary. Rather, we are persuaded that the effect of breath temperature on BAC is theoretical at best, and that the effect, if any, is ameliorated because the Alcotest uses both truncation and the 2100 to 1 blood/breath ratio to calculate BAC. Because both of these safeguards effectively underestimate BAC, any additional subtraction to account for temperature is redundant and unnecessary. We therefore reject the Special Master's finding and recommendations concerning the breath sensor and a 6.58 percent compensating reduction.

D. Acceptable Tolerance Analysis

The Special Master recommended that the firmware be revised to correct the acceptable tolerance among the reported results so as to permit results to be accepted if they are within plus or minus 0.005 percent BAC or plus or minus five percent of the mean for the four readings, whichever is greater. (Special Master's Finding*110 10). Although the State does not dispute the need to correct future firmware versions, both the recommendation of the Special Master as to the accept-

able tolerance range and the effect of this determination upon pending cases require our analysis.

The acceptable tolerance question raises a variety of concerns, including its implications for the validity of any particular test result, our confidence in the accuracy and reliability of a specific Alcotest unit, the need for performance of a third test on any particular test subject, and the appropriate method by which to assess tolerance in light of changes to the quantification of the per se violation in recent years. We address each of these difficult issues in turn.

1. Doubled Tolerance Range in Firmware version 3.11

Tolerance is the range of any set of measurements that is accepted as being representative of a true reading. Precision and accuracy can be ensured by requiring the application of a narrow range for tolerance. Conversely, the wider the acceptable tolerance between reported results, the lower our confidence in the accuracy of any of the reported results. Therefore, for purposes of permitting any device to be utilized for proof of a per se violation of the statute, the acceptable tolerance is of fundamental importance.

As a matter of historical perspective, we first considered the question of acceptable tolerance ranges in *Romano, supra*. There, as a part of our evaluation of whether the test results obtained from two breathalyzer models which might have been affected by radio frequency interference (RFI) could be admissible, we accepted the 0.01 percent BAC standard as a scientifically reliable tolerance range, based on the opinions of two experts who so opined, *see Romano, supra*, 96 N.J. at 86, 474 A.2d 1. At the time, the statute created a per se offense for any person whose BAC was 0.10 percent or greater, *see id.* at 78, 474 A.2d 1. As we articulated the tolerance analysis in *Romano*, "admissibility is satisfactorily established ... [i]f the breathalyzer results consist of two tests or readings within a tolerance of 0.01 percent of each *111 other...." *Id.* at 87-88, 474 A.2d 1. The point, of course, was that if a breathalyzer that might be influenced by RFI could nevertheless read two separate breath samples with results within this range, we would

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presume those results were unaffected by external influences and, therefore, valid.

After our decision in *Romano*, the 0.01 percent BAC tolerance range became the benchmark against which all breathalyzer *148 results, not just those from RFI-susceptible models, were tested for general reliability and accuracy. In *Downie*, we again referred to the 0.01 percent BAC tolerance range as a benchmark for reporting accurate results. See *Downie*, *supra*, 117 N.J. at 455, 569 A.2d 242. Although we did not independently evaluate the continuing validity of that tolerance range, we adhered to it as a part of our evaluation of the overall scientific accuracy and reliability of the breathalyzer. Indeed, we have never departed from that standard and have not previously been called upon to consider any different articulation of that accepted range of tolerance.

Prior to the trial court's decision in *Foley*, the tolerance range for the Alcotest was fixed by the software to be 0.01 percent BAC or a range of ten percent for all samples. That range was determined by Brettell when the Alcotest program was first devised. The range, however, was tested by reference to the arithmetic mean, the effect of which halves the expression of the range. In addressing the challenge to the tolerance as being inconsistent with *Romano*, the court in *Foley* described the tolerance as fixed in the Alcotest in somewhat different terms. The *Foley* court explained that our long-accepted standard of a required tolerance of 0.01 percent BAC between two breath samples was the "strictest standard in the United States," and concluded that, as applied to the four results derived by Alcotest, "the additional parameter of ± 10 [percent] is within the tolerance considered acceptable for reliable results by the scientific community." *Foley*, *supra*, 370 N.J.Super. at 357, 851 A.2d 123.

In so articulating the tolerance range, however, the court did not simply re-articulate a long-accepted tolerance, expressing it as *112 a percentage rather than an absolute. Nor did it accurately express the tolerance used by the device, an earlier version of software known as Firmware version 3.8, in which the tolerance was expressed in alternate terms. Rather, the court, inadvertently, we think, endorsed a tolerance range that effect-

ively doubled that which we have allowed.

There are several considerations arising from this expanded tolerance that are now before us. First, the use of a percentage tolerance range tends to permit readings at higher levels that are wide of the previously accepted 0.01 percent BAC standard. This might lead to results that are, in and of themselves suspicious in terms of their intrinsic reliability. That is to say, although for purposes of guilt, it might not matter whether we accepted two test results that were within ten percent but beyond 0.01 percent BAC of each other, those results might raise a concern about the overall reliability of the particular machine. Second, however, use of an absolute rather than a percentage might arguably disadvantage subjects whose test results are at the lower end of the range by accepting test results that are, by percentage, more widely separated and that would be rejected as out of tolerance were a percentage analysis applied.

Third, in some measure the amendments to the statute and the creation of new per se offenses, not extant when we considered the acceptable tolerance in *Romano* and *Downie*, makes our evaluation of this issue more complex. In the abstract, tested against a statute that only utilized one per se test for drunkenness, namely, 0.10 percent BAC, our acceptance of the single test for acceptable tolerance was well supported in the scientific record. The question, in light of the lowered per se limits now in force, is what we should demand in terms of precision to demonstrate accuracy and support admissibility.

*149 Taking into account these considerations, we turn to an evaluation of the evidence in the record concerning tolerance and its significance. At present, assuming the subject has provided an otherwise acceptable sample, the Alcotest reports the EC and IR *113 results of the first sample. The device is programmed to accept the EC and IR test results from a second sample only if those results are within its programmed tolerance of the EC and IR results from the first breath sample. If the second-sample results are not within the tolerance, the Alcotest will record the results, but require a third sample.

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For Firmware version 3.8, used in the Alcotest program at issue in *Foley*, Brettell testified that he set the tolerance in accordance with the breathalyzer tolerance expressed in *Downie*. He interpreted the *Downie* standard to mean that two breath tests had to be within 0.01 percent BAC of each other when the mean BAC measured below 0.10 percent BAC, which was the per se level when *Downie* was decided. Brettell testified that, notwithstanding the fact that the Court never varied from the 0.01 percent BAC standard, he assumed we intended a tolerance of ten percent for BAC values above 0.10 percent BAC. Therefore, Firmware version 3.8 was programmed to accept the second breath test if there was no more than 0.01 percent BAC or ten percent between the highest and lowest readings.

Notwithstanding Brettell's acknowledgment that he knew that the *Foley* statement about tolerance was mathematically incorrect, he concedes that following the decision in *Foley*, the State directed Draeger to reprogram the device so as to take advantage of that far wider, effectively doubled, range for tolerance. He explained that he did so to make the test conform with programs in other states and to address criticism of the relative frequency with which the device in *Foley* rejected results for being out of tolerance and required the administration of a third test. Brettell believed that taking advantage of the court-sanctioned wider tolerance would alleviate a similar challenge in the future. The State concedes that Firmware version 3.11 did precisely that, creating a range of either plus ten percent or minus ten percent of the mean, for a doubled tolerance.^{FN28}

FN28. There is, in addition, a further distinction that is a subtle one. Using a range, whether expressed in absolute or percentage-based terms, when comparing two numbers as in *Romano*, is not the same as expressing the same range for tolerance among four numbers as evaluated against their arithmetic mean. Technically, Firmware version 3.11 is a good deal more sophisticated in its measure for tolerance. In fact the device tests tolerance as the greater of plus or minus ten percent of the mean of all four results or plus or minus 0.01 percent BAC

of that mean.

*114.2. Expert Testimony

Although New Jersey, prior to the introduction of Firmware version 3.11, in compliance with our decision in *Romano* and *Downie*, adhered to the 0.01 percent BAC tolerance standard, there is no general agreement among the states as to what standard is acceptable. Many states other than New Jersey utilize the 0.01 percent BAC tolerance standard as well, but the National Safety Council, for example, recommends a tolerance of no more than 0.02 between the highest and lowest readings.

One of the State's witnesses, Rod Gullberg, testified about his previously published conclusions on tolerance measurement. He opined, therefore, that the Firmware version 3.11 tolerance is too broad. See R.G. Gullberg, *Determining an Appropriate Standard for Duplicate *150 Breath Test Agreement*, 39 *Can. Soc'y Forensic Sci. J.* 15, 23 (2006). Instead, he recommended using plus or minus five percent of the mean of the four tests. He estimated that if the firmware were changed to utilize this tolerance, the number of people who would have to submit additional samples would increase by approximately five percent. That estimate is mirrored by a comparison of the data from Pennsauken, in which Firmware version 3.8 was used, with the data from Middlesex County, in which Firmware version 3.11, with its doubled tolerance, was used.

Another of the State's witnesses, Hansueli Ryser, explained that if New Jersey used a tolerance of plus or minus 0.005 percent BAC, or plus or minus five percent, of the mean, whichever is greater, then for mean measurements below 0.10 percent BAC, the acceptable tolerance would be plus or minus 0.005 percent BAC. As an example, if a person had a mean alcohol concentration of 0.08 percent BAC, the tests would be in tolerance if they fell *115 between 0.075 and 0.085 percent BAC.^{FN29} For mean concentrations above 0.10 percent BAC, the relevant tolerance would be plus or minus five percent.

FN29. The significance of tolerance, as this example demonstrates, is related to the truncation

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procedure. A test subject with results ranging from 0.075 to 0.085 would not be guilty of the per se violation because the machine must report the lowest truncated value, here 0.07 percent BAC. By the same token, however, the machine could not reject these results and subject the individual to a third test, with a potentially higher BAC.

Brettell testified that he planned to "revisit" the tolerance because it had caused "so much litigation." He testified that the 0.02 percent BAC National Safety Council recommendation might be the easiest to adopt, but he preferred the use of a combination of a set value and a percentage because the percentage would account for scientifically defensible wider tolerance at very high values. Overall he favored ^{FN30} plus or minus 0.005 percent BAC from the mean or plus or minus five percent of the mean, whichever was greater.

FN30. We are constrained to observe that, for purposes of assessing scientific accuracy and therefore admissibility in evidence as proof of a per se violation, "ease" and "simplicity" are irrelevant. Similarly, a test based on whatever the current director of the program "favors" is unlikely to withstand scrutiny.

3. Future Firmware Revisions

[17] Although we have never considered the use of a tolerance other than the absolute 0.01 authorized in *Romano*, intervening legislative enactments require us to address the continuing validity of that standard. At the time that we decided the question of acceptable tolerance in *Romano*, there was but one per se standard for drunk driving prosecutions, namely, the 0.10 percent BAC. Since that time, however, the Legislature has reduced that per se limit to 0.08 percent BAC, while maintaining the 0.10 percent BAC standard for enhanced punishment.^{FN31} The issue is *116 what measure of tolerance comports with scientifically reliable, and therefore admissible, results.

FN31. In addition, the separately-adopted per se limits that apply to commercial drivers (0.04

percent BAC) and individuals under the legal drinking age (0.01 percent BAC) are entirely new. Although the effect of the absolute measure of tolerance might have less validity when applied to these separate offenses, it is not challenged here and we do not address it.

Expressing the tolerance in terms of the greater of the absolute or a percentage of deviation from the mean authorizes, in effect, a wider range of tolerance at the higher readings. There is, in this record, evidence that demonstrates to our satisfaction that at the higher readings, all measures*151 of BAC are somewhat less precise than they are at the lower ranges. As a result, the wider tolerance expressed by a percentage deviation from the mean applied to the upper ranges of possible readings does not suggest that the device is not working properly. At the lower readings, in contrast, a deviation outside of the tolerance limit we have traditionally required most assuredly will raise a question about the functioning of the particular device.

Our evaluation of the record compels us to conclude that, even in light of the lowered overall per se limit adopted since *Romano*, the continued use of the absolute 0.01 percent BAC standard, coupled with the use of a like range of tolerance expressed as a percentage deviation from the mean, is both scientifically appropriate and consistent with our understanding of the intention of the Legislature in adopting these per se limits.

To the extent that Firmware version 3.11 took advantage of an explanation of the tolerance range in *Foley* that inadvertently doubled the permissible range, however, it cannot be sustained. We therefore direct that for future firmware revisions, the device be programmed to fix the tolerance range to be plus or minus 0.005 percent BAC from the mean or plus or minus five percent of the mean, whichever is greater, in order to ensure scientifically accurate, admissible test results.

4. Application to Pending Prosecutions

[18] Our inquiry, however, cannot end there. There is stark evidence in the record, based on a comparison of

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the data from the *117 Pennsauken program, in which the device with Firmware version 3.8 and the appropriate tolerance was utilized, with the data collected in Middlesex County, using Firmware version 3.11 and its doubled range, that the intervening expansion of the tolerance range resulted in tests being deemed acceptable by the device that cannot meet the tolerance range we have required. In fact, the data demonstrates that precisely the effect that Brettell desired, namely, reducing the frequency of out of tolerance readings that required third samples, was achieved to the point of apparent elimination. The Special Master, while recommending that the software be revised for future uses to reflect his analysis of acceptable tolerance ranges, did not regard the State's adoption of a different and widely expanded tolerance to be problematical for pending prosecutions. The State urges us to adopt this finding that the doubled tolerance had no effect on any defendant's substantive rights. We disagree.

The simple fact is that the tolerance range is a critical component in our conclusion that this or any other device correctly and accurately measures breath alcohol and converts that data into a scientifically reliable, accurate BAC analysis. Our acceptance of those results for purposes of supporting, without more, a criminal conviction, must be based on our conclusion that the results are reliable and accurate. The use of a doubled tolerance, however, deprived some percentage of test subjects of a third, and perhaps dispositive, test. At the same time, it undermines our confidence in the accuracy of the reports of those tests that fall outside of the range that we have demanded be utilized as a prerequisite for scientific accuracy and that undergirds admissibility in a criminal proceeding.

It is easy enough to identify those individuals for whom a third test should have been given. To be sure, if we had the third test data for those defendants, some of them would achieve a result within the authorized tolerance and thus be shown to have violated the per se limits. But just as surely, there may be others for whom a *152 third test would have yielded a result still further out of *118 range so as to, perhaps, call the accuracy of the particular machine into question. And it is even pos-

sible that there might be a defendant for whom a third test would result in a reading that would meet the test for tolerance but would exonerate that individual.

The suggestion that we permit those test results that are outside of the range for tolerance to be utilized for purposes of a per se conviction unfortunately is, simply put, unacceptable. Zealousness in ridding our roads of drunk drivers cannot overcome our ordinary notions of fairness to those accused of these offenses. Therefore, we are constrained to direct not only that future firmware updates utilize the tolerance computation that we have concluded is acceptable, but that all pending prosecutions include an evaluation of whether the two reported test results exceeded this acceptable tolerance.

Any AIR that reports results from tests of only two breath samples, therefore, must be analyzed to determine whether its results are within our accepted tolerance by use of a mathematical calculation. The appropriate calculation for this purpose will consist of applying the following formula: (a) add the IR and EC results given for the first breath sample to the IR and EC results for the second breath sample; (b) divide the sum calculated in (a) by 4 to derive the arithmetic mean; (c) compute the upper limit of tolerance by taking the larger value of the mean multiplied by 1.05 or the mean plus 0.005 percent BAC; (d) compute the lower limit of tolerance by taking the smaller of the value of the mean multiplied by 0.95 or the mean minus 0.005 percent BAC; (e) if all of the IR and EC results of the two samples fall within the upper and lower limits of the tolerance range, the AIR is valid, but if any of the results fall outside of the tolerance range, the AIR is not valid.

Although we have prepared a worksheet that is attached to the order that accompanies this opinion for use in all prosecutions pending reprogramming of the device, two examples will, we think, illustrate the way in which the formula should be utilized in *119 practice to differentiate between an AIR that reports results within tolerance and one that does not. If, for example, a defendant's first breath test sample yielded an IR result of 0.100 percent BAC and an EC result of 0.101 percent BAC, and the second sample yielded an IR result of 0.104 percent BAC and an EC result of 0.103 percent BAC, the calcu-

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lations would be performed as follows:

(a) first all four of the results (two IR and two EC) would be added, in this example, $0.100 + 0.101 + 0.104 + 0.103 = 0.408$;

(b) next, the arithmetic mean would be derived by dividing that sum by four, $0.408 / 4 = 0.102$;

(c) then the upper limit of acceptable tolerance must be determined by comparing the two methods for computing the range, namely, the use of the absolute or the percentage. This is done by computing each separately and selecting the greater of the two. In this example, the computation would yield the following options: $(0.102 \times 1.05 = 0.1071)$ OR $(0.102 + 0.005 = 0.1070)$. Because the greater of these is 0.1071, that will be the correct upper tolerance limit;

(d) next, the lower limit of acceptable tolerance must be derived by comparing the two methods for computing the range, again, by using the absolute and the percentage calculations. This is done by computing each separately and selecting the lesser of the two. In this example, the computation would yield the following options: $(0.102 \times 0.95 = 0.0969)$ OR $(0.102 - 0.005 = 0.0970)$. Because the lesser of these is 0.0969, that will be the correct lower tolerance limit; and

(e) finally, by comparing all four of the reported test sample results (0.100, 0.101, 0.104, 0.103) against this accepted tolerance range of 0.0969 to 0.1071, it becomes plain that, in this example, the *AIR is valid* because all four test results fall within the accepted tolerance range.

Because the Firmware version 3.11 utilized a doubled tolerance range, there will be AIRs that will not meet the test for tolerance that we have deemed to be permissible. We therefore provide a further example to illustrate the calculations relating to an AIR that would be out of tolerance under this standard and, therefore, inadmissible in a prosecution. If, for example, a defendant's first breath test sample yielded an IR result of 0.089 percent BAC and an EC result of 0.080 percent

BAC, and the second sample yielded an IR result of 0.091 percent BAC and an EC result of 0.084 percent BAC, the calculations, which would be performed in the same manner, would yield a different outcome, as follows:

(a) first, all four of the results (two IR and two EC) would be added, in this example, $0.089 + 0.080 + 0.091 + 0.084 = 0.344$;

*120 b) next, the arithmetic mean would be derived by dividing that sum by four, $0.344 / 4 = 0.086$;

(c) then the upper limit of acceptable tolerance must be determined by comparing the two methods for computing the range, namely, the use of the absolute or the percentage. This is done by computing each separately and selecting the greater of the two. In this example, the computation would yield the following options: $(0.086 \times 1.05 = 0.0903)$ OR $(0.086 + 0.005 = 0.0910)$. Because the greater of these is 0.0910, that will be the correct upper tolerance limit;

(d) next, the lower limit of acceptable tolerance must be derived by comparing the two methods for computing the range, again, by using the absolute and the percentage calculations. This is done by computing each separately and selecting the lesser of the two. In this example, the computation would yield the following options: $(0.086 \times 0.95 = 0.0817)$ OR $(0.086 - 0.005 = 0.0810)$. Because the lesser of these is 0.0810, that will be the correct lower tolerance limit; and

(e) finally, by comparing all four of the reported test sample results (0.089, 0.080, 0.091, 0.084) against this accepted tolerance range of 0.0810 to 0.0910, it becomes plain that, in this example, the *AIR is invalid* because the first breath sample's EC result (0.080) does not fall within the accepted tolerance range.

The use in Firmware version 3.11 of the doubled tolerance range, which we have rejected, requires that all AIRs that report results of only two breath samples be tested for validity against the tolerance range we have accepted. Therefore, in all prosecutions stayed by our January 10, 2006 Order, the State shall review the BAC

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results as reported in the AIR and shall calculate whether those results fall within tolerance, and the court shall review those calculations and make them a part of the record. In those cases in which this review reveals that the results fall outside of the acceptable tolerance, the AIR cannot be deemed to be sufficiently scientifically reliable to be admissible and it shall not be admitted into evidence as proof of a per se violation.

IX. Source Code Remand

We turn, then, to a series of issues that arose following the supplemental remand *154 for evaluation of the source code. Not all of the firmware issues we must address are disputed, but our review of the record has identified issues that bear on the extent and manner in which existing AIR results may be utilized in pending prosecutions. We begin with the software-based questions that are in dispute.

*121 A. EC Readings and Fuel Cell Drift Algorithm

One of the most controversial findings that came out of the second remand proceedings, during which the parties were afforded the opportunity to undertake an analysis of the source code that is the heart of the operation of the Alcotest device, related to the EC readings. During the proceedings, the Special Master summoned Brian Shaffer, a Draeger employee responsible for the code and for implementing changes to the New Jersey Firmware since the *Foley* decision, to testify. Near the end of his testimony, Shaffer revealed that Firmware version 3.11 utilizes a compensating algorithm to account, in part, for a phenomenon known as fuel cell drift.

As Shaffer explained it, the EC reading is obtained by passing an electrical current through a small sample of the breath that has otherwise been captured for IR testing in the cuvette. The fuel cell that creates the electrical charge reacts in the presence of alcohol. The reaction of the fuel cell can be represented graphically as a curve and the percentage of alcohol in the breath is measured by calculating the area under the curve mathematically. As fuel cells age, the area under the curve that expresses

the same breath alcohol content is unchanged, but the shape of the curve itself changes from a high sharp peak to a longer, flatter one. As a matter of mathematical computation, the area being measured is the same even though the curves, were they plotted graphically, would appear to be different when observed visually.

According to Shaffer, the flattening of the curve is caused by the aging of the fuel cell, which reacts more slowly and with less intensity to the same amount of alcohol than when the fuel cell is new. This phenomenon, known as fuel cell drift, does not actually alter the accuracy of the EC measurement. However, because the fuel cell begins to react more slowly to the presence of alcohol as it ages, a portion of the area under the curve that is the basis for the alcohol measurement is not captured during the time when the Alcotest EC data is collected. Instead, a portion of the end of the *122 curve is, in essence, cut off, resulting in a lower than accurate measurement.

Because fuel cell drift is a known scientific phenomenon that would otherwise result in an inaccurate underreporting of the percentage of alcohol in the test subject's breath, Draeger added a compensating algorithm into the firmware. The EC fuel cell drift algorithm, therefore, is intended to capture a portion of the missing data and, in theory, create a more accurate result as the reported EC reading. The algorithm, however, does not attempt to quantify the missing area under the curve per se, but instead attempts to compensate in part for the lack of complete data arising from the EC measurement. In the event that fuel cell drift is detected during the control test, the algorithm mathematically increases the EC reading that is reported by up to twenty-five percent of the difference between the IR and EC readings from the tests of the subsequent breath samples.

The compensating algorithm is not routinely applied, but only functions if the appropriate preconditions are met. The device, in performing the control test, compares the EC and the IR readings and *155 accurately reports those results. Because the control test utilizes a known test solution to ensure that the device is functioning properly and that it accurately reads a solution of a known percentage of alcohol, fuel cell drift can be

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detected from the control test's results. If the device detects drift, the algorithm will adjust the EC measurement standard, which, in turn, will slightly increase the reported EC results for the test subject's breath sample to account for the fuel cell drift.

The discovery of the EC fuel cell drift algorithm in the source code prompted the Special Master to conclude that more frequent re-calibration of the devices with replacement of fuel cells that had become "depleted" would reduce reliance on the EC fuel cell drift algorithm and, therefore, increase the accuracy of the readings. The State objects to this proposal as unnecessary and burdensome, arguing that its current program of annual calibration is sufficient.

*123 Defendants, on the other hand, raise several challenges to this EC algorithm, both in theory and in practice. First, they argue that it demonstrates that Draeger's claim that the device uses two completely independent measurements for breath alcohol is false. Second, they argue that it demonstrates that the device is simply not accurate in any sense. Third, they argue that the algorithm, which they attack as having been hidden from them throughout the initial remand proceedings, is evidence that the software may be utilizing other hidden mechanisms that might inflate readings so that the accuracy of the results can never be reliable.

We do not share either the State's or defendants' concerns. The record reflects that a semi-annual inspection and recalibration program recommended by the Special Master is consistent with the manufacturer's recommendations. At the same time, it provides a useful safeguard by affording a more regular opportunity to evaluate and replace aging fuel cells. We discern no reason to permit the State to continue to adhere to its program of annual recalibration, particularly in light of the concerns raised as to the utilization of a compensating algorithm in the interim.

[19] However, we do not find merit in defendants' concerns about the EC algorithm or its use. There is sound scientific evidence that supports the conclusion that fuel cells begin to age as soon as they are put into service and that fuel cell drift is inevitable. But there is equally

ample support for the proposition that even as the intensity of the peak demonstrated by the EC evaluation of the sample diminishes over time, the reactive effect overall (that is, the area under the curve being calculated) does not. Instead, the time within which the test is performed simply truncates the EC reading before all of the otherwise appropriate data can be generated. Theoretically, one could, perhaps, program the machine to calculate the missing area based on a presumed regularly-shaped curve. Although that might even be a more accurate method of supplying the missing data, it would not, in the end, be as advantageous to defendants as is the minor upward adjustment that the algorithm effects. Indeed, because *124 the device will not generate a result that can be utilized if the readings are out of tolerance, the algorithm alters the EC result in an amount that, we are confident, cannot fairly be seen as convicting the innocent.

Nor do we consider the fact that the algorithm was unknown until Shaffer revealed it or the fact that neither of the independent experts who evaluated the source code recognized its existence to be indicative of any broader shortcoming in the firmware. Two reasons support this result. First, in "black box" testing, the *156 machine performed accurately by demonstrating the ability to identify the percentage of alcohol in known solutions within the applicable tolerance parameters. Were there a fundamental defect in the source code, one would expect that the machine would not be able to perform in this fashion. Second, the evidence in the record demonstrates that the EC reading is not always less than the IR reading either during control tests or in actual testing. If, as defendants fear, the EC is always being artificially inflated to approximate, if not absolutely match, the IR, one would expect to find only results in which the IR was the higher reading. That, however, is simply not the case, as there are numerous examples of readings from both actual and control tests in which the EC reading is higher than the IR. We cannot therefore conclude that the source code includes hidden commands to artificially inflate the EC to raise it to the level of the IR.

Finally, however, defendants argue that the existence of

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the EC algorithm calls into question all of the testimony received during the original remand proceedings. They point out that several witnesses referred to the fact that the Alcotest uses two independent testing methods as proof of its superiority and as support for their opinions that the device is scientifically reliable and accurate. They further point to Draeger's representations to the State that this technology made the device superior to others which was essentially accepted by the Special Master. Although the use of this algorithm certainly undercuts the accuracy of the marketing claims made by Draeger, it does not, in and of itself, alter the *125 support in the record for the conclusion by the Special Master about the general scientific reliability of the device.

B. Weighted Averaging Algorithm

[20] During the supplemental remand proceedings, source code analysis revealed the use of a calculation referred to as the weighted averaging algorithm. In short, this algorithm relates to the manner in which the IR result is calculated. This technology measures the effect of breath alcohol on an infrared signal. In order to calculate the result, the device is programmed to calculate a reading every quarter of a second, based on measurements taken every 8.192 milliseconds. The reported IR result is then computed by means of the algorithm, which places proportionately greater weight on the later measurements than on the earlier ones. In operation, the algorithm directs that the first two readings are averaged, and that value is averaged further with each successive reading. The effect is that the measurement is calculated to place greater and greater weight on the readings taken as the sample of breath continues.

Defendants attack the use of this methodology as scientifically unsound. They point out, correctly, that it is neither an average nor technically even a weighted average. They further assert, however, that the use of this algorithm is evidence of a scientifically unsound device operated by inherently flawed software. We do not find merit in these arguments. To be sure, the calculation is not an average in accordance with the strict mathematical definition. It is, however, in a more general sense, a

calculation designed to accord greater weight to that part of the breath sample that enters the cuvette at the end. In doing so, it gives greater weight to the breath that, inevitably, includes the deepest air drawn from the lung. It therefore focuses the analysis on the portion of the breath sample that most accurately represents the subject's BAC. In this manner, the weighted averaging algorithm seeks to achieve a more accurate result. We discern nothing in defendants' attacks on this *157 weighted averaging algorithm that *126 persuades us that it is inherently flawed or that it leads to an inaccurate measurement of BAC.

C. Buffer Overflow Error

During the proceedings on remand, Draeger's expert, Bruce Geller, identified a significant flaw in the program's source code that, in limited circumstances, can lead to an inaccurate reported BAC test result. Following Geller's testimony, Draeger's programmer, Shaffer, disputed many of the conclusions proffered by defendants' experts, but he acknowledged and explained the buffer overflow defect, admitting that he was responsible for the inclusion of this error in the code.

The buffer overflow error is only relevant when a test subject, based on the IR and EC results of the first two breath samples that fall outside of the accepted tolerance, is given a third test.^{FN32} Whenever that occurs, there are six results (an IR and EC value for each test) that must be evaluated. According to Shaffer, an array of temporary variables is declared in order to calculate the blood alcohol level from the six readings. The available Alcotest array, as currently programmed, however, is only large enough for four readings, and therefore does not hold the second and third EC values. For purposes of this calculation, the third EC value is stored, accurately, in a previous memory location, but the second EC value is altered because of the buffer overflow error. In a situation in which there are six readings, if the second EC result is the lowest value, the device will effectively overlook it and the calculated BAC level will be incorrectly reported instead as the next lowest of the six readings.

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FN32. Although the frequency with which this error occurs has not been quantified with precision, the experience in Pennsauken suggests that, absent the State's adoption of an expanded tolerance level between the two initial sets of results in NJ Firmware version 3.11, and its resultant diminution of third test results in Middlesex, one might estimate that as many as five percent of all test subjects would ordinarily have results that would require a third breath sample.

*127 Shaffer testified that although the buffer overflow error must be corrected,^{FN33} the previously recorded AIRs correctly display the values for each of the six readings. According to Shaffer, the only error on the AIR will be its report of the BAC. Whether the buffer overflow error affected the reported result, however, is not immediately obvious from looking at the AIR. Instead, a set of calculations, referred to by all of the parties as the Shaffer formula, must be employed to determine whether the buffer overflow error occurred, and, if so, what the proper BAC should have been.

FN33. He explained that he has not done so because of the pendency of this litigation.

The Special Master, finding Shaffer's candor to be impressive and his testimony "completely reliable," concluded that the buffer overflow error is a "real" one that must be corrected. Pending any corrective action, he recommended that the use of all AIRs that report three breath samples either be prohibited as a basis for prosecution or, in the alternative, that Shaffer's corrective formula be applied.

Defendants argue that the Special Master's solution is inadequate because of the effect of the widened tolerance which led to fewer third tests, but they do not otherwise suggest that either of his proposed alternatives is inappropriate for AIRs reporting third test results. The State, although conceding that the error is one that must be corrected, argues that there is no basis on which to discard previously reported*158 results in light of the ability of the courts to apply the corrective formula to the reported results.

There is no doubt in the record that the Firmware version 3.11 source code includes an error, which may cause the BAC to be incorrectly reported in cases when a third breath sample has been taken.^{FN34} The record, however, makes clear that the error does not *128 in any way alter the accuracy of the reported results for each test of each breath sample, but instead lies in the manner in which the device reads and evaluates that data to calculate the lowest BAC, which then may be both inaccurately calculated and reported.

FN34. We recognize, of course, the force of defendants' argument that the severity of the impact of this error has been masked by the State's unilateral decision to double the tolerance and therefore to reduce the circumstances in which a third test would be permitted. Our decision to address the extant third test result cases does not in any way, in our view, alter the separate manner in which we have elected to deal with the problem presented to us by the increased tolerance range. We instead have addressed that aspect of the record separately, see Section VIII.D., *supra*.

[21] Were we without confidence in the accuracy of the individually reported results, we would be constrained to agree with the Special Master's suggestion that we reject all of the tests in which a third sample was taken. However, in light of the fact that there is no evidence in the record on which to conclude that the six readings will themselves be inaccurate, we find no ground on which to order a resolution so drastic.

Instead, we conclude that each AIR that includes three breath tests will be admissible as evidence of an accurate BAC reading only after application of the Shaffer formula ^{FN35} to ensure the correct calculation of the lowest possible result and reading. We do so, however, with two added cautions heretofore unspoken. First, a third sample is taken only when the four readings from the first two samples are outside of the accepted range of tolerance. As a result, where there are three breath samples, the device does not simply identify and report the lowest of the six reported readings. Instead, it must first evaluate the six readings to determine which of the

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samples fall within the accepted tolerance and then determine, through truncation, which is the lowest acceptable reported result. Calculating the correct result in the *129 face of the buffer overflow error is therefore not a matter of visually inspecting the reported results and selecting the lowest of them. Rather, the use of the formula is required to ensure that the apparently lowest result is also the lowest acceptable one in accordance with the tolerance range.^{FN36} Second, we note that in devising the formula, Shaffer continued to utilize the tolerance calculation reflecting the doubled range. Because we have rejected that range as unacceptable, we have revised the formula, in the form of a worksheet,*159 and have appended it to the Order that accompanies this opinion in its corrected format.

FN35. Although referred to as the Shaffer formula, the mechanism for the correct determination of whether a buffer overflow error has occurred and, if so, the calculation of the correct BAC is embodied in a worksheet that we have revised to apply the correct tolerance range and have appended as Worksheet B to the Order that accompanies this opinion for use in all proceedings pending revision of Firmware version 3.11.

FN36. As an example, if the results on test one were IR = 0.030 and EC = 0.031 and the results on test two were IR = 0.085 and EC = 0.088, and the results on the third test were IR = 0.091 and EC = 0.092, the latter tests are within tolerance of one another, but neither of the latter tests is in tolerance with the first. The correct BAC result, therefore, would be 0.08 even though the results of the first test were far lower. We use this example by way of explanation and only to highlight the need for applying the formula.

The use of this methodology, however, will require that, pending appropriate correction to the firmware, each AIR with three test sample results must be separately reviewed and that calculations must be performed and verified for accuracy in accordance with Shaffer's formula.^{FN37} We therefore direct that the State undertake

to review all such AIRs, perform the calculations to identify the correct BAC in accordance with the Shaffer formula as we have adopted it, and provide that data to the court in which each matter is pending. We further direct that the calculations be made a part of the evidence in any prosecution, pending correction of the firmware, to facilitate appellate review.

FN37. The calculations based on the formula, which is set forth in a table, appended to the Order that accompanies this opinion, should be included as part of the record to facilitate further review.

D. Catastrophic Error Detection

[22] Following the remand for source code analysis, the Special Master also recommended that the machine's catastrophic error detection device be re-enabled. He based his *130 recommendation on his findings that the Alcotest's ability to detect catastrophic errors, which was included in the original source code, had been disabled from use in Firmware version 3.11 and that, if utilized, it would ensure that the device would shut down if it encountered such an error. Although defendants agree with the recommendation that this device be enabled in future software updates, they argue that the implications of the unilateral decision of the manufacturer to disable this feature and the use of the Alcotest without this error detection capability must undermine any confidence in any of the results reported. The State, although disagreeing with both the significance of the decision to disable this detection device and with the impact it might have had on any readings by the machine, agrees that the firmware will be revised to re-enable catastrophic error detection.

Our review of the record demonstrates that there is ample support for the findings and recommendations of the Special Master concerning this aspect of the source code. The witnesses were in general agreement that the absence of an operational catastrophic error detection device is not optimal, and they candidly conceded that in the interim, and based on these proceedings, the feature has been re-enabled for use in other jurisdictions. Notwithstanding that general agreement, the experts

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disagreed about how the machine would respond if it encountered a catastrophic error.

Defendants' expert suggested that the machine might under those circumstances create an inaccurate AIR, although he could not explain, even theoretically, how it would do so. Apart from that rather speculative opinion, the experts agreed that the machine would most likely enter an endless loop of non-productive analysis and become unresponsive. Because there is no credible evidence in this record that an Alcotest machine that encounters a catastrophic error would create, in reaction thereto, an incorrect AIR, we discern no basis on which to conclude that any of the previously-generated AIRs might represent a test in which the machine encountered an error of this magnitude and reacted by *131 recording an inaccurate series of test results. Rather, we direct that the State arrange to have the software corrected to re-enable the catastrophic error detection feature.

*160 E. Overall Firmware Reliability

As part of the analysis during the supplemental remand proceedings, defendants' expert opined that his evaluation of the source code revealed thousands of programming errors. He criticized the source code on multiple levels, arguing that the style utilized is outdated, that the reliance on global variables leaves too much room for executional errors, and that the program lacks adherence to any recognizable design criteria. In short, he opined that there are so many, and so great a variety of shortcomings in the source code and the programming methodology that we should conclude it is too flawed to be relied upon to generate accurate test results.

The State and Draeger disagree. They assert that most of the programming flaws that defendants' expert identified are simply stylistic programming preferences and that they do not, in fact, represent errors in theory or in reality. They urge us not to be misled into concluding that the source code is inadequate for purposes of scientific reliability.

Our consideration of this matter need not be extended. In actuality, few aspects of the firmware required our

analysis and fewer still require our intervention. Of the four major issues—the EC fuel cell drift algorithm, the buffer overflow error, the disabled catastrophic error detection device, and the weighted averaging algorithm—only the buffer overflow error is capable of producing an erroneous AIR. Two of the challenged features, the EC fuel cell drift algorithm and weighted averaging algorithm, we have concluded, contrary to defendants' assertions, are scientifically sound. The last of these, the catastrophic error detection device, we have concluded should not have been disabled but its absence was incapable of producing an inaccurate AIR.

Our evaluation of the exhaustive record relating to the source code leaves us confident that its errors have been revealed. *132 Based on that record, we do not share defendants' larger concerns that it is likely to generate inaccurate results simply because, from a source code writer's viewpoint, it is complex or prolix. There being no evidence in the record that these asserted shortcomings are anything more than stylistic, theoretical challenges, we decline defendants' invitation to require that the firmware comply with any specific programming standards as unnecessary at this time.

X. Additional Firmware Recommendations

We next turn to a variety of issues arising from the Special Master's recommendations that require our attention. Some of these matters are not in significant dispute, but our consideration of each of them is essential to ensuring that the Alcotest remains in compliance with our directives. Most of these matters relate to the recommendations of the Special Master concerning the future revisions to the firmware, but some we independently deem to be necessary based on our review and analysis of this record. None, however, requires significant analysis or detail.

[23] The Special Master included a recommendation (Special Master's Finding 2(c)) that the firmware be locked so that only the manufacturer or the coordinators would be able to make changes to the firmware. Although defendants and the State agreed with this recommendation, the NJSBA argued that it would be more ap-

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propriate if only the manufacturer had the ability to make changes to the firmware. In light of defendants' continued criticism of the programming style and lack of rigorous programming standards used in the source code, we are firmly *161 convinced that the pool of individuals who are able to make alterations to the firmware should be reduced rather than expanded. Our concern for uniformity in the firmware compels us to direct that the firmware be locked so that only the manufacturer will be able to make changes to it, which changes may then be downloaded by the coordinators.

[24] Further, considering the numerous changes that we have directed be incorporated into the Alcotest in order to ensure that *133 the device is scientifically reliable and as a prerequisite for admissibility of its BAC readings in the future, we anticipate that our courts will encounter AIRs from devices that utilize different versions of the firmware. We therefore direct, for ease of analysis, that the device be programmed so that on all future AIR printouts, the firmware version then being utilized by the device is reported.

[25] The Special Master also recommended that the State should be required to publish future firmware revisions and that notice of all such future revisions should be given to the public in general and to the amicus NJSBA in particular. Our analysis of this record demonstrates, however, that this recommendation may be insufficient. In our view, merely requiring that the parties or the NJSBA receive notice of future revisions will not be sufficient to ensure that the device is not reprogrammed in a manner inconsistent with producing accurate and reliable results that will be admissible in DWI prosecutions. We therefore have concluded that this required notice, to the parties, the public and the amicus NJSBA, of the future firmware revisions must be sufficiently specific to identify the proposed changes in a manner that affords notice in compliance with due process. A generic notice to the effect that the firmware has been revised, in light of some of the previous alterations that we today correct, will not suffice.^{FN38}

FN38. We note that the parties asked this Court to appoint an independent software house to be responsible for any future reviews of the Al-

cotest source code. We decline to do so at this time, and will determine that issue should there be a challenge in the future to the scientific reliability of the Alcotest based on future firmware revisions.

[26] The Special Master also recommended that the State provide Alcotest training for defense attorneys and their experts similar to that provided for operators and coordinators. The State, understandably, objected to this recommendation and urges us to reject it. Although we reject it in part, defense attorneys should not be left without any means of learning about the device *134 or its operation. Rather, we deem it to be in the interests of justice that some form of training be made available to defense attorneys to enable them to better prepare to represent their clients. However, we agree that the State should not be burdened with this responsibility. We therefore direct that Draeger make Alcotest training, substantially similar to that provided to Alcotest operators and coordinators, available to licensed New Jersey attorneys and their designated experts. The training shall be offered at regular intervals and at locations within the State of New Jersey, at a reasonable cost to those who attend.

XI. Requirements Prior to the Admissibility of Alcotest Evidence

Our analysis of the general scientific reliability of the Alcotest is grounded, in part, on our expectation that there will be proof that the particular device that has generated an AIR being offered into evidence was in good working order and that *162 the operator of the device was appropriately qualified to administer the test. This requirement that the test results be supported by foundational proofs for admissibility has been part of our jurisprudence since we decided *Romano*. There we demanded that, as a precondition for admissibility of the results of a breathalyzer, the State was required to establish that: (1) the device was in working order and had been inspected according to procedure; (2) the operator was certified; and (3) the test was administered according to official procedure. *Romano*, *supra*, 96 N.J. at 81, 474 A.2d 1.

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In matters relating to the Alcotest, the same general considerations that gave rise to these requirements must, of course, apply. In an effort to address these concerns, the Special Master recommended that certain documents, which he referred to as the "foundational documents," be produced during discovery and that they be admitted into evidence as part of the State's case-in-chief.^{FN39} The documents in question can be described as follows: *135 1) Calibrating Unit, New Standard Solution Report, most recent change, and the operator's credentials of the officer who performed that change; (2) Certificate of Analysis 0.10 Percent Solution used in New Solution Report; (3) Draeger Safety Certificate of Accuracy Alcotest CU34 Simulator; (4) Draeger Safety Certificate of Accuracy Alcotest 7110 Temperature Probe; (5) Draeger Safety Certificate of Accuracy Alcotest 7110 Instrument (unless more relevant NJ Calibration Records (including both Parts I and II are offered)); (6) Calibration Check (including both control tests and linearity tests and the credentials of the operator/coordinator who performed the tests); (7) Certificate of Analysis 0.10 Percent Solution (used in Calibration-Control); (8) Certificate of Analysis 0.04, 0.08, and 0.16 Percent Solution (used in Calibration-Linearity); (9) Calibrating Unit, New Standard Solution Report, following Calibration; (10) Draeger Safety Certificate of Accuracy Alcotest CU34 Simulator for the three simulators used in the 0.04, 0.08, and 0.16 percent solutions when conducting the Calibration-Linearity tests; (11) Draeger Safety Certificate of Accuracy Alcotest 7110 Temperature Probe used in the Calibration tests; and (12) Draeger Safety, Ertco-Hart Digital Temperature Measuring System Report of Calibration, NIST traceability.

FN39. Technically, in his initial report, the Special Master only suggested that these documents be admitted into evidence in cases in which the defendant was not represented by counsel. He amended that recommendation in his supplemental report to extend it to all prosecutions, without regard to whether the particular defendant was represented by counsel or not. Regardless of that, the arguments raised by the State as to this requirement have not been

altered.

Defendants, although not conceding the scientific reliability of the Alcotest device, generally or otherwise, and the NJSBA, agreed with the Special Master that the State should be required to produce all of these documents as part of routine discovery. In addition, in their initial briefs, they also agreed that admitting these documents into evidence in all prosecutions based on Alcotest results is essential. In response to our request for further briefs directed to the admissibility of these documents, defendants have altered their position, contending that the documents can only be admitted into evidence if accompanied by testimony from a *136 witness who may be cross-examined about the statements included within them.

The amicus NJSBA has argued that testimony from the operator, the officer who performed the control solution change, and the coordinator who calibrated the machine,*163 should be routinely required. The amicus ACDL charted a middle course. They suggested that testimony from the coordinator should be required. Nevertheless, they conceded that if the Court concludes that the device is generally scientifically reliable, it would serve no purpose to require a witness to testify about the reports, generated by the device itself, that evidence its good working order.

The State disagreed in part with the Special Master's recommendations in its initial and supplemental briefs. Although representing that all of these documents are and will continue to be routinely produced in discovery, the State asserts that only four documents should be required to be admitted into evidence in support of the use of the device: the AIR itself, which should be deemed admissible, and the required foundational documents, which should be limited to the New Standard Solution Report that immediately preceded the administration of the test in question and is referred to in the AIR, the Calibration Check Report documents, which are also referred to in the AIR, and the documents demonstrating that the operator was certified as an Alcotest Breath Test Operator.^{FN40} Those alone are required, in the view of the State, because all of the other documents included on the Special Master's list are, in essence, tests

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of tests or relate to testing standards that are not now, and should not be in the future, required for prosecution.

FN40. Although the State refers to this as being four documents, in fact the State's list includes parts of multiple categories from the Special Master's list and others not included in his foundational list.

A. Confrontation Clause Implications

We begin by noting that this argument is complicated by our consideration of the way in which the standards set forth by the *137 United States Supreme Court in *Crawford*, *supra*, impact on admissibility of these proofs. We turn, then, to an analysis of the implications of the constitutional protections identified by *Crawford* and its progeny.

The Sixth Amendment of the United States Constitution guarantees defendants in criminal ^{FN41} cases "the right ... to be confronted with the witnesses against" them. *U.S. Const.* amend. VI. Our own Constitution includes identical language. *N.J. Const.* art. I, ¶ 10. As we have previously recognized, defendants exercise their right to confrontation through cross-examination. *See State v. Branch*, 182 N.J. 338, 348, 865 A.2d 673 (2005); *see also Crawford*, *supra*, 541 U.S. at 61, 124 S.Ct. at 1370, 158 L.Ed.2d. at 199 ("reliability [of witnesses must be] assessed by testing in ... the crucible of cross-examination"). Although we commented in *Branch* that "[a]n established and recognized exception to the hearsay rule will not necessarily run afoul of the Confrontation Clause," *Branch*, *supra*, 182 N.J. at 349, 865 A.2d 673, the United States Supreme Court in *Crawford* explained that for certain categories of evidence, falling within a recognized hearsay exception is not enough. *Crawford*, *supra*, 541 U.S. at 51-52, 124 S.Ct. at 1364, 158 L.Ed.2d. at 192-93.

FN41. We recognize, and our Appellate Division has recently observed, that we have not specifically held that the Confrontation Clause applies to quasi-criminal proceedings or that it applies generally to DWI matters. *See State v.*

Kent, 391 N.J.Super. 352, 387-88, 918 A.2d 626 (App.Div.2007) (Stern, P.J.A.D., concurring). In light of the manner in which we have addressed the potential impact of *Crawford* on the evidence we here consider, we need not directly consider this constitutional question.

*164 Rather, the Court held that the Confrontation Clause derives from the concern of the Framers that certain categories of evidence are the equivalent of testimony and thus only appropriately tested through cross-examination. *Ibid.* For evidence in these categories, namely, "testimonial" evidence, only confrontation through cross-examination will suffice. As a result, merely testing such evidence against the standards for reliability represented by *138 the exceptions to the hearsay rules is insufficient to comport with the protections afforded by the Confrontation Clause. *See Crawford*, *supra*, 541 U.S. at 60-61, 124 S.Ct. at 1369-70, 158 L.Ed.2d at 198-99.

Although the Court "[le]ft for another day," *id.* at 68, 124 S.Ct. at 1374, 158 L.Ed.2d. at 203, the precise delineation of what it meant by "testimonial" as opposed to "nontestimonial" evidence, the Court identified that the "core class of 'testimonial' statements" includes:

"*ex parte* in-court testimony or its functional equivalent—that is, material such as affidavits, custodial examinations, prior testimony that the defendant was unable to cross-examine, or similar pretrial statements that declarants would reasonably expect to be used prosecutorially," "extrajudicial statements ... contained in formalized testimonial materials, such as affidavits, depositions, prior testimony, or confessions," [and] "statements that were made under circumstances which would lead an objective witness reasonably to believe that the statement would be available for use at a later trial[.]"

[*Id.* at 51-52, 124 S.Ct. at 1364, 158 L.Ed.2d. at 193 (citations omitted).]

The Court further explained that this definition of testimonial includes "*ex parte* testimony at a preliminary hearing [and s]tatements taken by police officers in the

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course of interrogations....”*Id.* at 52, 124 S.Ct. at 1364, 158 L.Ed.2d at 193. More recently, the Court has explained the distinction between “testimonial and nontestimonial” as follows:

Statements are nontestimonial when made in the course of police interrogation under circumstances objectively indicating that the primary purpose of the interrogation is to enable police assistance to meet an ongoing emergency. They are testimonial when the circumstances objectively indicate that there is no such ongoing emergency, and that the primary purpose of the interrogation is to establish or prove past events potentially relevant to later criminal prosecution.

[*Davis, supra* 547 U.S. at 822, 126 S.Ct. at 2273-74, 165 L.Ed.2d at 237.]

The *Crawford* paradigm, therefore, begins with an analysis of whether any particular piece of evidence is admissible as a matter of complying with the rules of evidence. Typically, the issue arises in the context of hearsay and the exceptions thereto. The model adopted in *Crawford* then considers whether the particular evidence is “testimonial” within the meaning of the Confrontation Clause, for if it is, then the fact of admissibility for purposes of the *139 exceptions to the hearsay rules is insufficient. See *Crawford, supra*, 541 U.S. at 60-61, 124 S.Ct. at 1369-70, 158 L.Ed.2d at 198-99. That is to say, if the evidence is testimonial, reliability as defined by the exceptions to the hearsay rules does not equate with, and cannot substitute for, confrontation through cross-examination.

In order to correctly apply the *Crawford* analysis, then, we must consider first whether the particular evidence is admissible under the ordinary rules of evidence and then whether it is testimonial, thus requiring the declarant to be made available for cross-examination. Significantly, *165 for purposes of our analysis, the Court in *Crawford* noted that business records are considered “by their nature” to be nontestimonial, see *id.* at 56, 124 S.Ct. at 1367, 158 L.Ed.2d at 195, and therefore their admission into evidence would not implicate the Confrontation Clause’s guarantees. Although we recognize that the broadest reading of that observation would per-

mit us to end the analysis here, we do not regard the Court’s apparent exclusion of all business records from the Constitution’s protective scope to be dispositive of the issues before us.

B. Application of *Crawford v. Washington*

For purposes of our analysis of the *Crawford* issue, the foundational documents identified by the Special Master are only part of the matters we must consider. Overall, we perceive of three categories of documents ^{FN42} relevant to our discussion: (1) the documents evidencing the qualifications of the operator; (2) the documents evidencing that the machine was in working order at the time of the test; and (3) the AIR being offered into evidence to demonstrate ^{FN43} the results of the breath testing. Very different levels of analysis pertain to each of these categories.

FN42. The NJSBA, in its supplemental letter brief addressing the *Crawford* question, suggested dividing these documents into categories based upon which entity could be identified as having prepared it. We believe that our functional analysis provides the more useful analytical framework.

FN43. Two issues generally relating to the AIR require comment. First, the amicus ACDL urges us to conclude that the Alcotest is sufficiently new that the AIR should merely be evidence of BAC. In light of the thorough record about the general scientific reliability of the device, we reject that suggestion. Second, the Special Master recommended that incomplete AIRs should be inadmissible. An AIR that is incomplete in its report of breath test results cannot be admissible as proof of a per se DWI violation. On the other hand, an AIR that is “incomplete” in that it does not include added data we here order for the future is not necessarily inadmissible.

*140 1. Operator’s Qualifications

For *Crawford* purposes, we begin by noting that the

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parties agree that, unlike the breathalyzer, the Alcotest is not "operator-dependent," meaning that the device is not subject to influences from the operator. Instead, the record demonstrates that the operator will play a relatively lesser role here than has been the case in the past. His role now consists of observing the subject to ensure that twenty minutes has passed and to be certain that the subject has neither swallowed nor regurgitated any substances during that time that would influence the test results; inputting and verifying the accuracy of the identifying information needed to start the sequence; changing the control solution if the machine alerts him to do so; attaching a new mouthpiece; reading the instructions about how to blow into the machine; observing the LED screen and following its prompts; and observing the subject to ensure that he or she actually provides a sample. There are no meters to read, no dials to turn, and if the machine detects an error, the error is reported and no test results are derived. The operators are not able to alter or affect the software that governs the performance of the device and cannot fix the machine should a repair be needed.

Even so, the Special Master recommended, and the State concedes, that the operator should be available to testify in a contested matter. Notwithstanding this reduced role to be played by the operator as relates to the ultimate BAC results reported, requiring that he or she be made available for cross-examination is an important*166 constitutional safeguard. We therefore, consistent *141 with our longstanding practice, see *Romano*, *supra*, 96 N.J. at 90-91, 474 A.2d 1, can ensure that each defendant has the opportunity to confront the witness who has potentially relevant testimony.^{FN44}

FN44. It may well be that, as the use of the device becomes more routine, some, or even most, defendants will eventually forgo cross-examination of the operator in light of the limited information that can be achieved in that effort.

[27] It is in this context, however, that we consider the Special Master's requirement that the operator produce evidence of his qualifications through a certificate or a current operator card.^{FN45} We perceive of no potential

violation of the right to confrontation that might arise from the admission into evidence of these documents. Apart from the fact that these documents fall squarely within the traditional business records exception ^{FN46} to the hearsay rule, *N.J.R.E.* 803(c)(6); see *State v. Matulewicz*, 101 N.J. 27, 28, 499 A.2d 1363 (1985) (defining scope of business record exception), and thus are presumably exempted from the *Crawford* analysis entirely, see 541 U.S. at 56, 124 S.Ct. at 1367, 158 L.Ed.2d at 195, they are not testimonial within the contemplation of *Crawford*. On the contrary, these supporting documents are not testimonial because they neither establish an element of the offense charged nor demonstrate the truth of any fact in issue. Even were we concerned that there is some constitutional infirmity in permitting these documents to be offered into evidence, in light of the fact that the operator will ordinarily be called to testify, all defendants will be able to exercise their right to cross-examine the individual to whom these documents actually pertain.

FN45. Technically, the Special Master included this as part of his description of the required operator's testimony rather than listing it among the foundational documents. None of the parties has voiced any objection to this requirement.

FN46. Although in *Crawford* the Court used business records as an example of nontestimonial evidence, other courts have suggested that the distinction is not so clear. See, e.g., *Thomas v. United States*, 914 A.2d 1, 13 (D.C.2006) (contrasting historically limited definition of business records with current interpretation; questioning validity for Confrontation Clause analysis).

*142 2. Foundational Documents

[28] In addition to the requirement relating to the operator's credentials, however, we next consider the *Crawford*-based challenge to the twelve foundational documents, relating to the good working order of the device, that the Special Master has recommended be produced and admitted into evidence. These documents fall into

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two categories: (1) documents directly evidencing the good working order of the machine as of the time of the test, including: the most recent calibration record, the most recent new standard solution report, and the certificate of analysis of the 0.10 simulator solution used in the control tests; and (2) documents evidencing the accuracy of the devices used and chemical composition of the solutions used to routinely test and calibrate the machine, including the analysis of all of the solutions used to test linearity, the documents attesting to the accuracy of the devices used in the simulator, and the certificates of accuracy of the simulator and temperature probes.

As a threshold matter, we perceive no shortcoming, from a constitutional perspective, with respect to any of this large group of foundational documents that the *167 Special Master identified as prerequisites to a finding of guilt. All of the twelve documents that the Special Master identified qualify as business records in the traditional sense. For purposes of the hearsay exception, we can describe all of these documents as being records of tests of the device, or of the simulator unit that is used to calibrate the device, or of the chemical composition of the solutions used to either perform the control tests or calibrate the machine. Although these are part and parcel of ensuring that the machine is in good working order, from the perspective of the hearsay analysis, we do not regard them as being anything other than business records that are ordinarily reliable. We reach this conclusion notwithstanding the arguments raised by defendants to the effect that any document prepared by either the State Police or Draeger, in connection with the Alcotest, should be viewed with suspicion. In part, defendants' concerns pre-suppose that these documents are *143 similar to affidavits or include statements by their preparers. There is, however, nothing in this record that suggests that any of these foundational documents is subject to manipulation by the preparer.

Nor do we reach a different conclusion on the question of whether they fall within the ambit of that which *Crawford* teaches us is testimonial and therefore requires an opportunity for cross-examination. In this, we find accord with the great majority of the jurisdictions

that have considered this, or similar, questions relating to foundation documents for scientific testing devices. See *Bohsancurt v. Eisenberg*, 212 Ariz. 182, 129 P.3d 471, 476-77 (App.2006) (holding that maintenance and calibration records for breath testing machine are routine business records that are not testimonial); *Rack-off v. State*, 281 Ga. 306, 637 S.E.2d 706, 707, 709 (2006) (holding that inspection certifications are business records and are not testimonial); *People v. Kim*, 368 Ill.App.3d 717, 307 Ill.Dec. 92, 859 N.E.2d 92, 93-94 (2006), *appeal denied*, 224 Ill.2d 589, 312 Ill.Dec. 660, 871 N.E.2d 60 (2007) (holding that affidavit certifying that device was tested is non-testimonial); *Jarrell v. State*, 852 N.E.2d 1022, 1026 (Ind.Ct.App.2006) (holding that a breath test device certification is not testimonial); *Napier v. State*, 820 N.E.2d 144, 149 (Ind.Ct.App.2005) (holding that inspection and operator certifications are not testimonial); *Commonwealth v. Walther*, 189 S.W.3d 570, 575 (Ky.2006) (holding that notations regarding maintenance and testing of device are not testimonial); *State v. Fischer*, 272 Neb. 963, 726 N.W.2d 176, 181-83 (2007) (holding that a simulator solution certificate is not testimonial); *People v. Lebrecht*, 13 Misc.3d 45, 823 N.Y.S.2d 824, 826-27 (Sup.2006) (holding that calibration/maintenance report and simulator solution certification are not testimonial); *State v. Norman*, 203 Or.App. 1, 125 P.3d 15, 18-20 (2005), *review denied*, 340 Or. 308, 132 P.3d 28 (2006) (holding that certificates of accuracy are not testimonial). But see *Shiver v. State*, 900 So.2d 615, 618 (Fla.Dist.Ct.App.2005) (holding that breath test affidavit, including portion used to show that device had required maintenance, is testimonial).

*144 To be sure, some of these documents and certificates are prepared by the police, but none of them relates to or reports a past fact and none of them is generated or prepared in order to establish any fact that is an element of the offense. See *Davis, supra*, 547 U.S. at 821-24, 126 S.Ct. at 2273-74, 165 L.Ed.2d at 237. The fact that they may be used to demonstrate that a device, which was used to conduct the breath tests for a particular defendant, was in good working order does not transform them into evidence of an element of the offense nor make them testimonial in the constitutional sense. We

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perceive both *168 in the Constitution itself and in *Crawford*, ample room for admissibility of these foundational documents consistent with protecting defendants' rights.

Although we therefore conclude that they would all be admissible within the confines of the Constitution, we will not adopt the Special Master's recommendation and require that they all be offered into evidence routinely. Indeed, as the State has correctly pointed out, many of the documents on the Special Master's list of foundational proofs are tests of tests and, therefore, are too attenuated to require that they be admitted as part of the evidence. We include in that category all of the documents relating to the working order of the simulator, the reports of the solutions used during simulation and calibration, the certificate of accuracy of the simulator used to calibrate the device, and the temperature probe documents. Although, as all parties agree, these documents should continue to be produced in discovery,^{FN47} they are not *145 fundamentally a part of demonstrating that the particular device was in good working order.^{FN48}

FN47. We note that there is already, according to the State, a routine disclosure of all of the documents on the Special Master's list. We presume that, in the event that any defendant perceives of an irregularity in any of these documents that might affect the proper operation of the device in question, timely issuance of a subpoena will suffice for purposes of protecting that defendant's rights. Were the use of the subpoena power to become routine, we would commend to the parties, with the assistance of our municipal courts, the use of pretrial *de bene esse* depositions or video conferencing technology to reduce the burden on the State or any independent testing laboratories.

FN48. The record includes scant evidence relating to repair history of any of these devices. Presumably the devices that were part of the evidence in the prosecutions for the named defendants were so newly put into service that no repairs have been needed. At the same time,

there is evidence suggesting that from time to time one or more of the devices has been adjusted by a coordinator or returned to Draeger for repair. The record reflects that in either event, a document is generated by the coordinators that evidences those repairs. We commend to the State the establishment of a protocol for maintaining repair logs to the extent that these become more frequent and, therefore, potentially relevant.

The foundational documents that we conclude need to be entered into evidence therefore are few. They are: (1) the most recent calibration report prior to a defendant's test, with part I-control tests, part II-linearity tests, and the credentials of the coordinator who performed the calibration; (2) the most recent new standard solution report prior to a defendant's test; and (3) the certificate of analysis of the 0.10 simulator solution used in a defendant's control tests. Absent a pre-trial challenge to the admissibility of the AIR based on one of the other foundational documents produced in discovery, we perceive of no reason to require that they be made a part of the record routinely.

3. Alcohol Influence Report Admissibility

The final aspect of our *Crawford* analysis must be focused on the AIR itself. In the time since *Crawford* was decided, courts around the country have struggled to analyze its import in matters relating to scientific or forensic testing generally. A few have directly confronted documents that are similar to the AIR and have attempted to apply *Crawford's* constitutional commands in that context.

The AIR, unlike the foundational documents evidencing the good working order of the machine, reports the results of a test which, in and of itself under our statute, suffices to support a conviction. It is proof of BAC, over a specified threshold, that forms the basis for a *per se* violation. *169 Were we to step back and *146 consider it in *Crawford* terms, we might well conclude that it is the modern day, functional equivalent of testimony. It comes, however, not from the mouth of a living wit-

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ness, but from a machine. Surely the Founding Fathers did not envision the day when a device that cannot itself be cross-examined would be the equivalent of a witness.

We have previously addressed the constitutional question of the right to confront a written document that is itself evidence of a crime. In *State v. Simbara*, 175 N.J. 37, 811 A.2d 448 (2002), we identified the essence of the constitutional quandary in considering the admissibility of a laboratory certificate analyzing suspected controlled dangerous substances. We reasoned:

A laboratory certificate in a drug case is not of the same ilk as other business records, such as an ordinary account ledger or office memorandum in a corporate-fraud case. Those latter documents have not been prepared specifically for the government's use in a potential criminal prosecution. In contrast, the analyst prepares the laboratory certificate at a prosecuting agency's request for the sole purpose of investigating an accused. Because the certificate is singularly important in determining whether the accused will be imprisoned or set free, we must be sensitive to Sixth Amendment interests whenever a defendant preserves those interests for trial.

[*Id.* at 49, 811 A.2d 448.]

In *Simbara*, we acknowledged that a defendant could seek to cross-examine the laboratory technician who performed the test on the sample as a means to protect his or her Confrontation Clause rights. *Ibid.* The AIR presents us with a somewhat more complex constitutional question.

Although no court has considered the Alcotest and its AIR, other courts have suggested a variety of analytical frameworks to be utilized in determining whether test results are testimonial. Some have concluded that because a test result or report is generated by a machine, rather than a human, it cannot qualify as a statement in the sense *Crawford* intended. See *United States v. Washington*, 498 F.3d 225, 230-32 (4th Cir.2007) (finding that "[t]he raw data generated by the diagnostic machines are the 'statements' of the machines themselves, not their operators"); *United States v. Khoroz-*

an, 333 F.3d 498, 506 (3d Cir.2003) *147 explaining that "a statement is something uttered by 'a person,' so nothing 'said' by a machine ... is hearsay").

Other courts have focused on the fact that the machine has no discretion as to whether it will produce a particular result and cannot be manipulated to produce a result to secure a conviction of a particular defendant in the way that interrogating a person could. See *People v. Geier*, 41 Cal.4th 555, 61 Cal.Rptr.3d 580, 161 P.3d 104, 140 (2007) (holding that lab reports are not testimonial because they are made of part of a routine and non-adversarial process); *Commonwealth v. Verde*, 444 Mass. 279, 827 N.E.2d 701, 705 (2005) (holding that lab reports are not testimonial because they are neither discretionary nor based on opinion); *State v. Forte*, 360 N.C. 427, 629 S.E.2d 137, 143 (2006) (holding that a serology report is nontestimonial because it is neutral and has the possibility to exonerate or convict).

[29] Neither of these analytical frameworks is entirely sufficient in our view. Instead, we return to the fundamentals of the definition of testimonial as the Court explained in both *Crawford*, *supra*, and *Davis*, *supra*. Viewed against that standard, the essential elements of testimonial *170 evidence are a report of a past event, given in response to police interrogation, with the purpose of establishing evidence that a defendant committed an offense. Judged against this standard, the AIR falls outside of the definition of testimonial on two, and arguably all three, grounds. First, the AIR reports a present, and not a past, piece of information or data. Second, although given in the presence of a police officer who operates the device, nothing that the operator does can influence the machine's evaluation of the information or its report of the data. Third, although the officer may have a purpose of establishing evidence of a BAC in excess of the permissible limit, the machine has no such intent and may as likely generate a result that exonerates the test subject as convicts him or her. Seen through this prism, we conclude that the AIR is not testimonial in the sense that was intended by the Framers of the Confrontation Clause.

*148 Although we have concluded that the AIR is not testimonial, we have nevertheless concluded that de-

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defendants are entitled to certain safeguards that we have required be implemented in prosecutions based on the Alcotest. We have directed that an opportunity for cross-examination similar to that described in *Simbara* and *Romano* be provided to these defendants through our requirement that the operator of the device be made available to testify. Likewise, we have required the routine production in discovery of all of the foundational documents that might reveal some possible flaw in the operation of the particular device and we have demanded that the core foundational documents that establish the good working order of the device be admitted into evidence.

But more than implementing these safeguards, because the ability to cross-examine the operator of the Alcotest will provide little means to challenge the veracity of the AIR, we appointed a Special Master, who we commend and thank for his extraordinary assistance. Through him, we have engaged in a lengthy process of receiving testimony and evidence, both initially and in the supplemental proceedings to ensure the scientific reliability of the Alcotest. In our effort to judge the scientific reliability of the device, we have made available the opportunity for cross-examination of the witnesses who are most familiar with the device and we have directed that the manufacturer divulge its source code and make available the personnel who can explain it.

We are confident, based on this far-reaching and searching inquiry, that the device is sufficiently reliable so that the rights of all defendants have been protected. We are satisfied that, with the directions we here adopt for pending and future matters, the confrontation rights of all defendants have been, and will continue to be, protected. We have no doubt that the device, with the safeguards we have required, is sufficiently scientifically reliable that its reports may be admitted in evidence. And we are confident that, in so concluding, all of defendants' rights have been advanced and considered.

*149 XII. Conclusion

The Report and Recommendations and the Supplemental Report and Recommendations of the Special Master

are adopted as modified. The stay effected by our January 10, 2006 Order shall be lifted in accordance with the Order that accompanies this decision and that sets forth the precise manner in which our directives shall be applied. The matters involved in these consolidated proceedings are remanded to the Law Division for further proceedings consistent with this opinion and the accompanying Order.

*171 For adopted as modified-Chief Justice RABNER and Justices LONG, LaVECCHIA, ALBIN, WALLACE, RIVERA-SOTO and HOENS-6.
 Opposed-None.

ORDER

The Court having previously certified the within matter directly pursuant to *Rule* 2:12-1, and having contemporaneously appointed retired Appellate Division Presiding Judge Michael Patrick King to serve as the Court's Special Master,

And the Court having remanded the matter to the Special Master to develop a record, conduct hearings, and report his findings and conclusions regarding the scientific reliability of the Alcotest 7110 MKIII-C (the Alcotest),

And the Court having received the Special Master's Report dated February 13, 2007, and Supplemental Report dated November 8, 2007,

*150 And the Court having considered the briefs and arguments of counsel for the parties, the intervenor, Draeger Safety Diagnostics, Inc. (Draeger) and the amici curiae, New Jersey State Bar Association and Association of Criminal Defense Lawyers,

And the Court having on January 10, 2006, issued an Order governing prosecution, appeals, and imposition of sentences pursuant to *N.J.S.A.* 39:4-50 pending the decision in this matter,

And the Court having issued this day its decision in the matter,

And good cause appearing,

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1. IT IS ORDERED that the previously imposed stay is vacated and prosecutions, appeals, and imposition of sentences in all matters arising pursuant to *N.J.S.A.* 39:4-50, shall proceed in accordance with the following directives:

A. For all pending prosecutions, including all prosecutions in which imposition of sentence has been stayed by our January 10, 2006 Order, and in all future prosecutions based on tests conducted prior to the implementation of our directives through creation of and implementation of revised firmware, Alcotest 7110 MKIII-C with New Jersey Firmware version 3.11 is sufficiently scientifically reliable, and the Alcohol Influence Report (AIR) which sets forth the results of breath tests is admissible as evidence of blood alcohol content (BAC), *except* that:

(1) in each prosecution in which an AIR is offered as evidence and in which there are only two reported test samples:

(a) the State shall prepare and produce a calculation, in a form consistent with Worksheet A attached hereto, that ensures that the two samples meet the acceptable range of tolerance as follows:

(i) add the sum of the IR and EC results given for the first breath sample to the sum of the IR and EC results for the second breath sample;

(ii) divide the sum calculated in (a) by 4 to derive the arithmetic mean;

(iii) compute the upper limit of the tolerance range by taking the higher of the mean multiplied by 1.05 or the mean plus 0.005;

(iv) compute the lower limit of the tolerance range by taking the lower of the mean multiplied by 0.95 or the mean minus 0.005;

(v) if *all* of the IR and EC results of the two samples fall within the upper and lower limits of the tolerance range, the two tests are in tolerance and the AIR is valid; if any of the results fall outside of the tolerance range, the AIR is not valid;

(b) the court shall verify the accuracy of the State's calculation and, in any *172 event, shall make the calculation a part of the record to facilitate further review;

*151 (c) if the two samples meet the test for tolerance as we have defined it, the AIR shall be deemed admissible (unless challenged on an alternate ground as set forth herein) into evidence in the prosecution of the matter;

(d) if the two samples do not meet the test for acceptable tolerance as we have defined it, the AIR shall not be admissible into evidence;

(2) in each prosecution in which an AIR is offered as evidence and in which there are three reported test samples,

(a) the State shall prepare and produce a calculation, in a form consistent with Worksheet B attached hereto, that, in accordance with the formula on the attached worksheet, analyzes the reported results to determine which, if any, meet the test for tolerance as we have defined it, and

(i) if, after completing the worksheet there are at least two breath samples for which IR and EC results are within the acceptable range of tolerance, the AIR will be admissible and the BAC shall be the lowest of those results; but

(ii) if, after completing the worksheet, there are no two test samples that meet the test for tolerance as we have defined it, then the AIR shall not be admissible into evidence;

(b) the court shall verify the accuracy of the State's calculations and shall ensure that there has been no buffer overflow error or that the calculation of the BAC, accounting for a buffer overflow error, has been corrected;

(c) the calculations relating to the possibility of a buffer overflow error and its correction, if appropriate, shall be made a part of the record to facilitate further review;

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(3) in each prosecution involving any woman who, at the time of the alleged offense, was over the age of sixty and for whom an AIR was generated with an error message evidencing a breath sample of inadequate volume, the AIR shall not be admissible as evidence in a prosecution for refusal, *see N.J.S.A. 39:4-50.4a*, unless the woman also provided another breath sample of at least 1.5 liters; and it is further

2. ORDERED that the State shall arrange forthwith with Draeger for revisions to the New Jersey Firmware utilized in Alcotest 7110 MKIII-C, as needed to accomplish the directives set forth in the Court's opinion regarding the admissibility into evidence of results of Alcotest breath testing, currently New Jersey Firmware version 3.11, as follows:

A. The firmware shall be locked so that only the manufacturer of the device is able to change the firmware, with changes to be downloaded by State Police Coordinators as needed;

***152** B. The firmware shall utilize minimum breath sample criteria as follows: (1) minimum volume of 1.5 liters for all test subjects except for women over sixty years of age, for whom the minimum volume shall be fixed at 1.2 liters; (2) for all subjects, regardless of age or gender, the minimum criteria shall also include (a) a minimum 4.5 second blowing time; (b) a minimum flow rate of 2.5 liters per minute; and (c) a plateau as established by the infrared (IR) measure which does not differ by more than one percent in 0.25 seconds;

C. The firmware shall be corrected to set the acceptable tolerance range for breath sample readings at the greater of plus or minus five percent of the mean, or plus or minus 0.005 percent BAC from the mean;

***173** D. The firmware shall be corrected to eliminate the buffer overflow programming error;

E. The firmware shall be corrected to re-enable catastrophic error detection;

F. The firmware shall be corrected so that the AIR will report control test results for IR and EC readings prior to the application of the fuel cell drift algorithm;

G. The firmware shall be programmed to include the serial number of the Ertco-Hart digital temperature measuring system utilized as a part of each calibration, certification and linearity report;

H. The firmware shall be corrected to identify, on any AIR which reveals that the test subject has no reportable results, why there has been no reportable result derived or generated;

I. The firmware shall be reprogrammed to include, on all future AIR printouts, solution change reports, calibration documents, and a listing of the temperature probe serial number and value; and

***153** J. The firmware shall be reprogrammed to include, on all future AIR printouts, a designation of the firmware version utilized by the device reporting breath results; and it is further

3. ORDERED that the State shall forthwith:

A. Commence inspection and recalibration of all Alcotest devices every six months in place of the current annual inspection and recalibration program;

B. Create and maintain a centralized statewide database, comprised of downloaded Alcotest results, and shall make the data, following appropriate redactions of personal identification as needed, available to defendants and counsel; and

C. Produce in discovery the twelve foundation documents identified by the Special Master as follows:

(1) New Standard Solution Report of the most recent control test solution change, and the credentials of the operator who performed that change;

(2) Certificate of Analysis for the 0.10 percent solution used in that New Solution Report;

(3) Draeger Safety Certificate of Accuracy for the Alcotest CU34 Simulator;

(4) Draeger Safety Certificate of Accuracy for the Alcotest 7110 Temperature Probe;

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(5) Draeger Safety Certificate of Accuracy for the Alcotest 7110 Instrument;

(6) Calibration Records, including control tests, linearity tests, and the credentials of the coordinator who performed the calibration;

(7) Certificate of Analysis for the 0.10 percent solution used in the calibration control test;

(8) Certificate of Analysis for the 0.04, 0.08, and 0.16 percent solutions used in the calibration linearity test;

(9) New Standard Solution Report, following the most recent calibration;

(10) Draeger Safety Certificates of Accuracy for the Simulators used in calibration;

(11) Draeger Safety Certificate of Accuracy for the Alcotest 7110 Temperature Probe used in calibration; and

(12) Draeger Safety Ertco-Hart Calibration Report; and it is further

4. ORDERED that the State shall provide notice, both to the parties and by means calculated to be generally accessible to the public and shall specifically provide notice to the New Jersey State Bar Association, of any and all proposed future revisions to the *154 Alcotest New Jersey Firmware, which notice shall not be generic, but *174 shall be sufficiently specific to identify the proposed software changes so as to afford notice in compliance with due process; and it is further

5. ORDERED that Draeger shall make training on the Alcotest device, substantially similar to that provided to Alcotest operators and coordinators, available to licensed New Jersey attorneys and their designated ex-

perts, at regular intervals and at locations within the State of New Jersey, at a reasonable cost to those who attend; and it is further

6. ORDERED that in all pending prosecutions based on or including Alcotest New Jersey Firmware version 3.11 and all future firmware versions, and consistent with past practices in prosecutions based on breathalyzer analysis,

A. The operator who conducted the tests shall be made available to testify and shall produce the documents evidencing his or her training, and

B. The following foundational documents shall be offered into evidence to demonstrate the proper working order of the device:

(1) the most recent Calibration Report prior to a defendant's test, including control tests, linearity tests, and the credentials of the coordinator who performed the calibration;

(2) the most recent New Standard Solution Report prior to a defendant's test; and

(3) the Certificate of Analysis of the 0.10 Simulator Solution used in a defendant's control tests.

Justices LONG, LaVECCHIA, ALBIN, WALLACE, RIVERA-SOTO, and HOENS join in the Court's Order. Chief Justice RABNER did not participate.

WORKSHEET A

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WORKSHEET A

State v. Chun, et al.
 Supreme Court of New Jersey
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Tolerance Worksheet (for use in connection with Alcotest New Jersey Firmware 3.11)
 How to Calculate Whether Two Breath Samples are in Tolerance Under Acceptable Tolerance Standard

Line #	Subject Alcohol Results to be Input from Alcohol Influence Report	
1	Valid Breath Sample 1 IR	(Value entered from AIR)
2	Valid Breath Sample 1 EC	(Value entered from AIR)
3	Valid Breath Sample 2 IR	(Value entered from AIR)
4	Valid Breath Sample 2 EC	(Value entered from AIR)
Breath Samples Tolerance Agreement Check		
5	Add Lines #1, #2, #3, and #4:	(This is the sum)
6	Divide Line #5 by 4:	(This is the arithmetic mean)
7	Multiply Line #6 by 1.05:	(This is relative tolerance upper limit)
8	Add 0.005%BAC to Line #6:	(This is absolute tolerance upper limit)
9	Multiply Line #6 by 0.95:	(This is relative tolerance lower limit)
10	Subtract 0.005%BAC from Line #6:	(This is absolute tolerance lower limit)
11	Report the greater of Line #7 or Line #9, to four digits after decimal point:	(This is the upper tolerance limit)
12	Report the lesser of Line #9 or Line #10, to four digits after decimal point:	(This is the lower tolerance limit)
13	Lines #1, #2, #3, and #4 are within the values of Lines #11 and #12. TRUE or FALSE?	(If TRUE, breath samples are in tolerance and AIR is valid; if FALSE, breath samples are not in tolerance and the AIR is invalid)

*175 WORKSHEET B

WORKSHEET B

State v. Chun, et al.
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Buffer Overflow Worksheet (for use in connection with Alcotest New Jersey Firmware 3.11)
 How to Calculate Reported Breath Test Result When Third Valid Breath Sample is Collected

Line #	Subject Alcohol Results to be Input from Alcohol Influence Report	
1	Valid Breath Sample 1 IR	(Value entered from AIR)
2	Valid Breath Sample 1 EC	(Value entered from AIR)
3	Valid Breath Sample 2 IR	(Value entered from AIR)
4	Valid Breath Sample 2 EC	(Value entered from AIR)
5	Valid Breath Sample 3 IR	(Value entered from AIR)
6	Valid Breath Sample 3 EC	(Value entered from AIR)
Valid Breath Samples 1 & 3 Tolerance Agreement Checks		
7	Copy Line #1	(Copy from appropriate field above)
8	Copy Line #2	(Copy from appropriate field above)
9	Copy Line #3	(Copy from appropriate field above)
10	Copy Line #4	(Copy from appropriate field above)
11	Add Lines #7, #8, #9, and #10:	(This is the sum)
12	Divide Line #11 by 4:	(This is the arithmetic mean)
13	Multiply Line #12 by 1.05:	(This is relative tolerance upper limit)
14	Multiply Line #12 by 0.95:	(This is relative tolerance lower limit)
15	Add 0.005%BAC to Line #12:	(This is absolute tolerance upper limit)
16	Subtract 0.005%BAC from Line #12:	(This is absolute tolerance lower limit)
17	Report the greater of Line #13 or Line #15, to four digits after decimal point:	(This is the upper tolerance limit)
18	Report the lesser of Line #14 or Line #16, to four digits after decimal point:	(This is the lower tolerance limit)
19	Lines #7, #8, #9, and #10 are within the values of Lines #17 and #18. TRUE or FALSE?	(Valid Breath Samples 1 & 3 are in tolerance agreement if TRUE)
Valid Breath Samples 2 & 3 Tolerance Agreement Checks		
20	Copy Line #3	(Copy from appropriate field above)
21	Copy Line #4	(Copy from appropriate field above)
22	Copy Line #5	(Copy from appropriate field above)
23	Copy Line #6	(Copy from appropriate field above)
24	Add Lines #20, #21, #22, and #23:	(This is the sum)
25	Divide Line #24 by 4:	(This is the arithmetic mean)
26	Multiply Line #25 by 1.05:	(This is relative tolerance upper limit)
27	Multiply Line #25 by 0.95:	(This is relative tolerance lower limit)
28	Add 0.005%BAC to Line #25:	(This is absolute tolerance upper limit)
29	Subtract 0.005%BAC from Line #25:	(This is absolute tolerance lower limit)
30	Report the greater of Line #26 or Line #28, to four digits after decimal point:	(This is the upper tolerance limit)
31	Report the lesser of Line #27 or Line #29, to four digits after decimal point:	(This is the lower tolerance limit)
32	Lines #20, #21, #22, and #23 are within the values of Lines #30 and #31. TRUE or FALSE?	(Valid Breath Samples 2 & 3 are in tolerance agreement if TRUE)
Selection of Reported Breath Test Result		
33	If Lines #19 and #32 are both TRUE, report the lowest value from Lines #1, #2, #3, #4, #5, and #6. Truncate to two digits after the decimal point. Otherwise, write FALSE	(The value here is the RBTR. If FALSE, there is not agreement both for breath samples 1&3 AND 2&3.)
34	If Line #19 is TRUE and Line #32 is FALSE, report the lowest value from Lines #1, #2, #3, and #6. Truncate to two digits after the decimal point. Otherwise, write FALSE	(The value here is the RBTR. If FALSE, there is not agreement only for breath samples 1&3.)
35	If Line #19 is FALSE and Line #32 is TRUE, report the lowest value from Lines #3, #4, #5, and #6. Truncate to two digits after the decimal point. Otherwise, write FALSE	(The value here is the RBTR. If FALSE, there is not agreement only for breath samples 2&3.)
36	If Line #19 and Line #32 are both FALSE, write TRUE. When TRUE, the breath test will result in a TESTS OUTSIDE +/- TOL error and no alcohol value will be reported. Otherwise, write FALSE	(If TRUE, there is no tolerance agreement between any of the three samples provided. Therefore the AIR is invalid.)

END OF DOCUMENT

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