FORENSIC TECHNICAL BRIEF

THE ANALYTICAL GAP

DECONSTRUCTING THE 1.18 SAC:BAC MULTIPLIER UNDER THE *ROCHKIND–DAUBERT* STANDARD

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Maryland DUI Defense · Forensic Reliability & Evidentiary Challenges

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RE: Forensic Reliability of Serum Alcohol Conversion in Maryland Prosecutions

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I. EXECUTIVE SUMMARY

This Technical Brief addresses a recurring move in Maryland DUI prosecutions involving hospital-drawn blood: the State presents a Serum (or Plasma) Alcohol Concentration ("SAC") and then purports to convert it into a Whole Blood Alcohol Concentration ("BAC") using a fixed multiplier—most commonly 1.18. The conversion is then treated as a case-specific BAC, offered to satisfy statutory per se elements, and argued to the factfinder as if it were a measurement rather than an estimation.

That methodology is not a scientific measurement. It is a population-average guess. It is not reliably applied to the facts of any particular case unless the State can establish the subject-specific variables that control the SAC:BAC ratio, most importantly the subject's hematocrit at or near the time of draw. Absent that missing data point, the State is not doing science; it is doing arithmetic theatre.

Rochkind v. Stevenson did not just "tweak" expert admissibility—it reset the trial court's job. Maryland adopted the *Daubert* reliability framework and reaffirmed that an expert opinion is inadmissible when it is connected to the underlying data only by assumption, ipse dixit, or a population-average leap that cannot be tied to the facts of the case. *Rochkind* v. Stevenson, 471 Md. 1, 38-40 (2020) (adopting *Daubert*; emphasizing analytical-gap screening) (citing *Daubert* v. Merrell Dow Pharm., Inc., 509 U.S. 579, 592-95 (1993); Gen. Elec. Co. v. Joiner, 522 U.S. 136, 146 (1997); *Kumho Tire Co. v. Carmichael*, 526 U.S. 137, 141-42 (1999)). Long before *Rochkind* formally adopted *Daubert*, Maryland had already been importing the same analytical-gap logic into Frye-Reed and Rule 5-702 case law. See, e.g., *Blackwell v. Wyeth*, 408 Md. 575, 604-08, 971 A.2d 235, 253-55 (2009) (requiring generally accepted methodology plus generally

accepted analysis to avoid an analytical gap); *Savage v. State*, 455 Md. 138, 164-70, 166 A.3d 183, 198-202 (2017) (excluding expert where the analysis did not "connect[] the dots" between data and conclusion). The point is not academic: in BAC cases built on serum/plasma numbers, the State's 1.18 conversion is a shortcut that can move a defendant across a criminal threshold without case-specific proof.

This Brief provides (1) the biochemical foundation explaining why SAC and BAC differ; (2) the controlling role of hematocrit and biological variance; (3) demonstrable error-rate examples; (4) a *Rochkind–Daubert* reliability analysis tailored to the 1.18 multiplier; and (5) a practical protocol for counsel to obtain the missing case-specific data, audit the State's workflow, and frame clean gatekeeping objections.

II. LEGAL PREMISE: *ROCHKIND*, RULE 5-702, AND THE ANALYTICAL GAP

Under Maryland Rule 5-702, expert testimony is admissible only if: (1) the witness is qualified, (2) the testimony will assist the trier of fact, and (3) the opinion rests on a sufficient factual basis—meaning it is grounded in reliable principles and methods and reliably applied to the facts of the case. Md. Rule 5-702. *Rochkind* confirms what the Rule actually requires in practice: judges must act as gatekeepers and must exclude expert opinions where there is "too great an analytical gap between the data and the opinion proffered." *Rochkind*, 471 Md. at 38 (*quoting Joiner*, 522 U.S. at 146).

The controlling problem with a fixed SAC:BAC multiplier is not merely that it is 'imperfect.' The problem is that, in the case sub judice, the State's opinion typically contains an unstated premise, that the defendant's biology matches the population mean.

That premise is not proven, it is assumed. And if it is assumed, the opinion is not grounded in sufficient facts or data.

In plain English, if the State did not measure the variable that drives the ratio (hematocrit), it cannot honestly claim that 1.18 is the right number for this person. The State may be able to say, 'On average, serum runs higher than whole blood.' That is a general proposition. But *Rochkind* does not admit general propositions as substitutes for case-specific proof when the inference is doing the work of an element.

The analytical gap here is straightforward. The data is a hospital serum/plasma number. The opinion offered to the court is an alleged whole-blood BAC. The bridge between the two is a fixed multiplier (1.18) chosen without any subject-specific predicate—no contemporaneous hematocrit, no validated conversion study for the individual, and no quantified uncertainty. That is not a "minor dispute over weight." It is a reliability failure, because the methodology cannot be reliably applied to the facts of the case. See *Rochkind*, 471 Md. at 38-39; *Joiner*, 522 U.S. at 146.

III. DEFINITIONS AND LABORATORY WORKFLOW (SAC VS. BAC)

A reliable analysis starts with naming the units and identifying what was actually tested. In many hospital settings, the lab reports a serum or plasma ethanol result, often generated for clinical management rather than forensic precision. Law enforcement later seeks to use that clinical value as the backbone of a criminal prosecution.

Key definitions:

- Whole Blood Alcohol Concentration (BAC): ethanol concentration in whole blood, which includes plasma/serum plus cellular components (primarily red blood cells).

- Serum Alcohol Concentration (SAC): ethanol concentration measured in serum (liquid portion after clotting).
- Plasma Alcohol Concentration (PAC): ethanol concentration measured in plasma (liquid portion with clotting factors preserved).
- Hematocrit (Hct): proportion of blood volume occupied by red blood cells. Higher hematocrit generally means less plasma water fraction in whole blood.
- Conversion Factor / Multiplier: a numeric ratio used to estimate BAC from SAC or PAC (e.g., 1.18).

Typical workflow in a hospital-draw case is (1) clinical blood draw; (2) hospital lab reports serum/plasma ethanol; (3) the State later receives records; (4) a State witness testifies that serum is 'higher' than whole blood and applies a fixed ratio to 'convert' it; (5) the converted number is presented to the factfinder as if it were a measured whole-blood BAC.

This workflow matters because reliability lives in the details like the specimen type, tube type, anticoagulant, storage conditions, analytical method, calibration, quality control, and—critically—the defendant's biological variables at the time of draw. A conversion that ignores the controlling variable is not a methodology; it is a placeholder.

IV. THE BIOCHEMICAL FOUNDATION: WATER CONTENT AND PARTITIONING

Ethanol is water soluble and its distribution is governed primarily by the water content of the medium, not by some mystical forensic ratio. Serum (or plasma) contains a higher fraction of water than whole blood because whole blood includes cellular components with different water content. As a result, serum/plasma ethanol values are generally higher than whole-blood values taken from the same person at the same time.

That general statement is not controversial, the controversy is what the State does next: it takes that general principle and converts it into a purportedly exact BAC by applying a fixed multiplier. The moment the State does that, it assumes away variance, error rate, and individualized biology.

The water-fraction difference is the starting point for why the ratio exists. It is not a justification for pretending the ratio is constant. The ratio moves with hematocrit, protein content, disease states, trauma, hydration, and laboratory handling. Any honest witness must concede that these variables exist. Once they are conceded, the need for subject-specific data becomes axiomatic.

V. THE HEMATOCRIT (HCT) VARIANCE: THE VARIABLE THAT CONTROLS THE RATIO

The (SAC):(BAC) ratio is not a constant, it's a variable function of hematocrit and related physiological parameters. As hematocrit increases, the plasma fraction decreases; as it decreases (e.g., dilution, trauma resuscitation), the plasma fraction increases. Because ethanol partitions into water, shifts in these fractions move the ratio.

Scientific literature identifies a broad range of reported ratios. Even studies that report an average around ~1.15–1.18 are explicit that the variance is meaningful. Other studies identify ranges that are even wider. Where the range includes both sides of a statutory threshold, the State cannot credibly call the conversion 'reliable' without the individual hematocrit.

Three points are non-negotiable from a scientific viewpoint, and those are:

1. Inverse relationship: hematocrit materially changes the serum-to-whole-blood ratio, and therefore changes any converted BAC.

2. Biological range: published ranges (and observed casework) include ratios low enough that 1.18 can materially overstate a converted BAC.
3. Case-specific necessity: absent a contemporaneous hematocrit (or at minimum a defensible reconstruction), a fixed multiplier is not 'reliably applied' to the facts of the case.

The State's habitual practice is to ignore hematocrit, then testify to certainty. That is backwards. In the case sub judice, hematocrit is the fact that must be established before a conversion opinion can pretend to be individualized.

VI. ERROR RATE: HOW THE 1.18 GUESS MANUFACTURES AN ELEMENT

Daubert reliability analysis cares about error rate because error rate is where math meets due process. If the error rate is large enough to shift a number across a legal threshold, the opinion is not merely 'imprecise'—it is outcome-determinative.

Worked example (illustrative, not hypothetical in the sense of implausible). Suppose a hospital reports SAC = 0.094. The State applies 1.18 and reports BAC ≈ 0.080. The courtroom hears 'point zero eight.' The legal consequence changes. But if the subject's true ratio was 1.06 (a value within reported ranges), then BAC ≈ 0.089, i.e., materially different. If the ratio was 1.26, BAC ≈ 0.075. The same serum number yields both sides of the line depending on the person.

The State or State's chief forensic officer (in Maryland Dr. Haley Mulder, PhD) will often respond with 'But 1.18 is conservative' or '1.18 is standard.' Neither statement is a *reliability foundation*. A standard is not a validated peer-reviewed scientific study. And '*conservative'* is not a scientific property when the data needed to justify the claim was never collected.

The overstatement risk is plain. When the true ratio is lower than 1.18, the State's conversion inflates BAC. In plain English, it turns a non-crime into a per se case. That is precisely the type of analytical gap *Rochkind* applying *Daubert* warns against.

VII. *ROCHKIND–DAUBERT* RELIABILITY FACTORS APPLIED TO THE 1.18 MULTIPLIER

Rochkind instructs courts to examine reliability in substance, not by label. The inquiry is flexible, but the focus must be on principles and methodology—not on the comfort of a familiar conclusion. *Rochkind*, 471 Md. at 37-39 (discussing *Daubert* factors and gatekeeping). *Daubert* requires the trial court to evaluate indicia of reliability such as testability, peer review, known or potential error rate, standards controlling the technique, and general acceptance. *Daubert*, 509 U.S. at 593-94. Joiner then makes clear that methodology and conclusions are not "entirely distinct," and that courts may exclude opinions connected to data only by the expert's say-so. *Joiner*, 522 U.S. at 146. *Kumho* extends this gatekeeping obligation to all expert testimony, including technical and specialized opinions. *Kumho Tire*, 526 U.S. at 141-42.

Applied factors such as:

4. Testability: Can the 1.18 multiplier be tested in the case sub judice? Yes—by measuring hematocrit and comparing concurrent serum and whole-blood values. If the State did not do that, it cannot claim testability in this case.
5. Peer review/publication: Literature discusses average ratios and variance; it does not bless a universal conversion as a forensic certainty for any given defendant.
6. Known or potential error rate: The variance itself is the error rate. Where the range spans legal thresholds, the error rate is not trivial.

7. Standards/controls: A hospital's clinical workflow is not a forensic SOP. Even if an SOP exists, it must address subject-specific variables; otherwise it is a standard that institutionalizes an analytical gap.
8. General acceptance: General acceptance that 'serum is higher than whole blood' is not the same as acceptance that a fixed conversion yields a reliable case-specific BAC.

When courts apply these factors honestly, the 1.18 multiplier does not survive. It is not case-specific, it lacks a reliable foundation absent hematocrit (or equivalent individualized data), and it carries an unquantified error risk that is outcome-determinative at per se thresholds. That is exactly what *Rochkind* and the *Daubert* trilogy exist to prevent—expert "conclusions" that smuggle in the missing facts. See *Rochkind*, 471 Md. at 38-40; *Daubert*, 509 U.S. at 595; *Joiner*, 522 U.S. at 146; *Kumho Tire*, 526 U.S. at 152.

VIII. WHAT THE STATE MUST SHOW (AND USUALLY CANNOT SHOW)

If the State wants to offer a converted BAC as a case-specific number, it must do more than say 'this is the number we use.' At minimum, the State must establish the factual predicates that justify choosing 1.18 for this person, at this time, with this specimen. Necessary predicates include:

- Specimen type and processing: serum vs plasma; clotting vs anticoagulant; time to centrifugation; storage conditions.
- Analytical method validation: assay type; calibration; controls; linearity; known interferences; reporting units.

- Temporal anchoring: draw time and relation to driving; any delay; any medical intervention between incident and draw.
- Subject-specific biology: hematocrit (and ideally total protein/albumin context) at or near time of draw, or a defensible reconstruction from clinical records.
- A transparent calculation: how the witness selected the ratio, what range is acknowledged, and what error rate is admitted.

When these predicates are missing, the proffered converted BAC is, by definition, not reliably applied. It is an opinion built on missing facts. In a fact-pleading jurisdiction, that would be called woefully inadequate. In an evidentiary gatekeeping context, it is inadmissible or must be strictly limited.

IX. PRACTICAL LITIGATION PROTOCOL: DISCOVERY, SUBPOENAS, AND PRESERVATION

Counsel should treat a hospital-blood conversion case as a data case. The goal is to force the State to show its work, lock in concessions on variance and error rate, and obtain the clinical records needed to prove the conversion is not case-specific. Recommended steps:

9. Subpoena the complete hospital laboratory packet: ethanol result, method sheet, units, reference ranges, specimen type, collection tube type, and accession logs.
10. Subpoena CBC results (or any contemporaneous hematology panels): locate hematocrit and hemoglobin values near the ethanol draw time.
11. Subpoena chain-of-custody and handling documentation: time of draw, time of receipt, time of analysis, storage conditions, retests, and any dilution flags.
12. Demand the State's toxicology SOP (if any) for serum/plasma conversions, including any claimed scientific basis for selecting 1.18.

13. If a state lab touched the specimen: subpoena LIMS logs, analyst notes, manual overrides, and QC records for that batch/run.
14. Preserve and demand underlying data in native format where possible (PDF printouts hide metadata; native exports preserve timestamps and flags).

This is where cases are won. Once the record shows hematocrit was never measured (or was measured and contradicts the State's chosen ratio), the conversion collapses into what it is: a generalized average being proffered as a forensic certainty.

X. CROSS-EXAMINATION OUTLINE FOR THE STATE'S TOXICOLOGY WITNESS

The purpose of cross is not to debate chemistry. It is to establish the analytic gap, the missing predicate facts, and the consequence: the witness cannot truthfully say the converted number is the defendant's BAC.

A. Lock in the specimen type and the fact of conversion

- You did not test whole blood, correct? The hospital reported serum/plasma ethanol, correct?
- Your 'BAC' number is an estimate derived by applying a multiplier, correct?
- That multiplier is not printed on the hospital report as a measured value, correct?

B. Establish variance and the controlling variable (hematocrit)

- The serum-to-whole-blood ratio varies between individuals, correct?
- Hematocrit affects the ratio, correct? Higher hematocrit changes the conversion, correct?
- If hematocrit is unknown, you cannot know the person's true ratio, correct?

C. Force admissions on error rate and threshold risk

- You cannot tell this Court the error rate of applying 1.18 to this defendant without knowing hematocrit, correct?
- A different ratio would produce a different converted BAC, correct?
- The difference can be large enough to change whether the number is above or below 0.08, correct?

D. Tie back to *Rochkind* gatekeeping

- Your opinion requires the assumption that this defendant matches a population mean, correct?
- You did not perform a case-specific validation study, correct?
- So your bridge from serum data to whole-blood BAC is an assumption, not a measurement, correct?

XI. PROPOSED GATEKEEPING FINDINGS AND LIMITING INSTRUCTIONS

Courts are not required to accept a converted BAC as a per se fact. Where the foundation is missing, the Court can: (1) exclude the converted number entirely; (2) limit the testimony to a qualitative proposition; or (3) permit testimony only with strict disclosures.

Recommended gatekeeping findings (drafted in neutral form):

- The underlying data is a serum/plasma ethanol result, not a whole-blood BAC measurement.
- The proposed conversion relies on a fixed multiplier selected without case-specific hematocrit data.
- Published literature recognizes meaningful variance in SAC:BAC ratios, creating a non-trivial error rate.

- Because the case-specific predicates are not established, the conversion is not reliably applied to the facts of the case under Rule 5-702.
- Accordingly, testimony presenting a converted number as the defendant's BAC is excluded (or limited) to avoid misleading the trier of fact.

If the Court permits any conversion testimony, the limiting instruction should make explicit that the number is an estimate, that the ratio varies, and that the conversion may overstate or understate the true whole-blood value.

XII. APPENDIX A: CALCULATIONS AND WORKED EXAMPLES

Appendix A provides simple arithmetic demonstrations. The purpose is to show that the multiplier is doing the heavy lifting, and that plausible ratios produce different legal outcomes.

- Example 1: SAC 0.094 → BAC 0.0797 (÷1.18) vs BAC 0.0887 (÷1.06) vs BAC 0.0746 (÷1.26).
- Example 2: SAC 0.100 → BAC 0.0847 (÷1.18) vs BAC 0.0943 (÷1.06) vs BAC 0.0794 (÷1.26).
- Example 3: Show percent error when using 1.18 instead of 1.06: $(1.18/1.06) - 1 \approx 11.3\%$ inflation.

These are not exotic calculations. They are the inevitable consequence of using a fixed ratio in a world where the ratio varies. When the law draws a bright line, arithmetic variance becomes constitutional variance.

XIII. APPENDIX B: DOCUMENT REQUESTS / SUBPOENA CHECKLIST

- Complete hospital laboratory record for ethanol test (including specimen type, tube type, accession, analytical method, and QC summary).

- Complete clinical chart entries from incident to discharge: IV fluids, transfusions, medications, trauma notes, and timestamps.
- CBC/hematology panels (hematocrit/hemoglobin) within 6 hours before/after ethanol draw, and any repeats.
- Chain-of-custody forms, evidence logs, transport conditions (temperature, sealing, storage).
- Any State lab documentation: submission forms, retest logs, LIMS exports, analyst notes, override flags.
- SOPs, training records, and validation materials for any serum/plasma conversion practice.

XIV. APPENDIX C: SAMPLE OBJECTIONS AND MOTION LANGUAGE (NON-PLEADING FORMAT)

Objection (*foundation!/reliability!?*): 'Objection, Rule 5-702. The witness is offering a case-specific BAC without sufficient facts or data. The underlying data is serum/plasma ethanol. The witness did not measure hematocrit or otherwise establish the subject-specific ratio. Under *Rochkind*, the conversion presents too great an analytical gap and risks misleading the trier of fact.'

Proposed limitations to be applied at trial: Example: 'If any testimony is allowed, it must be limited to the general proposition that serum/plasma values tend to be higher than whole-blood values, and the witness must disclose that any converted number is an estimate subject to biological variance and a non-trivial error rate.'

Closing principle is simply 'The State bears the burden of proof. It cannot meet that burden by importing a population mean and calling it a defendant-specific fact.'

CONCLUSION

This paper does not argue that serum testing is "junk science." It argues something far more narrow—and far more damning: Maryland (and any other jurisdiction that lets this happen) cannot lawfully convict people on an arithmetic guess dressed up as a measurement. Under the post-*Rochkind* framework, the trial judge is not a passive referee. The judge is a gatekeeper. And the gatekeeper's job is to stop expert testimony when the methodology is not reliably tethered to the facts of the case.

Rochkind adopted *Daubert* because modern expert testimony demands a modern reliability screen, and because courts must do more than accept an expert's conclusion "because an expert said so." *Rochkind*'s holding is explicit: in light of *Daubert* and its progeny, Maryland adopts *Daubert* as the governing standard for interpreting Maryland Rule 5-702. Under that standard, the court must scrutinize not only the general methodology, but also the fit—the relationship between the data and the conclusion. When the connection is missing, courts are permitted to find "too great an analytical gap." (*Rochkind* v. Stevenson, No. 47, Sept. Term 2019, slip op. at 40 (Md. Aug. 28, 2020); *Daubert* v. *Merrell Dow Pharm., Inc.*, 509 U.S. 579, 589, 597 (1993); *Gen. Elec. Co. v. Joiner*, 522 U.S. 136, 146 (1997); *Kumho Tire Co. v. Carmichael*, 526 U.S. 137, 147–49 (1999).)

That is exactly the problem with the State's reflexive 1.18 SAC:BAC conversion. In a hospital draw, the raw number is serum. The crime element is whole blood. The bridge between those two is not a constant; it is a person-specific variable driven by hematocrit and other physiological factors. When the State does not measure hematocrit

at the relevant time, it does not have "data" to support selecting 1.18 for this defendant. What it has is a population average. Under *Daubert-Rochkind*, a population average is not a substitute for a factual basis.

If courts take the gatekeeping role seriously, the consequence is not academic. It is corrective. A meaningful *Daubert* screen should trigger an institutional review of convictions and pleas that were built on hospital blood math—especially where the conversion multiplier supplied the difference between a non-per se result and a per se conviction. And the cleanest way to do that review is not to pretend every old case automatically becomes void; it is to triage the cases and let State's Attorneys decide which ones they can ethically and legally retry with admissible proof.

Procedurally, the path will vary. For some defendants, the claim will be ineffective assistance of counsel because trial counsel failed to litigate reliability, failed to demand the missing predicate data, or failed to exclude a conversion methodology that was never validated for the individual defendant. Strickland supplies the governing two-prong test—deficient performance and prejudice—and Maryland's post-conviction framework recognizes that prejudice turns on whether the error created a substantial possibility of a different outcome in context. (*Strickland v. Washington*, 466 U.S. 668, 687–88, 694 (1984); *Bowers v. State*, 320 Md. 416, 426–27 (1990).)

For other defendants, the more direct vehicle is actual innocence relief where newly discovered evidence (including the availability of missing lab / medical data or scientific developments that materially undermine the conviction's factual premise) creates a substantial or significant possibility of a different result and speaks to factual innocence—meaning the petitioner did not commit the offense as charged. Maryland has

codified that remedy in Criminal Procedure § 8-301, and the Court of Appeals has emphasized that courts must "look back" to the trial record to determine whether the new evidence could have changed the outcome. (Md. Code Ann., Crim. Proc. § 8-301(a)(1); *State v. Hunt*, 443 Md. 238, 252, 264 (2015); *McGhie v. State*, 449 Md. 494, 510–12 (2016); Smallwood v. State, 451 Md. 290, 313, 323 (2017); Faulkner v. State, 468 Md. 418, 459–60 (2020).)

The bottom line is the same as the executive summary, because the bottom line does not change: 1.18 is not a measurement. It is a shortcut. Without subject-specific validation, it is not "reliably applied to the facts" of a criminal case. A judge doing the job *Rochkind* now requires should not let a criminal conviction rest on a multiplier that the State cannot tie to the person in the chair. When the prosecution cannot bridge the analytical gap, the testimony does not come in—and the case must be proved some other way, or not at all.