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### Evidence on Fire

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## EVIDENCE ON FIRE\*

VALENA E. BEETY & JENNIFER D. OLIVA\*\*

*Fire science, a field largely developed by lay “arson investigators,” police officers, or similar first responders untrained in chemistry and physics, has been historically dominated by unreliable methodology, demonstrably false conclusions, and concomitant miscarriages of justice. Fire investigators are neither subject to proficiency testing nor required to obtain more than a high school education. Perhaps surprisingly, courts have largely spared many of the now-debunked tenets of fire investigation any serious scientific scrutiny in criminal arson cases. This Article contrasts the courts’ ongoing lax admissibility of unreliable fire-science evidence in criminal cases with their strict exclusion of the same flimsy evidence in civil cases, notwithstanding that both criminal and civil courts are required to operate under the same exclusionary rules for expert evidence.*

*Judges are capable of ensuring that the forensic science evidence they admit at trial is reliable in both criminal and civil proceedings. In addition, the law mandates that they do so. The Federal Rules of Evidence and Daubert v. Merrell Dow Pharmaceuticals, Inc. demand the application of the same standards to vet the admissibility of expert evidence in criminal and civil cases. Moreover, Kumho Tire v. Carmichael expands that mandate to exclude capricious forensic evidence regardless of whether it is characterized as scientific or technical. Unfortunately, thirty-one states have failed to embrace the holding of Kumho Tire. As a result, litigants are not entitled to raise Daubert challenges to fire evidence that courts deem technical, rather than scientific, knowledge in the overwhelming majority of American jurisdictions.*

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*The ongoing admission of flawed fire science in criminal litigation brings us back to the problem Daubert sought to address: the courts' failure to exclude junk science in American trials. Criminal courts must follow their civil counterparts and rigorously enforce gatekeeping procedures when prosecutors proffer questionable forensic "science" evidence in order to secure a conviction. Moreover, criminal defense attorneys must invoke Daubert and challenge unreliable forensic science during the trial proceedings. As several courts have held, the failure to do so falls below the constitutional requirements that attend to effective advocacy.*

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## INTRODUCTION

*Slow and painful has been man's progress from magic to law.*  
—Ancient Chinese Proverb<sup>1</sup>

*To achieve justice, the law must serve as the vehicle through which imperfect institutions strive for greater justice through a more perfect understanding of the truth. Therefore, as our understanding of scientific truth grows and changes, the law must follow the truth in order to secure justice.*<sup>2</sup>

Human beings have long been fascinated by the awesome and unforgiveable power of fire.<sup>3</sup> From old southern stories about barn burners<sup>4</sup> to *The Confession Tapes*' chronicles of false confessions to murder by arson,<sup>5</sup> fire investigations evoke the worst of human imagination. Playing off the evocative and destructive power of fire, fire experts historically conjured up pseudomagical powers in the courtroom, regaling jurors with investigatory findings that were “more art than science” and with stories about accelerant-detection dogs' supercanine olfactory abilities, which enabled them to pinpoint a fire's origin.<sup>6</sup> The fire “expert,” imbued with gravitas due to his

1. Han Tak Lee v. Tennis, No. 4:08-CV-1972, 2014 WL 3894306, at \*1 (M.D. Pa. June 13, 2014) (“This proverb, inscribed at the University of Pennsylvania Law School on the statue of Hseih-Chai, a mythological Chinese beast who was endowed with the faculty of discerning the guilty, is a fitting metaphor for both the progress of the law and the history of this case.”), *adopting report and recommendation sub nom.* Lee v. Tennis, No. 4:CV-08-1972, 2014 WL 3900230 (M.D. Pa. Aug. 8, 2014), *aff'd sub nom.* Han Tak Lee v. Houtzdale SCI, 798 F.3d 159 (3d Cir. 2015).

2. *Id.* at \*19.

3. Natalie Wolchover, *Why We Are Drawn to Fire*, LIVE SCIENCE (Apr. 23, 2012, 5:27 PM), <https://www.livescience.com/19853-fire-fascination.html> [<https://perma.cc/KKV4-9SJ4>].

4. WILLIAM FAULKNER, *Barn Burning*, in COLLECTED STORIES OF WILLIAM FAULKNER 3, 20–21 (1st Vintage Int'l ed. 1995) (1950).

5. See generally *The Confession Tapes: Trial by Fire* (Netflix 2017).

6. John J. Lentini, *Evidence Collection at Fire Scenes*, in 3 ENCYCLOPEDIA OF FORENSIC SCIENCES 387, 388 (Jay A. Siegel & Pekka J. Saukko eds., 2d ed. 2013), <http://www.firescientist.com/Documents/NewOrder/2013%20EFS%20Evidence%20Collection%20from%20Fire%20Scenes-John%20.pdf> [<https://perma.cc/VL7G-RFRH>] (“As with any tool, canines are subject to limitations. The canine responds to scents that it has previously been rewarded for alerting to. If, on a particular scene, a canine responds to pyrolysis products, rather than foreign ignitable liquids, it is likely to respond inappropriately for the rest of the day because it has been rewarded for doing so. Canines are incapable of identifying different [ignitable liquid residues].”).

uncanny ability to understand the mysteries of the element, easily awes and persuades a Western jury, which, as studies have noted, is largely composed of individuals unfamiliar with how to start, maintain, or use fire.<sup>7</sup> As Professor Paul Giannelli has explained,

For decades arson investigators came from the “old school” of investigators—those who used intuition and a number of rules of thumb to determine whether a fire was incendiary. Critics complained that instead of being rooted in science, the approach was based on folklore that had been passed down from generation to generation—without any empirical testing. A government report noted, as early as 1977, that common arson indicators had “received little or no scientific testing” and that “[t]here appears to be no published material in the scientific literature to substantiate their validity.”<sup>8</sup>

Such rules of thumb include numerous scientifically debunked myths, such as accelerant-provoked fires burn hotter and faster than incendiary fires and crazed glass indicates arson. Unfortunately, these and numerous other arson-indicator-related myths were published and preserved in two widely referenced fire-science resources: *Arson and Arson Investigation Survey and Assessment* and *Fire Investigation Handbook*.<sup>9</sup> Continued reliance on these unreliable resources provoked the American Association for the Advancement of Science (“AAAS”) to characterize fire investigation as a field inundated with a “widespread, persistent, and problematic literature affecting the beliefs and the behavior of practitioners.”<sup>10</sup>

Fire science, as it became known along its “progression from magic to science,” is one of several forensic disciplines that has

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7. Wolchover, *supra* note 3 (explaining that “fire retains greater allure or fascination than would normally be the case” for Western peoples as a result of our lack of understanding and mastery of the element).

8. Paul C. Giannelli, *Forensic Science: Daubert’s Failure*, 68 CASE W. RES. L. REV. 869, 889 (2018) (footnotes omitted) (quoting JOHN F. BOUDREAU ET AL., NAT’L INST. OF LAW ENF’T & CRIMINAL JUSTICE, ARSON AND ARSON INVESTIGATION: SURVEY AND ASSESSMENT 88 (1977)).

9. John J. Lentini, *The Mythology of Arson Investigation 1* (unpublished manuscript) [hereinafter Lentini, *Mythology of Arson Investigation*], <http://www.firescientist.com/Documents/THE%20MYTHOLOGY%20OF%20ARSON%20INVESTIGATION,%20isfi%20manuscript.pdf> [https://perma.cc/PP95-3226].

10. CHARLIE HANGER, AM. ASS’N FOR THE ADVANCEMENT OF SCI., FORENSIC SCIENCE ASSESSMENTS: A QUALITY AND GAP ANALYSIS—FIRE INVESTIGATION, A PLAIN LANGUAGE SUMMARY 6 (2017).

historically generated inaccurate expert evidence.<sup>11</sup> Our research indicates, however, that while civil courts closely scrutinize and often exclude unreliable fire-science evidence, criminal courts routinely allow it to go to the jury. In criminal arson cases, prosecutors frequently proffer—and courts often admit—testimony from “fire experts,” that is, scientifically untrained police officers and first responders who have completed a multiweek fire investigation training usually taught by similarly scientifically untrained police officers and first responders.<sup>12</sup> In a fire-science-involved civil products liability or wrongful death case, on the other hand, litigants consistently challenge the admissibility of the opposing party’s fire experts, who are usually specialized scientists and chemists, under Federal Rule of Evidence 702<sup>13</sup> and *Daubert v. Merrell Dow Pharmaceuticals, Inc.*<sup>14</sup> Civil plaintiffs, often corporations, also tend to be willing to finance quality experts, particularly when a court decision can impact multiple future cases about a single product. Needless to say, civil courts generally exclude proffered expert fire-science testimony that fails to satisfy Rule 702, commonly referred to as the *Daubert* standard.<sup>15</sup>

As a general rule, the “forensic sciences” emerged from law enforcement gumshoe-crime-investigation tactics, which relied heavily on forensic fields that had never been subjected to scientific studies to verify their reliability or validity.<sup>16</sup> These fields include, among other things, bite mark matching, fingerprint evidence,

11. See, e.g., Mark Hansen, *Badly Burned: Long-Held Beliefs About Arson Science Have Been Debunked After Decades of Misuse and Scores of Wrongful Convictions*, A.B.A. J., Dec. 2015, at 37, 37–39.

12. JOHN J. LENTINI, SCIENTIFIC PROTOCOLS FOR FIRE INVESTIGATION, at xv (Keith Inman & Norah Rudin eds., 2d ed. 2013) [hereinafter LENTINI, SCIENTIFIC PROTOCOLS] (“The fire investigator . . . may have no education beyond high school. His training typically consists of a 40-hour ‘basic arson’ school, followed by an 80-hour ‘advanced arson’ school, and perhaps some continuing education taught by people with the same training and more experience.”).

13. FED. R. EVID. 702.

14. 509 U.S. 579 (1993).

15. See *Bryte ex rel. Bryte v. Am. Household, Inc.*, 429 F.3d 469, 477–80 (4th Cir. 2005); *Fireman’s Fund Ins. Co. v. Canon U.S.A., Inc.*, 394 F.3d 1054, 1057–58 (8th Cir. 2005); *Werth v. Hill-Rom, Inc.*, 856 F. Supp. 2d 1051, 1062–63 (D. Minn. 2012); *Travelers Indem. Co. v. Indus. Paper & Packaging Corp.*, No. 3:02–CV–491, 2006 WL 1788967, at \*4–5 (E.D. Tenn. June 27, 2006); *Ind. Ins. v. Gen. Elec. Co.*, 326 F. Supp. 2d 844, 847–53 (N.D. Ohio 2004); *Tunnell v. Ford Motor Co.*, 330 F. Supp. 2d 707, 727–31 (W.D. Va. 2004); *Snodgrass v. Ford Motor Co.*, No. 96-1814(JBS), 2002 U.S. Dist. LEXIS 13421, at \*45–46 (D.N.J. Mar. 28, 2002); *Chester Valley Coach Works v. Fisher-Price, Inc.*, No. 99 CV 4197, 2001 WL 1160012, at \*8–10 (E.D. Pa. Aug. 29, 2001).

16. See, e.g., Giannelli, *supra* note 8, at 870.

comparative bullet lead analysis, and hair analysis.<sup>17</sup> Enter fire science, a field developed by arson investigators—that is, police officers or similar first responders untrained in chemistry and physics—which has been historically dominated by the application of unreliable methods and, therefore, faulty conclusions.<sup>18</sup> As fire expert and methodological critic John Lentini explains, “The introduction and persistence of mythology in arson investigation is an unfortunate part of the history of the discipline, and is a subject that many fire investigators do not like to think about.”<sup>19</sup> The limits of fire investigation are apparent to scientists: oftentimes, postfire evidence is either so severely degraded or nonexistent that it is impossible to adequately analyze. Accordingly, typical standards that have been heralded as increasing the reliability of comparison and matching forensic science fields are often inapplicable to fire science.

In a recent opinion piece in the *Los Angeles Times*, famed legal novelist John Grisham framed the current state of affairs as follows:

Over the last five decades, our courtrooms have been flooded with an avalanche of unreliable, even atrocious “science.” Experts with qualifications that were dubious at best and fraudulent at worst have peddled—for a fee, of course—all manner of damning theories based on their allegedly scientific analysis of hair, fibers, bite marks, arson, boot prints, blood spatters and ballistics. Of the 330 people exonerated by DNA tests between 1989 and 2015, 71% were convicted based on forensic testimony, much of which was flawed, unreliable, exaggerated or sometimes outright fabricated.<sup>20</sup>

Unfortunately, faulty fire science has been responsible for several high-profile wrongful convictions. Unless and until the courts close their doors to subjective, inaccurate, and unreliable fire origin and causation conclusions, “horror stories about wrongful prosecutions and convictions will undermine the public’s confidence in the ability of the justice system to respond appropriately to fire losses.”<sup>21</sup>

We begin this Article by examining the development of fire science, its long-standing mythologies, and national challenges to the

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17. *See id.* at 875.

18. LENTINI, SCIENTIFIC PROTOCOLS, *supra* note 12, at xv.

19. Lentini, Mythology of Arson Investigation, *supra* note 9, at 2.

20. John Grisham, *Why the Innocent End Up in Prison*, L.A. TIMES, Mar. 11, 2018, at A21.

21. John J. Lentini, *The Evolution of Fire Investigation and Its Impact on Arson Cases*, CRIM. JUST., Spring 2012, at 12, 62.

field's methodologies and practices. Part II of this Article discusses the evolution of fire science from a field dominated by unreliable, experiential intuition to one that has codified methodological best practices guidelines. The fire investigation community has proven resistant to these evidence-based standards. We then compare the treatment of faulty fire science in civil courts, which generally exclude such evidence, with that of criminal courts, which often admit the same. As emphasized in our first piece in this trilogy of essays and articles on forensic evidence, *Discovering Forensic Fraud*, judges are capable of ensuring that forensic science evidence produced at trial is reliable.<sup>22</sup> In fact, the charge for reform that has revolutionized the reliability of modern-day fire science was instigated by corporate defendants subjected to civil liability in insurance coverage and products liability actions. These civil litigants have raised formidable *Daubert* challenges to exclude so-called fire-science "experts" from trial and, ultimately, created a body of case law demanding greater reliability and substantive scientific findings from fire investigators.

Part III of this Article explains that the Federal Rules of Evidence and *Daubert* demand the application of the same standards to vet the admissibility of expert evidence in criminal and civil cases. Nonetheless, and similar to other questionable forensic-expert evidence proffered by prosecutors, unreliable and unsubstantiated arson-expert testimony continues to be routinely admitted in criminal cases and has led to high-profile wrongful convictions. This part goes on to discuss a trifecta of issues that infect fire-science investigations in arson cases: negative corpus theory, the risk of compounding errors, and common cognitive biases heuristics.

Part IV of this Article acknowledges that forensic-science-induced wrongful convictions are not solely attributable to criminal courts and explains that criminal defense counsel who fail to raise trial-level *Daubert* challenges frequently fall below the constitutional standard for effective advocacy. This part also explains that defense counsel is precluded from raising trial-level *Daubert* challenges in jurisdictions that classify fire science as technical, rather than scientific, evidence and have failed to adopt *Kumho Tire*.

The final part of this Article proposes solutions. Science is catching up with fire investigation, and we urge criminal courts to follow their sister civil courts and catch up too. We also contend that, while criminal fire-investigation units should adopt the National Fire

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22. Jennifer D. Oliva & Valena E. Beety, *Discovering Forensic Fraud*, 112 NW. U. L. REV. 121, 134 (2017).



Protection Association guidelines, courts are still required to grapple with the guidelines' reliability flaws when conducting a *Daubert* assessment. We conclude our Article by advocating for the adoption of error rates, Linear Sequential Unmasking, and a standardized tool to evaluate the quality of the evidence at issue in fire investigation in order to mitigate the pernicious role of cognitive biases in forensic science investigations. We also propose that courts demand that fire-science investigation be sequestered from criminal investigations and appoint their own experts in arson cases where the state relies exclusively on law enforcement testimony.

### I. NATIONAL CHALLENGES TO FORENSIC SCIENCE

In 2009, the National Academy of Sciences (“NAS”) published a report, *Strengthening Forensic Science in the United States: A Path Forward* (the “NAS Report”), which challenged and criticized myriad forensic science disciplines, including fire science.<sup>23</sup> The NAS Report, which was the product of three years of research and study, opens by opining that “[i]t is clear that change and advancements, both systemic and scientific, are needed in a number of forensic science disciplines—to ensure the reliability of the disciplines, establish enforceable standards, and promote best practices and their consistent application.”<sup>24</sup> Its major findings conclude that “[w]ith the exception of nuclear DNA analysis, . . . no forensic method has been rigorously shown to have the capacity to consistently, and with a high degree of certainty, demonstrate a connection between evidence and a specific individual or source”<sup>25</sup> and that “there is a notable dearth of peer-reviewed, published studies establishing the scientific bases and validity of many forensic methods.”<sup>26</sup> The NAS Report, which includes thirteen separate recommendations, implores the United States Congress to “[r]emove [forensic science services] from the

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23. See generally NAT'L RESEARCH COUNCIL OF THE NAT'L ACADS., *STRENGTHENING FORENSIC SCIENCE IN THE UNITED STATES: A PATH FORWARD* (2009) [hereinafter NAS REPORT], <https://www.ncjrs.gov/pdffiles1/nij/grants/228091.pdf> [<https://perma.cc/Z9VR-ADYV>] (describing the state of forensic evidence and the need for scientifically rigorous standards). The disciplines analyzed by the NAS Report were biological evidence (DNA analysis), controlled substances analysis, fingerprints (friction ridge analysis), pattern and impression evidence, tool mark and firearm identification, hair analysis, fiber evidence analysis, questioned document examination, paint and coatings analysis, explosives and fire analysis, forensic odontology (bite marks), bloodstain and pattern analysis, and digital and multimedia analysis. *Id.* at 3–4, 38.

24. *Id.* at xix.

25. *Id.* at 7.

26. *Id.* at 8.

administrative control of law enforcement agencies or prosecutors' offices";<sup>27</sup> "[d]evelop tools for advancing measurement, validation, reliability, information sharing, and proficiency testing . . . and to establish protocols for forensic examinations, methods, and practices."<sup>28</sup> The NAS Report further recommends that Congress require the mandatory accreditation of all forensic laboratories and certification for all forensic science practitioners,<sup>29</sup> "[e]stablish a national code of ethics [with] . . . mechanisms of enforcement,"<sup>30</sup> and create a National Institute of Forensic Sciences.<sup>31</sup>

The NAS Report recommendations provoked the United States Department of Justice ("DOJ") to establish the National Commission on Forensic Science ("NCFS").<sup>32</sup> Created in 2013, the NCFS was an independent federal advisory board composed of law enforcement agencies, forensic laboratory directors, scientists, forensic practitioners, judges, and lawyers, among others, charged with making recommendations "to enhance the practice and improve the reliability of forensic science."<sup>33</sup> Among other things, the NCFS crafted directives on proficiency training, accreditation and certification, and quality control practices.<sup>34</sup> It also advised the Attorney General on forensic policy considerations.<sup>35</sup>

In April 2017, then-Attorney General Sessions III decided to disband the NCFS and shift certain of its functions to the DOJ.<sup>36</sup> Attorney General Sessions thereby wrested forensic science from independent, nonpartisan, evidence-based oversight and returned control over its reliability and validity to a law enforcement agency. As United States District Court Judge and former NCFS Commissioner Jed Rakoff responded, "It is unrealistic to expect that

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27. *Id.* at 24.

28. *Id.* at 24–25.

29. *Id.* at 215.

30. *Id.*

31. *Id.* at 19.

32. Rebecca McCray, *Jeff Sessions' Rejection of Science Leaves Local Prosecutors in the Dark*, SLATE (June 7, 2017, 9:45 AM), <https://slate.com/news-and-politics/2017/06/disbanding-the-ncfs-will-lead-to-worse-outcomes.html> [<https://perma.cc/KSA3-XJUF>]; *National Commission on Forensic Science*, U.S. DEP'T JUST., <https://www.justice.gov/archives/ncfs> [<https://perma.cc/AUU7-W57E>].

33. *National Commission on Forensic Science*, *supra* note 32.

34. SANDRA GUERRA THOMPSON, *COPS IN LAB COATS: CURBING WRONGFUL CONVICTIONS THROUGH INDEPENDENT FORENSIC LABORATORIES* 189–90 (2015).

35. *Id.*

36. Janet Burns, *Sessions Scraps Federal Commission on Forensic Accuracy, for Some Reason*, FORBES (Apr. 11, 2017, 11:35 AM), <https://www.forbes.com/sites/janetwburns/2017/04/11/sessions-scraps-federal-commission-on-forensic-accuracy-because-reasons/#3b79f88176c2> [<https://perma.cc/H9E4-8Z68>].

truly objective, scientifically sound standards for the use of forensic science . . . can be arrived at by entities centered solely within the Department of Justice.”<sup>37</sup>

Resistance to enhancing the reliability and validity of the forensic science disciplines, however, is not unique to the recent Sessions DOJ. Then–Attorney General Loretta Lynch took a similar stance in 2016, refusing to adopt the findings of the President’s Council of Advisors on Science and Technology (“PCAST”).<sup>38</sup> The PCAST report, *Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods* (the “PCAST Report”), concluded that several forensic disciplines lacked foundational scientific validity sufficient to support analyst claims, undermining years of convictions based on such evidence.<sup>39</sup> The PCAST Report recommended that courts take into account actual scientific criteria when assessing the admissibility of forensic evidence<sup>40</sup> and that the Attorney General “direct attorneys appearing on behalf of the [DOJ] to ensure expert testimony in court about forensic feature-comparison methods meets the scientific standards for scientific validity.”<sup>41</sup>

On the very day PCAST released its report, Attorney General Lynch publicly denounced its findings and recommendations and declared that “the [DOJ] will not be adopting the recommendations related to the admissibility of forensic science evidence.”<sup>42</sup> The Federal Bureau of Investigation (“FBI”) went even further, publicly

37. Spencer S. Hsu, *Sessions Orders Justice Dept. to End Forensic Science Commission, Suspend Review Policy*, WASH. POST (Apr. 10, 2017), [https://www.washingtonpost.com/local/public-safety/sessions-orders-justice-dept-to-end-forensic-science-commission-suspend-review-policy/2017/04/10/2dada0ca-1c96-11e7-9887-1a5314b56a08\\_story.html?utm\\_term=.2e4a4b623528](https://www.washingtonpost.com/local/public-safety/sessions-orders-justice-dept-to-end-forensic-science-commission-suspend-review-policy/2017/04/10/2dada0ca-1c96-11e7-9887-1a5314b56a08_story.html?utm_term=.2e4a4b623528) [https://perma.cc/68XD-QAVZ].

38. See Radley Balko, Opinion, *When Obama Wouldn’t Fight for Science*, WASH. POST (Jan. 4, 2017), [https://www.washingtonpost.com/news/the-watch/wp/2017/01/04/when-obama-wouldn-t-fight-for-science/?utm\\_term=.e8cf205d9d0e](https://www.washingtonpost.com/news/the-watch/wp/2017/01/04/when-obama-wouldn-t-fight-for-science/?utm_term=.e8cf205d9d0e) [https://perma.cc/RS8M-FLNE (dark archive)].

39. See PRESIDENT’S COUNCIL OF ADVISORS ON SCI. AND TECH., EXEC. OFFICE OF THE PRESIDENT, *FORENSIC SCIENCE IN CRIMINAL COURT: ENSURING SCIENTIFIC VALIDITY OF FEATURE-COMPARISON METHODS*, at x (2016) [hereinafter PCAST REPORT], [https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/PCAST/pcast\\_forensic\\_science\\_report\\_final.pdf](https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/PCAST/pcast_forensic_science_report_final.pdf) [https://perma.cc/2FC5-JLWN].

40. *Id.* at 19.

41. *Id.* at 18.

42. Gary Fields, *White House Advisory Council Report Is Critical of Forensics Used in Criminal Trials; U.S. Attorney General Says Justice Department Won’t Adopt Recommendations*, WALL ST. J. (Sept. 20, 2016, 4:25 PM), <https://www.wsj.com/articles/white-house-advisory-council-releases-report-critical-of-forensics-used-in-criminal-trials-1474394743> [https://perma.cc/5QTP-XXAR (dark archive)].

asserting its “disagree[ment] with many of the scientific assertions and conclusions of the report” and arguing that the report was flawed insofar as it failed to mention “numerous published research studies which seem to meet PCAST’s criteria for appropriately designed studies providing support for foundational validity.”<sup>43</sup>

In response, PCAST invited the DOJ, FBI, and other stakeholders “to identify any ‘published . . . studies’ that had not been considered by PCAST and that established the validity and reliability of any of the forensic feature-comparison methods that the PCAST report found to lack such support.”<sup>44</sup> In sharp contrast to the public statements the FBI had advanced in condemning the Report, the “DOJ ultimately concluded that it had no additional studies for PCAST to consider.”<sup>45</sup>

The PCAST Report focused on feature-comparison forensic methods, including disciplines that “attempt to determine whether an evidentiary sample . . . is or is not associated with a potential ‘source’ sample . . . based on the presence of similar patterns, impressions, or other features in the sample and the source.”<sup>46</sup> To this end, the report evaluated methods in six forensic disciplines: DNA analysis, bite marks, latent fingerprint analysis, firearm markings, footwear impressions, and hair microscopy.<sup>47</sup> In evaluating these feature-comparison methods, PCAST noted that “[w]ithout appropriate estimates of accuracy, an examiner’s statement that two samples are similar—or even indistinguishable—is scientifically meaningless: it has no probative value, and considerable potential for prejudicial impact. Nothing—not personal experience nor professional practices—can substitute for adequate empirical demonstration of accuracy.”<sup>48</sup>

The PCAST Report did not assess the validity or reliability of fire science, which is not a feature-comparison or “matching” science. This is because the reliability problems attendant to fire science differ

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43. FBI, COMMENTS ON: PRESIDENT’S COUNCIL OF ADVISORS ON SCIENCE AND TECHNOLOGY REPORT TO THE PRESIDENT (Sept. 20, 2016), <https://www.fbi.gov/file-repository/fbi-pcast-response.pdf> [<https://perma.cc/QE9V-B8FL>].

44. See PRESIDENT’S COUNCIL OF ADVISORS ON SCI. AND TECH., EXEC. OFFICE OF THE PRESIDENT, AN ADDENDUM TO THE PCAST REPORT ON FORENSIC SCIENCE IN CRIMINAL COURTS 2–3 (2017) [hereinafter PCAST ADDENDUM] (internal citation omitted), [https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/PCAST/pcast\\_forensics\\_addendum\\_finalv2.pdf](https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/PCAST/pcast_forensics_addendum_finalv2.pdf) [<https://perma.cc/EZ33-XMEM>].

45. *Id.* at 3.

46. PCAST REPORT, *supra* note 39, at 1.

47. *Id.* at x.

48. *Id.* at 143.

from those that infect the traditional comparison disciplines.<sup>49</sup> While the matching sciences are prone to challenges regarding the appropriateness of statistical pools and the veracity of their accuracy and exclusion rates, fire science remains more elusive and less susceptible to scientific assessment. In fact, the National Fire Protection Association's *NFPA 1033: Standard for Professional Qualifications for Fire Investigator* ("NFPA 1033") requires fire investigators to have and maintain "an up-to-date basic knowledge of the following [seventeen] topics beyond the high school level": fire science, fire chemistry, thermodynamics, thermometry, fire dynamics, explosion dynamics, computer fire modeling, fire investigation, fire analysis, fire investigation methodology, fire investigation technology, hazardous materials, failure analysis and analytical tools, fire protection systems, evidence documentation, collection and preservation, and electricity and electrical systems.<sup>50</sup>

Unlike the matching sciences, fire science is an interpretative reconstruction science. In other words, "[f]ire investigation is a forensic science that is a world unto itself. The investigator who ventures [t]here risks exposure . . . to scientific, professional, and personal challenges not found in any other field of forensic science."<sup>51</sup>

Those challenges include the evaluation of fire-scene evidence that frequently is so degraded or destroyed that it is extremely difficult—if not impossible—to analyze. Unsurprisingly, research makes clear that investigations of fire origin are most accurate very early in the fire. For example, in a study comparing similar rooms that had burned for 30 seconds, 70 seconds, and 180 seconds past the onset of full-room involvement, or "flashover,"<sup>52</sup> fire investigators accurately selected the room quadrant where the fire originated 84%, 69%, and 25% of the time, respectively.<sup>53</sup> In other words, a fire

49. See, e.g., Rachel Dioso-Villa, *Scientific and Legal Developments in Fire and Arson Investigation Expertise in Texas v. Willingham*, 14 MINN. J.L. SCI. & TECH. 817, 821 (2013) ("Unlike other forensic sciences that attempt to match crime scene evidence with a unique source, such as fingerprints or DNA evidence, fire investigators interpret evidence and make conclusions as to whether the fire was accidental or intentionally set.").

50. NAT'L FIRE PROT. ASS'N, *NFPA 1033: STANDARD FOR PROFESSIONAL QUALIFICATIONS FOR FIRE INVESTIGATOR* ¶ 1.3.7 (2014 ed. 2014) [hereinafter *NFPA 1033* (2014)].

51. LENTINI, *SCIENTIFIC PROTOCOLS*, *supra* note 12, at xv.

52. HANGER, *supra* note 10, at 3 ("[Flashover] is the moment when the fire gases trapped below the ceiling of a room reach 500–600°C (932–1112°F), so hot that every ignitable surface in a room will burst into flames. At this point, a fire in a room becomes a room on fire, and the investigator's job becomes exponentially tougher.").

53. Parisa Dehghani-Tafti & Paul Bieber, *Folklore and Forensics: The Challenges of Arson Investigation and Innocence Claims*, 119 W. VA. L. REV. 549, 566 (2016).

investigator’s ability to accurately determine fire origin at 180 seconds past flashover is no better than chance. We discuss the importance of the development of reliable error rates applicable to fire science origin and cause determinations in more detail in Part III of this Article.

## II. THE GOOD: NFPA 921 AND CIVIL CASE EXPERT REVIEW

Historically, American courts admitted faulty fire-science evidence in both civil and criminal cases due to a lack of disciplinary scientific expertise.<sup>54</sup> Once evidence-based fire experiments evolved to disprove fire investigators’ long-held folk wisdom, however, civil litigants were quick to challenge unreliable fire evidence. Criminal defendants, on the other hand, largely limited their challenges to fire science to habeas corpus proceedings—that is, postconviction civil petitions. In the following subsections, we discuss several positive developments pertinent to fire-science evidence, including the promulgation of the National Fire Protection Association’s treatise on fire and explosion investigations (“NFPA 921”) and civil courts’ adoption of NFPA 921 as the “gold standard” in assessing the reliability of fire-investigation evidence.

### A. *NFPA 921: The Gold Standard in Fire Investigation*

The National Fire Protection Association’s *NFPA 921: Guide for Fire and Explosion Investigations* is the single most important and reformative treatise in the field of fire investigation.<sup>55</sup> NFPA 921 is a guidebook “developed by the Technical Committee on Fire Investigations to assist in improving the fire investigation process and the quality of information on fires resulting from that process.”<sup>56</sup> NFPA 921 “establish[ed] guidelines and recommendations for the safe and systematic investigation or analysis of fire and explosion incidents.”<sup>57</sup> It is “intended for use by *both* public sector employees who [are responsible] for fire investigation and private sector persons

54. See generally John J. Lentini, “Progress” in Fire Investigation: Moving from Witchcraft and Folklore to the Misuse of Models and the Abuse of Science (unpublished manuscript), <http://firescientist.com/Documents/NewOrder/2010%20%E2%80%9CProgress%E2%80%9D%20in%20Fire%20Investigation-From%20Witchcraft%20to%20the%20Misuse%20of%20Science-John%20Lentini.pdf> [<https://perma.cc/FJT9-K5CQ>] (detailing older methodologies in fire science and their flaws).

55. LENTINI, SCIENTIFIC PROTOCOLS, *supra* note 12, at 13.

56. NAT’L FIRE PROT. ASS’N, NFPA 921: GUIDE FOR FIRE AND EXPLOSION INVESTIGATIONS, at 921-1 (2017 ed. 2017) [hereinafter NFPA 921 (2017)].

57. *Id.* ¶ 1.2.1.

[who conduct] investigations for insurance companies or litigation purposes.”<sup>58</sup>

Advances in fire science, such as the NFPA guidelines, first published in 1992, have undermined hundreds of faulty arson determinations and exposed fire investigation as a leading cause of wrongful convictions in the United States.<sup>59</sup> The NFPA standards are taught at the National Fire Academy, and NFPA 921 is widely regarded today as the gold standard for fire investigation within the field.<sup>60</sup> The NFPA 921 guidelines were established to ensure scientific reliability.<sup>61</sup> Thus, NFPA 921 requires fire investigators to use the “scientific method [as] a principle of inquiry that forms a basis for legitimate scientific and engineering processes, including fire incident investigation.”<sup>62</sup> NFPA 921 methodology involves several steps, including the collection of data, analysis of data using inductive reasoning, development of a hypothesis, and testing of the hypothesis.<sup>63</sup>

NFPA 921 also requires investigators to avoid “eliminat[ing] a potential ignition source merely because there is no obvious evidence for it.”<sup>64</sup> In other words, an investigator must have *definite* evidence that the fire was *not* started by a particular cause before he or she is permitted to rule out that cause.<sup>65</sup> Moreover, while investigative

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58. NAT'L FIRE PROT. ASS'N, NFPA 921: GUIDE FOR FIRE AND EXPLOSION INVESTIGATIONS, at 921-1 (2011 ed. 2011) [hereinafter NFPA 921 (2011)] (emphasis added).

59. See, e.g., Stephanie Chen, *Junk Science? Another Inmate on Death Row Fights to Disprove Arson*, CNN (Aug. 12, 2010, 10:23 AM), <http://www.cnn.com/2010/CRIME/08/12/pennsylvania.arson.dougherty.case/index.html?hpt=C1> [https://perma.cc/7DCE-7BME] (“In the last two decades, advances in arson science have spurred some investigators and lawyers to question past arson convictions. Some attorneys estimate dozens or even hundreds of cases may have been based on faulty arson science.”).

60. Although the development and adoption of NFPA 921 has operated to improve the reliability of fire investigation, the guidelines would benefit from certain reforms. See *infra* Part V.

61. See Caitlin M. Plummer & Imran J. Syed, “*Shifted Science*” Revisited: *Percolation Delays and the Persistence of Wrongful Convictions Based on Outdated Science*, 64 CLEV. ST. L. REV. 483, 492 (2016) (“Noting ‘the perception of a profession plagued by misconceptions,’ the Standards Council of the NFPA formed a Technical Committee on Fire Investigations in 1985. ‘After 7 years, the first edition of NFPA 921, *Guide for Fire and Explosion Investigations*, was released.’ [NFPA 921 was] [i]ntended to ‘assist in improving the fire investigation process and the quality of information on fires resulting from the fire investigation process.’” (footnotes omitted) (quoting LENTINI, SCIENTIFIC PROTOCOLS, *supra* note 12, at 13)).

62. NFPA 921 (2017), *supra* note 56, ¶ 4.3.

63. *Id.* ¶ 3.3.160.

64. *Id.* ¶ 19.5.

65. See *id.*

observation of the evidence is one of the steps in the NFPA methodology, investigator observation, standing alone, is insufficient to produce a scientifically reliable conclusion.<sup>66</sup> NFPA 921 is updated regularly and reflects the most reliable scientific investigatory procedures and methodologies applicable to fire science.<sup>67</sup>

Since the publication of NFPA 921, numerous courts have held that expert fire evidence that fails to comport with its guidelines is inadmissible.<sup>68</sup> Unfortunately, every one of those decisions involved a

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66. Craig M. Cooley, *Forensic Science and Capital Punishment Reform: An "Intellectually Honest" Assessment*, 17 GEO. MASON U. C.R.L.J. 299, 359 (2007) (“Casual or mere observation is [only one] aspect of the scientific method [and] is insufficient, standing alone, to draw valid inferences.”).

67. *NFPA 921: Guide for Fire and Explosion Investigations*, NAT’L FIRE PROTECTION ASS’N, <https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=921> [<https://perma.cc/U3WW-PPC8>] (showing that the most recent edition of NFPA 921 was published in 2017).

68. See *Russell v. Whirlpool Corp.*, 702 F.3d 450, 455 (8th Cir. 2012) (stating that although NFPA standards are not controlling, if the investigators purport to use NFPA 921, they need to “reliably apply” NFPA instructions); *Bryte ex rel. Bryte v. Am. Household, Inc.*, 429 F.3d 469, 478 (4th Cir. 2005) (upholding the district court’s exclusion of fire investigation causation testimony where a fire investigator failed “to exclude ‘[a]ll other reasonable origins and causes’” as mandated by NFPA 921 (alteration in original) (quoting NAT’L FIRE PROT. ASS’N, *NFPA 921: GUIDE FOR FIRE AND EXPLOSION INVESTIGATIONS* ¶ 2-3.6 (1998 ed. 1998))); *Fireman’s Fund Ins. Co. v. Canon U.S.A., Inc.*, 394 F.3d 1054, 1059 (8th Cir. 2005) (holding that the district court did not abuse its discretion in concluding that the fire investigators failed to apply an NFPA 921 evidentiary standard reliably to the facts of the case); *Werth v. Hill-Rom, Inc.*, 856 F. Supp. 2d 1051, 1060 (D. Minn. 2012) (excluding expert-fire-investigator testimony due to the expert’s failure to rely on NFPA 921 and, in so doing, stating that “[s]imply put, the experts’ failure to disclose their reliance on NFPA 921—in their initial Report, their Supplemental Report, their depositions, or at any other point in discovery—would alone justify excluding their opinion”); *Travelers Indem. Co. v. Indus. Paper & Packaging Corp.*, No. 3:02-CV-491, 2006 WL 1788967, at \*4-5 (E.D. Tenn. June 27, 2006) (denying, in part, motion in limine to exclude fire-expert testimony where expert methodology was “consistent with NFPA 921”); *Workman v. AB Electrolux Corp.*, No. 03-4195-JAR, 2005 U.S. Dist. LEXIS 16306, at \*31 (D. Kan. Aug. 8, 2005) (allowing admission, in part, of evidence because the investigator’s methodology comported with NFPA 921 standards); *Tunnell v. Ford Motor Co.*, 330 F. Supp. 2d 707, 725 (W.D. Va. 2004) (concluding that the expert’s testimony “was based on his investigation of the cause of the fire, an investigation which was conducted in accordance with the professional standards and scientific methodology . . . set forth in NFPA 921”); *TNT Rd. Co. v. Sterling Truck Corp.*, No. 03-37-B-K, 2004 U.S. Dist. LEXIS 13463, at \*9, \*17-18 (D. Me. July 19, 2004) (allowing admission of evidence that “substantially complied with the NFPA standard”); *Ind. Ins. v. Gen. Elec. Co.*, 326 F. Supp. 2d 844, 851-53 (N.D. Ohio 2004) (finding that reliance on a “suspect investigation . . . impugns the reliability of [the expert’s] analysis”); *Royal Ins. Co. of Am. v. Joseph Daniel Constr., Inc.*, 208 F. Supp. 2d 423, 426-27 (S.D.N.Y. 2002) (“A comparison of [the expert’s] methodology and the six steps of the NFPA 921 methodology reveals that his conclusions were based on these recognized standards and not merely his subjective belief.”); *Snodgrass v. Ford Motor Co.*, No. 96-1814(JBS), 2002 U.S. Dist. LEXIS 13421, at \*48, \*56-57 (D.N.J. Mar. 28, 2002) (allowing expert to testify to his opinions on fire causation as long as said opinions did not rely on unreliable statistics);



civil litigant's challenge to a civil opponent's proffered expert fire evidence.<sup>69</sup> For reasons discussed below, NFPA 921 has received a noticeably chillier reception from law enforcement, prosecutors, and criminal courts.

*B. Fire Experts' Resistance to Change*

NFPA 921 initially faced strong resistance from fire investigators.<sup>70</sup> Moreover, and despite the exposure of faulty fire evidence in civil litigation, fire investigators continue to combat the call to change how they conduct their investigations and reach their origin and causation conclusions.<sup>71</sup> Ironically, because it is well documented that unsound fire investigations have contributed to miscarriages of justice, fire investigators may feel besmirched and, as such, insist on defending the discipline against criticism instead of making strides to improve its reliability and validity.<sup>72</sup>

The DOJ released a report in 2000 entitled *Fire and Arson Scene Evidence: A Guide for Public Safety Personnel*, which endorsed NFPA 921 as a “benchmark for the training and expertise of everyone who purports to be an expert in the origin and cause determination of fires.”<sup>73</sup> The International Association of Arson Investigators (“IAAI”) begrudgingly followed suit.<sup>74</sup> The guidelines nonetheless

*Chester Valley Coach Works v. Fisher-Price, Inc.*, No. 99 CV 4197, 2001 WL 1160012, at \*8-13 (E.D. Pa. Aug. 29, 2001) (noting that an expert's deviations from NFPA 921 methodologies gave the court “serious doubts as to the . . . conclusions that [the expert] reached”); *Travelers Prop. & Cas. Corp. v. Gen. Elec. Co.*, 150 F. Supp. 2d 360, 365-66 (D. Conn. 2001) (remarking that an expert's methods were consistent with “the principles of NFPA 921”).

69. See cases cited *supra* note 68 (listing civil cases involving fire evidence).

70. See JOHN J. LENTINI, *THE EVOLUTION OF FIRE INVESTIGATION, 1977-2011*, at 2 (n.d.), <http://www.firescientist.com/Documents/The%20Evolution%20of%20Fire%20Investigation,%201977-2011.pdf> [<https://perma.cc/JKA2-F4GV>] (“To state that NFPA 921 was not immediately embraced by the fire investigation profession would be a serious understatement. In fact, the howls of protest from fire investigation ‘professionals’ were deafening.”).

71. *Id.* at 6.

72. See Steve Mills, *Convicted Arsonist Hopes Science Proves Innocence*, CHI. TRIB., May 18, 2015, at 1 (reporting that “in many jurisdictions, [NFPA 921 guidelines] were slow to take hold, as veteran investigators clung to what now are considered disproven theories” and “[i]n some police and fire departments, investigators were openly hostile to the updated science”).

73. U.S. DEP'T OF JUSTICE, NCJ 181584, *FIRE AND ARSON SCENE EVIDENCE: A GUIDE FOR PUBLIC SAFETY PERSONNEL* 6 (2000), <https://www.ncjrs.gov/pdffiles1/nij/181584.pdf> [<https://perma.cc/FY25-XEWK>].

74. In what can be fairly characterized as its most accepting statement, the IAAI explained that NFPA 921 is “an important reference manual, and sets forth guidance and methodology regarding the determination of the origin and cause of fires.” *NFPA*

continue to be ignored by fire investigators in criminal cases.<sup>75</sup> The purpose of NFPA 921 was to reform fire investigation on the front end in order to ensure a greater likelihood of obtaining accurate information.<sup>76</sup> Without fire investigator implementation, therefore, the NFPA 921 standards become meaningless, save attempts to challenge the admissibility of flawed fire science once the case proceeds to litigation.

### C. Exclusion of Faulty Fire Science in Civil Cases

NFPA 921 acts as a shield against the admissibility of faulty fire evidence in civil cases. We highlight how junk science, which is inadmissible in civil cases, permeates criminal proceedings in the first piece of this trilogy, *Discovering Forensic Fraud*.<sup>77</sup> In that essay, we explain that, notwithstanding the transsubstantive nature of the Federal Rules of Evidence that pertain to expert evidence, “judges are far more willing to fulfill their gatekeeping roles in civil cases than [in] criminal ones.”<sup>78</sup> We queried why judges, who routinely exclude highly technical scientific evidence in civil cases, seemed incapable of performing their gatekeeping function in criminal cases involving “scientific” forensic evidence. As we noted, the trend in criminal cases is for the courts to continue to admit the same unreliable evidence in case after case and long after the relevant scientific community has rebuked the validity of that evidence. Forensic odontology or “bite mark” evidence is perhaps the most well-known example of forensic evidence that has been thoroughly discredited by the scientific community and, yet, has been admitted in every criminal trial in the nation in which it has been offered.<sup>79</sup>

In *Daubert*, the Supreme Court of the United States established that trial judges are gatekeepers, tasked with determining as a threshold matter the reliability of an experts’ principles, techniques, and methods.<sup>80</sup> In its opinion, the Court abandoned the *Frye* general

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921/1033 Position Statement, INT’L ASS’N ARSON INVESTIGATORS (Jan. 12, 2013), <https://www.firearson.com/NFPA-9211033-Position-Statement/Default.aspx> [<https://perma.cc/Z4EP-RPCV>].

75. See Lentini, *Mythology of Arson Investigation*, *supra* note 9, at 1.

76. NFPA 921 (2011), *supra* note 58, at 921-1.

77. Oliva & Beety, *supra* note 22, at 123–24, 137–38.

78. *Id.* at 126.

79. Radley Balko, Opinion, *Incredibly, Prosecutors are Still Defending Bite Mark Evidence*, WASH. POST (Jan. 30, 2017), [https://www.washingtonpost.com/news/the-watch/wp/2017/01/30/incredibly-prosecutors-are-still-defending-bite-mark-evidence/?utm\\_term=.ceaf8e778156](https://www.washingtonpost.com/news/the-watch/wp/2017/01/30/incredibly-prosecutors-are-still-defending-bite-mark-evidence/?utm_term=.ceaf8e778156) [<https://perma.cc/WGN7-5KGT> (dark archive)].

80. *Daubert v. Merrell Dow Pharm., Inc.*, 509 U.S. 579, 592–93 (1993).

acceptance test,<sup>81</sup> thereby shifting the burden of assessing the reliability of scientific testimony from the relevant scientific community to judges.<sup>82</sup> While a minority of the states continue to retain the *Frye* test, the overwhelming majority have adopted *Daubert*.<sup>83</sup>

In 2000, Federal Rule of Evidence 702, which provides the federal standard for the admissibility of “scientific, technical, or other specialized knowledge,”<sup>84</sup> was amended to codify the *Daubert* trilogy.<sup>85</sup> Specifically, Rule 702 was amended to require trial judges to conduct a preliminary assessment of the methodology supporting an expert’s findings and testimony to determine whether they are valid and whether the methodology can be reasonably applied in the case.<sup>86</sup> The rule has been interpreted as precluding a trial court from “subject[ing] the jury . . . to confusing and misleading ‘pseudoscientific’ research.”<sup>87</sup>

As previously noted, civil courts routinely exclude unreliable fire-science testimony under Rule 702. As a result, junk fire science has been inadmissible for decades in civil cases. Insurance companies, product manufacturers, and other interested civil parties have thoroughly and successfully attacked disreputable, nonscientific evidentiary proffers.<sup>88</sup> Civil courts also exclude untrustworthy fire-science evidence that goes to a fire’s origin and causation, while criminal courts routinely permit prosecutors to admit the same evidence in arson trials.<sup>89</sup>

81. *Id.* at 591–93. The *Frye* test required judges to admit expert evidence so long as that evidence was generally accepted in the relevant scientific community. *Frye v. United States*, 293 F. 1013, 1014 (D.C. Cir. 1923).

82. *Daubert*, 509 U.S. at 592–93.

83. South Carolina and North Dakota have their own reliability determinations, and neither has adopted *Daubert* or *Frye*. *Daubert and Frye in the 50 States*, JURILYTICS, <https://jurilytics.com/50-state-overview> [<https://perma.cc/L6NW-SND3>].

84. FED. R. EVID. 702.

85. FED. R. EVID. 702 advisory committee’s notes to 2000 amendment. The *Daubert* trilogy includes *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579 (1993), *General Electric Co. v. Joiner*, 522 U.S. 136 (1997), and *Kumho Tire Co. v. Carmichael*, 526 U.S. 137 (1999).

86. FED. R. EVID. 702 (“A witness who is qualified as an expert by knowledge, skill, experience, training, or education may testify in the form of an opinion or otherwise if . . . the expert’s scientific, technical, or other specialized knowledge will help the trier of fact to understand the evidence or to determine a fact in issue.”).

87. *Black v. Rhone-Poulenc, Inc.*, 19 F. Supp. 2d 592, 606 (S.D. W. Va. 1998).

88. *See supra* note 68 and accompanying text.

89. *See supra* text accompanying note 77; discussion *infra* Part III.

For example, in *Bryte ex rel. Bryte v. American Household, Inc.*,<sup>90</sup> an elderly woman died in a fire while she was using an electric blanket in her Preston County, West Virginia, apartment.<sup>91</sup> The fire investigator, who the court described as “employed by the West Virginia State Fire Marshall’s [sic] Office” but “not certified as a fire investigator,” concluded that the victim’s electric blanket started the fire.<sup>92</sup> As a result, the deceased woman’s estate filed a lawsuit against the electric blanket manufacturer.<sup>93</sup> The district court ruled that the plaintiff’s proffered fire-science testimony was unreliable and inadmissible under *Daubert* and granted the defendant-manufacturer judgment as a matter of law.<sup>94</sup>

On appeal, the United States Court of Appeals for the Fourth Circuit affirmed the district court’s holding that plaintiff’s expert testimony—contending that the blanket had caused the fire—was inadmissible under *Daubert* because plaintiff’s expert had failed to eliminate all other possible origin sources.<sup>95</sup> The court noted that the fire investigator made no effort to physically examine other potential sources, such as a lamp, a candle, a cord found on the decedent’s arm, a wall outlet, and the wall outlet wiring.<sup>96</sup> Accordingly, the Fourth Circuit held that the investigator did not employ a methodology that was consistent with NFPA standards, “which require investigators to ‘exclude all other reasonable origins and causes.’”<sup>97</sup> Because “*Daubert* aims to prevent expert speculation,” the court held that the investigator’s conclusions of the fire origin source were unreliable.<sup>98</sup>

The United States Court of Appeals for the Eighth Circuit similarly held that expert fire-science testimony must be excluded when the fire investigation fails to reliably apply the appropriate methodology to the facts of the case.<sup>99</sup> In *Presley v. Lakewood Engineering & Manufacturing Co.*,<sup>100</sup> the plaintiff’s fire-science investigator concluded that a manufacturing defect in a space heater

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90. 429 F.3d 469 (4th Cir. 2005).

91. *Id.* at 471.

92. *Id.* at 472–73.

93. *Id.* at 471.

94. *Id.* at 471, 474.

95. *Id.* at 478.

96. *Id.* at 472–73. The fire investigator also failed to use the scientific method to reach his conclusion that the electric blanket was the cause of the fire. *Id.* 473–74.

97. *Id.* at 478 (quoting NAT’L FIRE PROT. ASS’N, NFPA 921: GUIDE FOR FIRE AND EXPLOSION INVESTIGATIONS ¶ 2-3.6 (1998 ed. 1998)).

98. *Id.* at 477.

99. *Presley v. Lakewood Eng’g & Mfg. Co.*, 553 F.3d 638, 645–47 (8th Cir. 2009).

100. 553 F.3d 638 (8th Cir. 2009).

caused the house fire at issue.<sup>101</sup> The investigator testified that he neither tested the heater to verify that conclusion nor attempted to eliminate several potential alternative causes of the fire.<sup>102</sup> The Eighth Circuit determined that the expert failed to reliably apply the standards of NFPA 921 to the facts of the case and that the expert's "fire spread theory was inconsistent with NFPA 921."<sup>103</sup> In affirming the district court's exclusion of the plaintiff's expert testimony, the court explained that the fire investigator's "applications of general observations and general science . . . led to 'vague theorizing based upon general principles'" and, as such, was unreliable under *Daubert*.<sup>104</sup> As explained below, criminal courts have been far less enamored with NFPA 921 than their civil counterparts, and, as a result, criminal defendants are often precluded from challenging unreliable fire-science evidence until they petition for habeas relief.

### III. THE BAD: WRONGFUL CONVICTIONS

In contrast to the consistent exclusion of fallacious fire science in civil cases, state and federal criminal courts frequently admit such evidence. Worse yet, innocent people have been charged, convicted, imprisoned and even executed for crimes they did not commit on the basis of flimsy and unreliable fire evidence.<sup>105</sup> As the case law illustrates, such miscarriages of justice begin and end with a fire investigator's testimony identifying the alleged origin and cause of the fire. The fire expert determines, for example, whether the defendant fell asleep with a cigarette,<sup>106</sup> and therefore accidentally caused the fire, or maliciously rigged a toaster to intentionally start a house fire in order to commit murder.<sup>107</sup> Perhaps most troubling are the cases in which fire experts contended that they found "proof" of accelerants at the scene and, operating under that faulty assumption, deduced

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101. *Id.* at 640–41.

102. *Id.* at 642.

103. *Id.* at 645–46.

104. *Id.* at 646–47 (quoting *Pro Serv. Auto., L.L.C. v. Lenan Corp.*, 469 F.3d 1210, 1216 (8th Cir. 2006)).

105. See generally Brandon L. Garrett & Peter J. Neufeld, *Invalid Forensic Science Testimony and Wrongful Convictions*, 95 VA. L. REV. 1 (2009) (examining the role that faulty forensic science has played in wrongful convictions).

106. See *Babick v. Berghuis*, No. 1:03-cv-20, 2008 WL 282166, at \*4 (W.D. Mich. Jan. 29, 2008).

107. *Anstey v. Ballard*, 787 S.E.2d 864, 869–70 (W. Va. 2016). In this bizarre case, a volunteer firefighter determined that defendant Sam Anstey had maliciously rigged a toaster to start the fire when there was no evidence whatsoever to support such a conclusion. *Id.* at 870. Sam Anstey was sentenced to life in prison for murder by arson. *Id.* at 873.

that the defendant intentionally set the fire.<sup>108</sup> In one such case, these “findings” were later proven to be false and those defendants’ convictions were overturned—but not before they had spent decades behind bars for crimes they did not commit.<sup>109</sup>

A. *Admissibility of Faulty Fire Evidence in Criminal Cases*

The irrelevance of *Daubert* to the federal courts’ assessment of scientific evidence in criminal cases has been well chronicled.<sup>110</sup> Even the 2009 NAS Report criticized the judiciary for falling down on its gatekeeping function in criminal cases, stating, “In a number of forensic science disciplines, forensic science professionals have yet to establish either the validity of their approach or the accuracy of their conclusions, and the courts have been utterly ineffective in addressing this problem.”<sup>111</sup> “*Daubert* has done little to improve the use of forensic science evidence in criminal cases.”<sup>112</sup> Indeed, the NAS Report noted the unjustified discrepancy in the admissibility standards that courts apply to expert evidence in civil and criminal cases, observing that “ironically, the appellate courts appear to be more willing to second-guess trial court judgments on the admissibility of purported scientific evidence in civil cases than in criminal cases.”<sup>113</sup>

108. See, e.g., *Han Tak Lee v. Tennis*, No. 4:08-CV-1972, 2014 WL 3894306, at \*1 (M.D. Pa. June 13, 2014), *adopting report and recommendation sub nom. Lee v. Tennis*, No. 4:CV-08-1972, 2014 WL 3900230 (M.D. Pa. Aug. 8, 2014), *aff’d sub nom. Han Tak Lee v. Houtzdale SCI*, 798 F.3d 159 (3d Cir. 2015).

109. *Id.*

110. D. Michael Risinger, *Navigating Expert Reliability: Are Criminal Standards of Certainty Being Left on the Dock?*, 64 ALB. L. REV. 99, 149 (2000) (“[T]he heightened standards of dependability imposed on expertise proffered in civil cases has continued to expand, but . . . expertise proffered by the prosecution in criminal cases has been largely insulated from any change in pre-*Daubert* standards or approach.”); see also Jennifer L. Groscup et al., *The Effects of Daubert on the Admissibility of Expert Testimony in State and Federal Criminal Cases*, 8 PSYCHOL. PUB. POL’Y & L. 339, 364 (2002) (reviewing reported criminal cases and finding that “the *Daubert* decision did not impact . . . the admission rates of expert testimony at either the trial or . . . appellate court levels”); Peter J. Neufeld, *The (Near) Irrelevance of Daubert to Criminal Justice and Some Suggestions for Reform*, 95 AM. J. PUB. HEALTH S107, S109 (2005) (“An analysis of post-*Daubert* decisions demonstrates that whereas civil defendants prevail in their *Daubert* challenges, most of the time criminal defendants almost always lose their challenges to government proffers.”).

111. NAS REPORT, *supra* note 23, at 53.

112. *Id.* at 106. The National Research Committee found that “trial judges rarely exclude or restrict expert testimony offered by prosecutors.” *Id.* at 11.

113. *Id.* at 11; see also J. Nancy Gertner, Commentary, *The Need for a Research Culture in the Forensic Sciences*, 58 UCLA L. REV. 789, 790 (2011).

As exposed by Professor Giannelli in his recent article, *Forensic Science: Daubert's Failure*, criminal courts continue to admit fire evidence grounded in discredited forensic techniques in arson cases.<sup>114</sup> He explains that the 2009 Texas Forensic Science Commission Report, which concluded that fire investigations that led to two separate Texas arson convictions and which failed to “comport with either the modern standard of care expressed by NFPA 921, or the standard of care expressed by fire investigation texts and papers in the period 1980–1992,”<sup>115</sup> “did more than the courts to curb flawed arson testimony.”<sup>116</sup> Professor Giannelli characterized criminal courts’ ongoing refusal to “appl[y] the ‘exacting’ standard that the Supreme Court said *Daubert* demanded”<sup>117</sup> to flawed forensic evidence, including faulty fire science, as a systemic failure of the judiciary.<sup>118</sup> Giannelli attributes this failure, in part, to the lack of regular access to independent scientific expertise in criminal cases, along with the routine admission of forensic evidence without foundational research, and forensic testimony dominated by “overstated and misleading conclusions.”<sup>119</sup>

#### B. Wrongful Convictions and Habeas Corpus Decisions

As noted above, unreliable fire-science testimony is routinely admitted in criminal cases.<sup>120</sup> Inexplicably, the courts’ limited scrutiny of fire science’s reliability has been confined to civil proceedings, specifically, postconviction habeas corpus review. To succeed on such review, petitioners are required to show that the admission of faulty fire expert testimony “‘undermine[d] the fundamental fairness of the entire trial’ . . . because ‘the probative value of [the fire expert] evidence, though relevant, is greatly outweighed by the prejudice to the accused from its admission.’”<sup>121</sup> *Han Tak Lee v. Glunt*<sup>122</sup> is a

114. See Giannelli, *supra* note 8, at 889–901 (summarizing several faulty methods of arson investigation and recent cases in which prosecution experts have relied on these methods).

115. *Id.* at 894 (quoting CRAIG L. BEYLER, ANALYSIS OF THE FIRE INVESTIGATION METHODS AND PROCEDURES USED IN THE CRIMINAL ARSON CASES AGAINST EARNEST RAY WILLIS AND CAMERON TODD WILLINGHAM 51 (2009)).

116. *Id.* at 901.

117. *Id.* at 875 (quoting *Weisgram v. Marley Co.*, 528 U.S. 440, 455 (2000)).

118. *Id.* at 937.

119. *Id.*

120. See *supra* notes 105–11 and accompanying text.

121. *Han Tak Lee v. Glunt*, 667 F.3d 397, 403 (3d Cir. 2012) (first quoting *Keller v. Larkins*, 251 F.3d 408, 413 (3d Cir. 2001); then quoting *Bisaccia v. Attorney Gen.*, 623 F.2d 307, 313 (3d Cir. 1980)).

122. 667 F.3d 397 (3d Cir. 2012).

seminal fire-science case in which the petitioner satisfied that demanding standard of review.<sup>123</sup>

Han Tak Lee was “charged with first degree murder and arson after his twenty-year-old mentally ill daughter died in a cabin fire at a religious retreat in the Pocono Mountains.”<sup>124</sup> Lee was found guilty on both counts by a jury and sentenced to life without the possibility of parole.<sup>125</sup> Lee litigated his innocence for *seventeen years* before finally obtaining federal habeas corpus review by the United States Court of Appeals for the Third Circuit.<sup>126</sup>

Lee asked the Third Circuit to reverse the district court’s denial of his request for an evidentiary hearing to present newly discovered expert evidence challenging the “fundamentally unreliable” fire science that had been admitted at his trial.<sup>127</sup> In granting that request for relief, the Third Circuit found that there exists “a *prima facie* case for granting [a petitioner] habeas relief on his due process claim” if his allegations show that the state’s “fire expert testimony undermined the fundamental fairness of [his] entire trial because the testimony was premised on unreliable science and was therefore itself unreliable.”<sup>128</sup> Along the way, the Third Circuit emphasized that the Commonwealth of Pennsylvania had “not offered any evidence supporting the validity of the old [fire-science] methodology and d[id] not challenge the accuracy of [Lee’s expert’s] affidavit, which describes the developments in fire science since Lee’s trial and explains that many of the scientific theories relied upon by the Commonwealth’s experts have been refuted.”<sup>129</sup>

On remand, the federal district court opened its report and recommendation with the ancient Chinese proverb “[s]low and painful has been man’s progress from magic to law,” explaining that it “is a fitting metaphor for both the progress of the law and the history of this case.”<sup>130</sup> The district court held that Lee had “show[n] that the

123. *Id.* at 403–08.

124. *Id.* at 400.

125. *Id.*

126. *Id.* at 400–02 (detailing Han Tak Lee’s efforts to litigate his innocence through the court system).

127. *Id.* at 407 (“Lee avers that his expert will conclude that there is no support for the conclusion that the fire was intentionally set if he is given the opportunity to analyze the fire scene evidence and apply the principles known through the new developments in fire science to that physical evidence.”).

128. *Id.*

129. *Id.*

130. Han Tak Lee v. Tennis, No. 4:08-CV-1972, 2014 WL 3894306, at \*1 (M.D. Pa. June 13, 2014) (“This proverb, inscribed at the University of Pennsylvania Law School on the statue of Hseih–Chai, a mythological Chinese beast who was endowed with the faculty



admission of the fire expert testimony undermined the fundamental fairness of the entire trial” and vacated his conviction and sentence.<sup>131</sup> In reaching that result, the court concluded as follows:

Today, with the benefit of extraordinary progress in human knowledge regarding fire science over the past two decades it is now uncontested that this fire science evidence—which was a critical component in the quantum of proof that led to Lee’s conviction—is invalid, *and that much of what was presented to Lee’s jury as science is now conceded to be little more than superstition.*<sup>132</sup>

Challenges to questionable forensic science convictions grounded in “change-in-science” theories are increasingly common in civil habeas proceedings.<sup>133</sup> For example, in *People v. Babick*,<sup>134</sup> a Michigan circuit court vacated the petitioner’s arson conviction because the “body of scientific knowledge and expert opinion that now exists regarding cause and origin of arson fires” made it probable that the petitioner would be acquitted in a new trial.<sup>135</sup> In sum, although criminal defendants continue to be convicted today as the result of criminal courts’ admission of faulty fire evidence at trial, the modern revolution in fire science provides petitioners with an arsenal of evidentiary ammunition to challenge those convictions on habeas review. As Federal Magistrate Judge Carlson explained in *Han Tak Lee v. Tennis*, “To achieve justice, the law must serve as the vehicle

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of discerning the guilty, is a fitting metaphor for both the progress of the law and the history of this case.”), *adopting report and recommendation sub nom.* Lee v. Tennis, No. 4:CV-08-1972, 2014 WL 3900230 (M.D. Pa. Aug. 8, 2014), *aff’d sub nom.* Han Tak Lee v. Houtzdale SCI, 798 F.3d 159 (3d Cir. 2015).

131. *Id.* at \*19 (quoting *Glunt*, 667 F.3d at 403).

132. *Id.* at \*1 (emphasis added).

133. *See, e.g.*, *Commonwealth v. Epps*, 53 N.E.3d 1247, 1249–50, 1266 (Mass. 2016) (holding that defendant was “deprived of a defense from the confluence of counsel’s failure to find . . . an expert and the evolving scientific research that demonstrates that a credible expert could offer important evidence in support of this defense”); *Ex parte Robbins*, 478 S.W.3d 678, 680 (Tex. Crim. App. 2014) (granting habeas applicant’s request for relief based on new expert medical testimony).

134. No. 1996-2562 FC (Mich. Cir. Ct. Nov. 7, 2014).

135. *Id.* at 12. At trial, the investigators testified that during their investigations there was a “perceived use of accelerants, multiple points of origin, burn patterns and/or dog sniffing hits.” *Id.* at 3. In postconviction proceedings, the defendant’s attorney claimed that “the fire science in use by experts at the time caused everyone to believe the fire was an arson as opposed to being accidentally caused.” *Id.* at 4. A certified arson investigator lent credence to her claim, explaining that the original investigators “fail[ed] to adhere to the protocol in NFPA 921, and, based on all the evidence, the cause and origin of the fire should be classified as ‘undetermined.’” *Id.* at 8. For a thorough discussion of the *Babick* trial and subsequent proceedings, see Plummer & Syed, *supra* note 61, at 486–90.

through which imperfect institutions strive for greater justice through a more perfect understanding of the truth. Therefore, as our understanding of scientific truth grows and changes, the law must follow the truth in order to secure justice.”<sup>136</sup> This understanding of scientific truth likewise means that more trial courts should seriously consider excluding faulty fire evidence pretrial, rather than years—or decades—later in postconviction review.<sup>137</sup>

### C. *Wrongful Convictions and Fire Science*

As *Han Tak Lee*, *Babick*, and the cases catalogued at the National Registry of Exonerations<sup>138</sup> demonstrate, faulty fire science is to blame for a significant number of wrongful convictions across the United States. Indeed, the AAAS, which includes noted fire-science expert and critic John Lentini, hypothesizes that the number of wrongful arson convictions secured as a result of the admissibility of invalidated fire science runs in the hundreds.<sup>139</sup> The high error rate in these cases is likely attributable to the undoubtedly persuasive power that expert fire-science evidence—no matter how flawed—has over juries.<sup>140</sup> As a result, it is particularly important that criminal courts begin to enforce their *Daubert* evidentiary gatekeeping function in arson prosecutions. Several problems persist in arson investigations that lead to wrongful convictions and could be exposed via a robust

136. *Tennis*, 2014 WL 3894306, at \*19.

137. See Caitlin M. Plummer & Imran J. Syed, *Criminal Procedure v. Scientific Process: The Challenging Path to Post-Conviction Relief in Cases that Arise During Periods of Shift in Science*, 41 VT. L. REV. 279, 291–92 (2016) (“Ultimately and reluctantly, the Court is persuaded that the deficits of the conclusions reached by either expert are significant enough in terms of reliability and crucial enough in terms of relevance to bar their presentation to the jury. The Court is keenly aware of the consequences of its ruling, the impact of which may ultimately jeopardize prosecution of this matter. However, these omissions are so fundamental, confounding and distressing that the Court is left with little choice but to grant Defendant’s motion to preclude admissibility of such experts’ opinions, despite acknowledging that it would have been far simpler to have allowed presentation of such viewpoints to the jury, particularly when considering such matters under the old [pre-*Daubert*] standard.” (quoting *State v. Gibson*, No. CR20104390-001 (Ariz. Super. Ct. July 25, 2013))).

138. *Browse Cases*, NAT’L REGISTRY EXONERATIONS, <https://www.law.umich.edu/special/exoneration/Pages/browse.aspx> [<https://perma.cc/W692-MZ8K>].

139. HANGER, *supra* note 10, at 5.

140. See, e.g., Valerie P. Hans, *Judges, Juries, and Scientific Evidence*, 16 J.L. & POL’Y 19, 23–24 (2007) (explaining that “jurors themselves have identified the task of interpreting scientific and technical evidence and expert testimony as particularly challenging” and “[c]ase studies examining juror comprehension of scientific testimony, and some experimental research, point out the types of expert evidence that can present problems for juries” (footnotes omitted)).

*Daubert* challenge, including the use of negative corpus theory and investigatory techniques that are likely to compound error.

### 1. Negative Corpus Theory

A common investigative theory in arson cases is that the fire was caused by an “open flame,” that is, that a human with an igniter intentionally started the fire.<sup>141</sup> This hypothesis is often based on “negative corpus” theory, which operates as follows:

A fire investigator determines, for instance, that a fire began in the northeast corner of the living room. A search of the northeast corner reveals no evidence of the ignition source that started the fire. Based on an absence of an ignition source commonly associated with an accidental fire (such as a heater, electric lamp, extension cord, cigarettes, or candles), the fire investigator, using the process of elimination, decides that the fire must have been ignited with a match or a lighter that was then removed from the scene.<sup>142</sup>

Negative corpus theory is thereby used to establish the necessary intent for arson.<sup>143</sup> The fire investigator testifies that the fire was caused by the intentional lighting of a specific ignition source, such as a match or a lighter, in the absence of any evidence of said ignition source.<sup>144</sup> Of course, if the fire expert identifies the wrong area of the scene as the source of the fire—the corner of the room without any electrical outlets as opposed to the other corner with the charred space heater—then it goes without saying that no evidence will be recovered that supports the notion that the fire actually started in another location. NFPA 921 explicitly rejects the application of negative corpus theory because it runs afoul of the scientific method.<sup>145</sup> Fire investigators, however, continue to provide expert conclusions based on this absence-of-evidence theory.<sup>146</sup>

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141. Dehghani-Tafti & Bieber, *supra* note 53, at 570–71.

142. *Id.* at 571.

143. *Id.*

144. *Id.*

145. NFPA 921 (2017), *supra* note 56, ¶ 19.6.5 (“Identifying the ignition source for a fire by believing to have eliminated all ignition sources found, known, or suspected to have been present in the area of origin, and for which no supporting evidence exists, is referred to by some investigators as *negative corpus*. . . . [Negative corpus] is not consistent with the scientific method, is inappropriate, and should not be used because it generates untestable hypotheses, and may result in incorrect determinations of the ignition source and first fuel ignited.”).

146. Dehghani-Tafti & Bieber, *supra* note 53, at 571.

Exacerbating the negative corpus problem is the well-documented fact that fire experts are notoriously inept at determining the source of a fire.<sup>147</sup> A 2005 study conducted by the DOJ Bureau of Alcohol, Tobacco, Firearms, and Explosives (“ATF”) found that only 6% of fire experts accurately identified the fire origin in a room that had burned two minutes past flashover.<sup>148</sup> The ATF study was repeated by the Federal Law Enforcement Training Center, which recorded fire investigator accuracy results ranging from 8% to 10%.<sup>149</sup> These abysmal error rates notwithstanding, criminal courts continue to admit expert testimony concluding that a fire, which started in an area that lacks any ascertainable ignition source, was man-made: arson.<sup>150</sup>

In addition, the misidentification of the origin of a fire infects the remainder of the investigation. As NFPA 921 makes explicit, if a fire expert is incapable of identifying the true area of origin, then the expert simply cannot accurately determine the cause of the fire.<sup>151</sup> Furthermore, fire investigators often confine their search for a fire source to the alleged area of origin. Given the importance of accurately determining the area of fire origin, fire investigators should be required to examine and analyze the entire scene.<sup>152</sup>

## 2. Compounding Errors in Wrongful Convictions

The potential for error compounds exponentially when faulty fire science intersects with other unreliable evidence in criminal cases. Flawed fire-science evidence, for example, frequently intersects with eyewitness misidentifications. NFPA 921 expressly permits fire investigators to interview eyewitnesses prior to examining the fire scene.<sup>153</sup> When a fire investigator communicates with the eyewitnesses prior to conducting any on-scene fire investigation, however, eyewitness accounts have the potential to drastically—and unscientifically—impact the investigator’s findings, including his determinations regarding point of origin and nature of the fire

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147. *Id.* at 566–67.

148. *Id.* at 566.

149. *Id.*

150. *See* Giannelli, *supra* note 8, at 889–98 (summarizing several faulty methods of arson investigation and recent cases in which prosecution experts have relied on these methods).

151. NFPA 921 (2017), *supra* note 56, ¶ 18.1 (“Generally, if the origin cannot be determined, the cause cannot be determined, and generally, if the correct origin is not identified, the subsequent cause determination will also be incorrect.”).

152. *Id.* ¶¶ 18.3.1.3–4.

153. *Id.* ¶ 18.1.2.

(accidental or intentional). Unfortunately, unreliable eyewitness commentary can provoke a fire investigator to conclude that a fire was intentionally set before the investigator has performed any on-scene evidence collection or assessment.<sup>154</sup>

Worse yet, eyewitnesses are notoriously prone to change or alter their memories of pertinent events when police or other first responders inform them that “scientific evidence” supports a particular theory of the fire under investigation.<sup>155</sup> In fact, this is precisely what occurred in the arson investigation and prosecution of Cameron Todd Willingham. At the onset of the Willingham investigation, multiple eyewitnesses to the blaze reported to police that Willingham was frantic to save his daughters from their burning trailer.<sup>156</sup> Once Willingham was suspected of arson, however, those eyewitnesses dramatically altered their accounts of what had occurred at the scene:

Police and fire investigators canvassed the neighborhood, interviewing witnesses. Several, like Father Monaghan, initially portrayed Willingham as devastated by the fire. Yet, over time, an increasing number of witnesses offered damning statements. Diane Barbee said that she had not seen Willingham try to enter the house until after the authorities arrived, as if he were putting on a show. And when the children’s room exploded with flames, she added, he seemed more preoccupied with his car, which he moved down the driveway. Another neighbor reported that when Willingham cried out for his babies he “did not appear to be excited or concerned.” Even Father Monaghan wrote in a statement that, upon further reflection, “things were not as they seemed. I had the feeling that [Willingham] was in complete control.”<sup>157</sup>

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154. Cf. D. Michael Risinger et al., *The Daubert/Kumho Implications of Observer Effects in Forensic Science: Hidden Problems of Expectation and Suggestion*, 90 CALIF. L. REV. 1, 16–17 (2002) (noting “anchoring effects” where individuals’ estimates are improperly influenced by preexisting, or predetermined, but task-irrelevant, data).

155. George Castelle & Elizabeth F. Loftus, *Misinformation and Wrongful Convictions*, in *WRONGLY CONVICTED: PERSPECTIVES ON FAILED JUSTICE* 17, 17–18 (Sandra D. Westervelt & John A. Humphrey eds., 2001) (“More important, while our study reveals errors in the collection of physical evidence and the testing and reporting of forensic science results, it also considers the poorly understood effect of the cross-contamination of evidence: when one piece of misinformation contaminates other information in a case and ultimately results in the conviction of the innocent.”).

156. David Grann, *Trial by Fire: Did Texas Execute an Innocent Man?*, *NEW YORKER* (Sept. 7, 2009), <https://www.newyorker.com/magazine/2009/09/07/trial-by-fire> [<https://perma.cc/VRF3-ZY77> (dark archive)].

157. *Id.* (alteration in original).

Professor Richard Leo identifies this phenomenon as the “false evidence ploy” and contends that it is particularly potent when deployed during eyewitnesses interviews and suspect interrogations.<sup>158</sup> Leo has found that the false evidence ploy creates a higher risk of false confessions and misidentification because lay people “tend to defer to scientific evidence.”<sup>159</sup> Indeed, such misuse of “scientific evidence,” which is viewed as reliable and impartial, is the “most potent kind of evidence ploy,” the “strongest at creating the risk of false or unreliable confessions,” and highly likely to induce an altered memory in an eyewitness.<sup>160</sup>

*D. Cognitive Biases: Tunnel Vision and Role Effect*

Forensic findings also run the risk of being influenced by various forms of cognitive biases, including tunnel vision and role effect. Research on cognitive biases challenges how forensic science evidence is collected and evaluated and questions whether forensic findings are arrived at objectively and independently or are, instead, police-dependent determinations.<sup>161</sup>

“Tunnel vision” is widely understood as a “compendium of common heuristics and logical fallacies,” to which we are all susceptible, that lead actors in the criminal justice system to “focus on a suspect, select and filter the evidence that will “build a case” for conviction, while ignoring or suppressing evidence that points away from guilt.”<sup>162</sup> Tunnel vision engenders police and prosecutors to focus on one theory of the crime and filter all case-related evidence exclusively through the lens of that theory.<sup>163</sup> As NFPA 921 emphasizes, tunnel vision and expectation bias are of particular

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158. Transcript of Motion Hearing at 147–48, *State v. Donley*, No. 03-CF-1035 (Wis. Cir. Ct. June 16, 2014) (on file with the North Carolina Law Review).

159. *Id.* at 148.

160. *Id.*

161. See, e.g., Jennifer L. Mnookin, *The Courts, the NAS, and the Future of Forensic Science*, 75 *BROOK. L. REV.* 1209, 1230–32 (2010) (examining cognitive biases in fingerprint analysis).

162. Keith A. Findley & Michael S. Scott, *The Multiple Dimensions of Tunnel Vision in Criminal Cases*, 2006 *WIS. L. REV.* 291, 292 (quoting Dianne L. Martin, *Lessons About Justice from the “Laboratory” of Wrongful Convictions: Tunnel Vision, the Construction of Guilt and Informer Evidence*, 70 *UMKC L. REV.* 847, 848 (2002)).

163. *Id.*; see also Myrna Raeder, *What Does Innocence Have to Do with It?: A Commentary on Wrongful Convictions and Rationality*, 2003 *MICH. ST. L. REV.* 1315, 1327–28.

concern in fire investigations,<sup>164</sup> where these phenomena can provoke fire investigators to disregard exculpatory evidence.<sup>165</sup>

Expectation bias, a form of confirmation bias,<sup>166</sup> results in a “selective information search and biased interpretation of available information.”<sup>167</sup> Similar to tunnel vision, expectation bias induces investigators to seek information and evidence that confirms, rather than disproves, a working theory of arson.<sup>168</sup> Therefore, fire investigators pursuing an arson theory are susceptible to dismissing as irrelevant or unreliable any evidence inconsistent with arson, such as evidence that points to an alternative fire source.<sup>169</sup> NFPA 921 warns fire investigators to be wary of expectation bias, explaining that such a phenomenon occurs “when [an] investigator[] reach[es] a premature conclusion without having examined or considered all of the relevant data,” thereby causing “premature determination[s] to dictate investigative processes, analyses, and . . . conclusions, in a way that is not scientifically valid.”<sup>170</sup>

As explained above, fire investigators are often law enforcement officers.<sup>171</sup> Accordingly, they are likely to have similar motives as the

164. See NFPA 921 (2017), *supra* note 56, ¶¶ 4.1, 4.3.9.

165. Jennifer E. Laurin, *Remapping the Path Forward: Toward a Systemic View of Forensic Science Reform and Oversight*, 91 TEX. L. REV. 1051, 1097 (2013) (“Cognitive bias of this sort is likely to have particularly perverse effects with respect to precisely the types of forensic evidence that, from a reliability-enhancing perspective, we should be most concerned about: exculpatory science, and science that is *less* than the ‘gold standard.’ On the former count, confirmation bias and tunnel vision have been widely accepted as causes of erroneous disregard, rejection, or recharacterization of exculpatory evidence by both police and prosecutors, and the anecdotal evidence is that the force of science does not render forensic evidence immune to this pressure.” (footnotes omitted)).

166. Findley & Scott, *supra* note 162, at 308 (“The foundational tendency is probably best understood as an expectancy bias, which is a form of confirmation bias. When people are led by circumstances to expect some fact or condition (as people commonly are), they tend to perceive that fact or condition in informationally ambiguous situations. This can lead to error biased in the direction of the expectation.” (footnotes omitted)).

167. Sherry Nakhaeizadeh, Itiel E. Dror & Ruth M. Morgan, *The Emergence of Cognitive Bias in Forensic Science and Criminal Investigations*, 4 BRIT. J. AM. LEGAL STUD. 527, 537 (2015) (“Selective information search within legal perspectives occurs when an individual examines information or evidence to incriminate a suspect based on a personal hypothesis, and ignores the search for evidence that could exonerate or lead to an alternative hypothesis.”); see also Alafair S. Burke, *Improving Prosecutorial Decision Making: Some Lessons of Cognitive Science*, 47 WM. & MARY L. REV. 1587, 1588–1613 (2006).

168. See Burke, *supra* note 167, at 1594–99 (discussing issues with confirmation bias and “selective information processing”).

169. See Findley & Scott, *supra* note 162, at 292.

170. NFPA 921 (2017), *supra* note 56, ¶ 4.3.9.

171. See *supra* Introduction.

other police and prosecutors with whom they work.<sup>172</sup> A fire investigator who views himself as a member of the police or prosecutorial team is unlikely to perform as an objective, impartial scientist; instead, he is vulnerable to subjective, “role effect” heuristics,<sup>173</sup> much like technicians who work in police-controlled forensic labs.<sup>174</sup> “Forensic scientists, aware of the desired result of their analyses, might be influenced—even unwittingly—to interpret ambiguous data or fabricate results to support the police theory.”<sup>175</sup> This “additional evidence then enters a feedback loop that bolsters the [investigator’s] confidence in the reliability and accuracy of their incriminating [evidence] . . . and reinforces the original assessment of guilt.”<sup>176</sup>

Professor Sandra Thompson characterizes the process by which police agencies or prosecutors provide accolades to crime lab analysts for case analysis that leads to a conviction as the “kudos” effect.<sup>177</sup> Like its sister forensic disciplines, fire science was developed by law enforcement as a tool to investigate and solve crimes. Consequently, fire investigators are encouraged to reach the “right” result, that is, the one that matches the police theory of the crime,<sup>178</sup> “[i]nstead of collecting and examining all of the data in a logical and unbiased manner to reach a scientifically reliable conclusion.”<sup>179</sup>

#### IV. THE UGLY: *DAUBERT* IS NO REMEDY IN STATES THAT FAIL TO RECOGNIZE FIRE SCIENCE AS SCIENTIFIC TESTIMONY

We contend the evidentiary reliability and validity standards applicable to fire-science evidence need to be as robust in criminal cases as they are in their civil counterparts. We are not alone: three state legislatures have passed resolutions that individuals who have been convicted of arson based on methods inconsistent with the scientific principles of NFPA 921 are entitled to postconviction

172. This concern of role bias is frequently raised in discussions concerning police-controlled crime labs, in which the police and prosecutors have overlapping interests.

173. See THOMPSON, *supra* note 34, at 131; Findley & Scott, *supra* note 162, at 292–93.

174. THOMPSON, *supra* note 34, at 127–44.

175. Findley & Scott, *supra* note 162, at 293.

176. See *id.*; see also THOMPSON, *supra* note 34, at 131–33 (discussing how “untruthful reporting of preliminary findings [have] become a common practice” in numerous laboratories).

177. THOMPSON, *supra* note 34, at 127.

178. *Id.* at 127–33.

179. NFPA 921 (2017), *supra* note 56, ¶ 4.3.9.



judicial review.<sup>180</sup> Moreover, the growing cadre of postconviction opinions holding trial counsel ineffective for failing to challenge fire science<sup>181</sup> indicate that faulty forensic-science-induced wrongful convictions are not solely attributable overzealous prosecutors: defense counsel must raise and preserve challenges to flawed fire science during trial proceedings. Perhaps these postconviction opinions will encourage skepticism of fire science in criminal cases, similar to civil cases. However, the development of such skepticism remains elusive if defense attorneys lack adequate tools to challenge fire-science experts pretrial. Our discussion below highlights the difficulty of challenging fire-science evidence when *Daubert* does not apply.

A. *Trial Counsel as Ineffective for Failing to Challenge Faulty Fire Science*

On postconviction review, courts have held defense counsel ineffective for failing to request a *Daubert* hearing during the trial proceedings to challenge unreliable arson evidence.<sup>182</sup> In *United States v. Hebshie*,<sup>183</sup> the United States District Court for the District of Massachusetts held that trial counsel's failure to challenge the testimony of the Commonwealth's fire experts was constitutionally deficient<sup>184</sup> and objectively unreasonable under *Strickland v. Washington*.<sup>185</sup> The *Hebshie* opinion explained that “[o]rdinarily competent counsel would have understood that men and women had been convicted, sentenced, [and] perhaps even executed, on the basis of flawed arson evidence and [would] take[] appropriate steps to litigate the issues using all the tools available.”<sup>186</sup> The *Hebshie* court also concluded that the result of the trial would likely have been different if defense counsel had properly challenged the Commonwealth's flawed fire evidence.<sup>187</sup>

The First and Sixth Circuits have also addressed issues of effective advocacy where the defendants faced incriminating fire

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180. H. Con. Res. 2066, 49th Leg., 2d Reg. Sess. (Ariz. 2010); Legis. Res. 411, 101st Leg., 2d Reg. Sess. (Neb. 2010); S. Res. 99, 52d Leg., 2d Sess. (Okla. 2010).

181. See, e.g., *Richey v. Bradshaw*, 498 F.3d 344, 363–64 (6th Cir. 2007); *United States v. Hebshie*, 754 F. Supp. 2d 89, 95 (D. Mass. 2010).

182. *Hebshie*, 754 F. Supp. 2d at 95.

183. 754 F. Supp. 2d 89 (D. Mass. 2010).

184. *Id.* at 94–95.

185. *Id.* at 122.

186. *Id.* at 92.

187. *Id.* at 119–22.

cause and origin testimony in arson cases. In *Dugas v. Coplan*,<sup>188</sup> the First Circuit held that defense counsel ineffectively represented his client in an alleged grocery store arson.<sup>189</sup> The State's fire investigators determined the cause and origin of the fire to be a pile of papers that had been located in front of a shelf in the basement, ruled out accidental causes, and tested samples of the area of the burn, some of which contained medium petroleum distillates.<sup>190</sup> Defense counsel decided against pursuing a "not arson" defense and, as such, failed to call any defense experts.<sup>191</sup> The First Circuit held that decision to be constitutionally deficient for multiple reasons: (1) it was the result of a failure to thoroughly investigate, (2) "the arson evidence was the cornerstone of the [S]tate's case," (3) there was sparse other evidence, (4) counsel knew that "a layperson would be likely to view the [fire] scene as arson" and that he would need expert assistance "to shake the jurors' views that they were dealing with an arson scene," and (5) there was reason to surmise that the State's cause and origin conclusions were flawed.<sup>192</sup> Accordingly, the First Circuit found an "inescapable need for expert consultation in [the instant] case."<sup>193</sup>

In *Richey v. Bradshaw*,<sup>194</sup> the Sixth Circuit similarly held that defense counsel's failure to properly attack the State's arson evidence at trial constituted ineffective assistance of counsel.<sup>195</sup> In *Richey*, defense counsel failed to hire a fire expert until the eve of trial, and the expert that he did hire ultimately agreed with the conclusions of the State's expert—without performing independent testing.<sup>196</sup> The *Richey* court criticized defense counsel for failing to either inquire as to what the State's expert had done to form his opinion or acquaint himself with "the basics of the science involved."<sup>197</sup> The Sixth Circuit further explained that

where counsel knew that there were gaps in the State's proof having to do with the lack of accelerants on Richey's boots and clothing, and the greenhouse owner's inability to say that any

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188. 428 F.3d 317 (1st Cir. 2005).

189. *Id.* at 319.

190. *Id.* at 320–21.

191. *Id.* at 328.

192. *Id.* at 329–30.

193. *Id.* at 331.

194. 498 F.3d 344 (6th Cir. 2007).

195. *See id.* at 362–64.

196. *Id.* at 362.

197. *Id.*

accelerants were missing, investigating the scientific basis for the State's arson conclusion became all the more imperative.<sup>198</sup>

The court concluded by ruling that “[t]here is a reasonable probability that had [Richey’s] counsel mounted the available defense that the fire was caused by an accident, and was not the result of arson at all, the outcome of either the guilt or the penalty phase would have been different.”<sup>199</sup>

### B. *Daubert as a Solution?*

As the above-discussed postconviction cases make clear, the federal courts expect defense counsel to challenge dubious fire science. One manner to do so is for defense counsel to request pretrial *Daubert* hearings. While routine in civil cases involving complex scientific testimony, *Daubert* hearings remain rare in criminal cases.<sup>200</sup> Moreover, fire investigators are not deemed experts subject to *Daubert* challenges in certain states. As a result, defense counsel is precluded from challenging fire-science testimony in pretrial *Daubert* hearings in those jurisdictions.

### C. *Fire Science: Scientific v. Technical Experts*

In arson cases, prosecutors rely on the fire investigation to prove intent. That is to say, the government needs its fire expert to convince the jury that the defendant intentionally set the fire beyond a reasonable doubt. Criminal jurors, however, are rarely apprised that fire investigators are unqualified to testify as to intent, let alone that they frequently base their causation and origin determinations on erroneous investigative techniques.<sup>201</sup> This is particularly problematic because juries are inclined to give forensic evidence far more weight

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198. *Id.* at 363.

199. *Id.* at 364.

200. *See, e.g.*, Garrett Villers, West Virginia and Forensic Science: Presently and Moving Forward 10 (unpublished manuscript) (on file with the North Carolina Law Review) (recounting an interview with West Virginia Circuit Court Judge Russell M. Clawges, Jr. in which the judge stated that “[i]f there is any question of forensics in a criminal case I definitely have a *Daubert* hearing,” but that “[r]eally you don’t have them very often and it’s kind of strange,” and that the “[b]ottom line is that our [c]ourts let it in”).

201. *See, e.g.*, Plummer & Syed, *supra* note 61, at 488–89 (explaining that when the lab analysis came back negative for gasoline in the house at issue in the *Babick* case, the fire investigator testified at trial that his dog was more accurate at detecting arson than laboratory equipment, and the prosecution in closing argued to the jury that “a dog’s nose on a trained dog is a mystical thing . . . a thousand times more sensitive than the lab equipment”).

based on an expert witness's persuasiveness than on evidentiary reliability or accuracy.<sup>202</sup> The admission of unreliable scientific or expert fire testimony creates a substantial danger of undue prejudice at trial stemming from the considerable deference that juries tend to afford to scientific experts.<sup>203</sup>

The United States Supreme Court has emphasized the importance of trial courts exercising their *Daubert*-gatekeeping function “to evaluate the reliability even of experience-based testimony.”<sup>204</sup> In *Kumho Tire*, the question before the Court was whether “technical” experts, such as tire engineers, were bound by the *Daubert* reliability factors.<sup>205</sup> In answering affirmatively, the Court explained that

whether the specific expert testimony focuses upon specialized observations, the specialized translation of those observations into theory, a specialized theory itself, or the application of such a theory in a particular case, the expert's testimony often will rest “upon an experience confessedly foreign in kind to [the jury's] own.” The trial judge's effort to assure that the specialized testimony is reliable and relevant can help the jury evaluate that foreign experience, whether the testimony reflects scientific, technical, or other specialized knowledge.<sup>206</sup>

In reaching its result in *Kumho Tire*, the Court emphasized three points. First, “Federal Rules 702 and 703 grant expert witnesses testimonial latitude unavailable to other witnesses on the ‘assumption that the expert's opinion will have a reliable basis in the knowledge and experience of his discipline.’”<sup>207</sup> Second, the express language of Federal Rule of Evidence 702 fails to distinguish “between ‘scientific’

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202. Balko, *supra* note 38.

203. See *United States v. Amaral*, 488 F.2d 1148, 1152 (9th Cir. 1973) (“Because of the peculiar risks of expert testimony, courts have imposed an additional test, i. e. that the testimony be in accordance with a generally accepted explanatory theory.”); see also Neil Vidmar & Shari Seidman Diamond, *Juries and Expert Evidence*, 66 BROOK. L. REV. 1121, 1125 (2001) (“[J]urors often ‘abdicate their fact-finding obligation’ and simply ‘adopt’ the expert's opinion . . . .” (quoting Brief Amici Curiae of Neil Vidmar et al., *Kumho Tire Co. v. Carmichael*, 526 U.S. 137 (1999) (No. 97-1709), reprinted in Neil Vidmar et al., *Amicus Brief: Kumho Tire v. Carmichael*, 24 LAW & HUM. BEHAV. 387, 390 (2000))).

204. *Kumho Tire Co. v. Carmichael*, 526 U.S. 137, 151 (1999).

205. *Id.* at 141.

206. *Id.* at 149 (alteration in original) (quoting Learned Hand, *Historical and Practical Considerations Regarding Expert Testimony*, 15 HARV. L. REV. 40, 54 (1901-1902)).

207. *Id.* at 148 (quoting *Daubert v. Merrell Dow Pharm., Inc.*, 509 U.S. 579, 592 (1993)).

knowledge and ‘technical’ or ‘other specialized’ knowledge.”<sup>208</sup> Finally and perhaps most pragmatically, “it would prove difficult, if not impossible, for judges to administer evidentiary rules under which a gatekeeping obligation depended upon a distinction between ‘scientific’ knowledge and ‘technical’ or ‘other specialized’ knowledge.”<sup>209</sup> This is because, of course, “[t]here is no clear line that divides the one from the others.”<sup>210</sup> Simply stated, under federal law, *Daubert*’s general principles are applicable to *all* expert testimony.

As pointed out previously, Congress amended Federal Rule of Evidence 702 in 2000 to expressly incorporate the major premises of *Daubert* and *Kumho Tire*.<sup>211</sup> As the Advisory Committee Notes to Rule 702 summarize:

The amendment affirms the trial court’s role as gatekeeper and provides some general standards that the trial court must use to assess the reliability and helpfulness of proffered expert testimony. Consistently with *Kumho*, the Rule as amended provides that *all types of expert testimony present questions of admissibility for the trial court in deciding whether the evidence is reliable and helpful*.<sup>212</sup>

To date, at least forty states have adopted *Daubert* as controlling on the issue of expert evidence admissibility.<sup>213</sup> Only nineteen of those forty states, however, have adopted the holding of *Kumho Tire*.<sup>214</sup> As

208. *Id.* at 147. The Court did, however, explain that “*Daubert*’s list of specific factors neither necessarily nor exclusively applies to all experts or in every case.” *Id.* at 141.

209. *Id.* at 148.

210. *Id.*

211. FED. R. EVID. 702 advisory committee’s notes to 2000 amendment.

212. *Id.* (emphasis added).

213. See Michael Morgenstern, *Daubert v. Frye – A State-by-State Comparison*, EXPERT INST. (Apr. 3, 2017), <https://www.theexpertinstitute.com/daubert-v-frye-a-state-by-state-comparison/> [<https://perma.cc/56MS-EYMC>].

214. See MICH. R. EVID. 702; *Coca-Cola Bottling Co. of Memphis, Tenn. v. Gill*, 100 S.W.3d 715, 729 (Ark. 2003); *M.G. Bancorp., Inc. v. Le Beau*, 737 A.2d 513, 522 (Del. 1999); *Goodyear Tire & Rubber Co. v. Thompson*, 11 S.W.3d 575, 577 (Ky. 2000); *Palandjian v. Foster*, 842 N.E.2d 916, 922–25 (Mass. 2006); *Miss. Transp. Comm’n v. McLemore*, 863 So.2d 31, 35–40 (Miss. 2003); *Schafersman v. Agland Coop*, 631 N.W.2d 862, 873 (Neb. 2001); *Baker Valley Lumber, Inc. v. Ingersoll-Rand Co.*, 813 A.2d 409, 416–17 (N.H. 2002); *Taylor v. Abernethy*, 149 N.C. App. 263, 273, 560 S.E.2d 233, 239 (2002); *State v. Drummond*, 854 N.E.2d 1038, 1063 (Ohio 2006); *Christian v. Gray*, 65 P.3d 591, 594 (Okla. 2003); *Raimbeault v. Takeuchi Mfg. (U.S.), Ltd.*, 772 A.2d 1056, 1061 (R.I. 2001); *Rogen v. Monson*, 609 N.W.2d 456, 462 (S.D. 2000); *Gammill v. Jack Williams Chevrolet, Inc.*, 972 S.W.2d 713, 727 (Tex. 1998); *USGen New England, Inc. v. Town of Rockingham*, 862 A.2d 269, 275–76 (Vt. 2004); *Bunting v. Jamieson*, 984 P.2d 467, 470 (Wyo. 1999); 4 SPENCER A. GARD, ROBERT C. CASAD & LUMEN N. MULLIGAN, KANSAS LAW & PRACTICE, CODE OF CIVIL PROCEDURE ANNOTATED § 60-456, Westlaw (database updated Oct. 2018); BOBBY MARZINE HARGES & RUSSELL L. JONES,

a result, litigants are not entitled to raise *Daubert* challenges to fire evidence that courts deem technical, rather than scientific, knowledge in the overwhelming majority of American jurisdictions.

*D. A Problem with “Technical” Witnesses: Unqualified Experts*

In an effort to establish standardized professional qualifications for fire investigators, the NFPA published *NFPA 1031: Professional Qualifications for Fire Inspector, Fire Investigator, and Fire Prevention Education Officer* in 1977.<sup>215</sup> Ten years later, the NFPA revamped its fire professional qualification standards and retitled it as *NFPA 1033: Standard for Professional Qualifications for Fire Investigator*.<sup>216</sup> NFPA 1033 requires fire investigators to “remain current [on specific, enumerated topics] by attending formal education courses, workshops, and seminars, and/or through professional publications and journals.”<sup>217</sup> These topics include, among other things, thermodynamics, fire chemistry, thermometry, fire science, fire dynamics, explosion dynamics, fire investigation methodology, and electricity and electrical systems.<sup>218</sup> This industry-created list provides courts with guidance in evaluating whether an investigator is qualified to testify.<sup>219</sup>

As explained above, fire investigators are often law enforcement officers who have little additional training beyond weekend seminars operated by other scientifically untrained law enforcement officers.<sup>220</sup> It should come as little surprise, therefore, that fire investigators often cannot articulate even the basic units of measurement of energy, power, or heat flux when confronted on cross-examination.<sup>221</sup> John Lentini provides the following example of testimony from one of the

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LOUISIANA PRACTICE EVIDENCE art. 702, Westlaw (database updated June 2018); 1 SHIRLEY J. MCAULIFFE, ARIZONA PRACTICE, LAW OF EVIDENCE § 702:1.50, Westlaw (database updated Apr. 2018).

215. NAT’L FIRE PROT. ASS’N, NFPA 1033: STANDARD FOR PROFESSIONAL QUALIFICATIONS FOR FIRE INVESTIGATOR, at 1033-1 (1993 ed. 1993).

216. *Id.*

217. NFPA 1033 (2014), *supra* note 50, ¶ 1.3.8.

218. *Id.* ¶ 1.3.7. The complete list of subjects includes: fire science, fire chemistry, thermodynamics, thermometry, fire dynamics, explosion dynamics, computer fire modeling, fire investigation, fire analysis, fire investigation methodology, fire investigation technology, hazardous materials, failure analysis and analytical tools, fire protection systems, evidence documentation collection and preservation, and electricity and electrical systems. *Id.*

219. John J. Lentini, *Confronting Inaccuracy in Fire Cause Determinations*, in FORENSIC SCIENCE REFORM: PROTECTING THE INNOCENT 66, 68 (Wendy J. Koen & C. Michael Bowers eds., 2017) [hereinafter Lentini, *Confronting Inaccuracy*].

220. LENTINI, SCIENTIFIC PROTOCOLS, *supra* note 12, at xv.

221. Lentini, *Confronting Inaccuracy*, *supra* note 219, at 68–70.

more highly qualified fire-science experts in the field, specifically, an electrical engineer fire investigator:

Q. How is radiant heat flux measured?

A. Oh, I can't remember the actual units but I could look it up. I just don't remember what the actual units are because it's not a common . . .

Q. Do you know what the generally accepted value of radiant heat flux that will result in a flashover is?

A. No.

Q. If you were outside like today on a cloudless day at noon, what is the radiant heat flux that a square meter of the earth's surface is receiving from the sun?

A. I don't know.<sup>222</sup>

Unfortunately, such lack of basic knowledge on the part of fire investigators concerning the fundamentals of energy, power, and heat flux is not uncommon. Lentini has cataloged myriad examples of fire investigator "expert" testimony from criminal cases, which expose those experts' failure to grasp even the rudimentary components of fire behavior.<sup>223</sup> For instance, consider the following testimony by a certified fire and explosion investigator whose opinion that a propane-fired weed burner was used to set a fire resulted in the defendant's capital murder charge:

Q. Do you know how many BTUs are present in a typical cubic foot of propane?

A. Not at this time.

Q. Do you know what the chemical formula for propane is?

A. I'm unsure at this time.

Q. Can you write down the chemical equation that describes the burning of propane in air?

A. I'm unsure.

Q. How many volumes of oxygen are required to burn a volume of propane?

A. Unsure.

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222. *Id.* at 70.

223. *Id.* at 70–72.

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Q. Can you explain the difference between heat and temperature?

A. My opinion? Not “921” or any . . .

Q. Yeah, your opinion.

A. Heat is the production of light and temperature from a product, and temperature is the natural measurement of that heat that’s produced.

Q. Okay. What’s the basic unit of energy called?

A. I’m unsure at this time.

Q. You ever heard of a joule?

A. I have.

Q. What is it?

A. It’s a measurement of energy or that’s how—it has to do with electricity as well.

Q. What are the basic units of power called?

A. AC and DC.

Q. I’m sorry?

A. AC and DC.

Q. Have you ever heard of a watt?

A. Yes, sir.

Q. Would that be the correct answer?

A. More than likely.

Q. What is a watt?

A. I mean I’m unsure. If you want me to look at a manual and give you these answers . . .

Q. Do you know what a watt is?

A. No, sir.

Q. Okay. How is the size of a fire measured?

A. I’m unsure at this time.

Q. Okay. What is radiant heat flux?



A. I'm unsure at this time.<sup>224</sup>

The prosecutor moved for dismissal at the close of this testimony.<sup>225</sup> This cross-examination of an alleged fire-science expert highlights at least two above-discussed problems pertinent to fire-expert testimony in criminal arson cases. First, defense counsel are frequently incapable of challenging such testimony during a pretrial *Daubert* hearing because the majority of jurisdictions have not adopted *Kumho Tire* and characterize such evidence as technical and not scientific. Second, defense counsel often fail to raise *Daubert* challenges even in jurisdictions that have adopted *Kumho Tire*. Consequently, the importance that defense counsel raise *Daubert* challenges to fire-science testimony where permitted and urge courts to apply *Daubert* to fire investigation evidence in non-*Kumho Tire* jurisdictions cannot be overstated in this context.

#### V. BEYOND *DAUBERT*: PROPOSED SOLUTIONS

Criminal courts continue to admit unreliable fire-science evidence notwithstanding *Daubert*, *Kumho*, and the Federal Rules of Evidence. We therefore propose several beyond-*Daubert*-styled solutions that aim to improve the quality of admissible fire-science evidence and thereby mitigate the wrongful conviction rate in cases involving fire science. As detailed below, we contend that the adoption of error rates, Linear Sequential Unmasking, and a standardized tool to evaluate the quality of fire-investigation evidence would enhance fire-science reliability. We also argue that fire-science investigation should be sequestered from criminal investigations and that courts should appoint their own experts in criminal cases where the prosecution relies on a scientifically untrained fire expert.

##### A. *Adoption of NFPA 921 as Controlling Is Not Enough*

The NFPA 921 guidelines are critical to criminal fire investigations. Indeed, the very purpose of the guidelines is “to provide guidance to both public and private investigators based on accepted scientific principles and scientific research.”<sup>226</sup> NFPA 921 is central to the National Fire Academy curricula.

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224. *Id.* at 72. Unbelievably, this “expert” asserted that he held a “‘magma [sic] cum laude’ degree in fire science.” *Id.* (alteration in original).

225. *Id.*

226. NFPA 921 (2017), *supra* note 56, at 921-1. This guidance is important since, “[u]nlike [other] forensic counterparts, fire investigators must determine whether a crime

While some courts recognize NFPA 921 as the gold standard<sup>227</sup> in fire investigation, others treat it like the Pirates' Code, espousing the attitude that NFPA 921 "is more what you'd call 'guidelines' than actual rules."<sup>228</sup> A recent decision by the West Virginia Supreme Court of Appeals, for example, entirely ignored the NFPA 921 standards in reviewing a botched fire investigation and held that, because the State had proven sufficient "motive," the inadequate underlying fire investigation was immaterial.<sup>229</sup> According to the court,

Although the ... NFPA ... has been cited in statutory and regulatory laws in this state, we cannot find, nor do the parties cite, any statute or regulation where the [West Virginia] State Fire Commission has expressly adopted NFPA 921 as either a compulsory or mandatory standard to be followed in fire investigations in this state.<sup>230</sup>

In sum, "NFPA 921 continues to be described in terms of constituting 'guidelines.'"<sup>231</sup>

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has taken place at all." Rachel Dioso-Villa, *Case Study: Cameron Todd Willingham*, in FORENSIC SCIENCE REFORM: PROTECTING THE INNOCENT, *supra* note 219, at 58, 61.

227. *McCoy v. Whirlpool Corp.*, 214 F.R.D. 646, 653 (D. Kan. 2003) ("The 'gold standard' for fire investigations is codified in NFPA 921, and its testing methodologies are well known in the fire investigation community and familiar to the courts.").

228. *PIRATES OF THE CARIBBEAN: THE CURSE OF THE BLACK PEARL* (Walt Disney Pictures 2003). In the film, there is an exchange between Captain Barbossa, commander of the Black Pearl, and Elizabeth Swan, during which Swan attempts to invoke the "Code of the Order of the Brethren," that is, "the Pirates' Code." *Id.* In response, Captain Barbossa explains that "the code is more what you'd call 'guidelines' than actual rules. Welcome aboard the Black Pearl . . ." *Id.*; *cf.* *Russell v. Whirlpool Corp.*, 702 F.3d 450, 455 (8th Cir. 2012) ("NFPA 921 qualifies as 'a reliable method endorsed by a professional organization,' but we have not held NFPA 921 is the *only* reliable way to investigate a fire. Our NFPA 921 cases stand for the simple proposition an expert who purports to follow NFPA 921 must apply its contents reliably." (citation omitted) (quoting *Fireman's Fund Ins. Co. v. Canon U.S.A., Inc.*, 394 F.3d 1054, 1057–58 (8th Cir. 2005))). The IAAI, which waited until 2013 to tepidly endorse NFPA 921, maintains that NFPA 921 is "widely recognized as an authoritative guide for the fire investigation profession," "an important reference manual [that] sets forth guidance and methodology regarding the determination of the origin and cause of fires." *NFPA 921/1033 Position Statement*, *supra* note 74. The IAAI, however, has never adopted the position that NFPA 921 represents the standard of care in fire investigation. *Id.*

229. *Anstey v. Ballard*, 787 S.E.2d 864, 880 & n.56 (W. Va. 2016).

230. *Id.* at 875–76 (footnotes omitted).

231. *Id.* at 876. The West Virginia Supreme Court of Appeals concluded that the change in arson science did not constitute newly discovered evidence—without conducting any analysis of the scientific evidence. *Id.* at 877–80. The court focused its conclusion on two main points: (1) the NFPA 921 guidelines were not codified in the West Virginia statutes, and (2) the motive evidence "overwhelmingly" proved Mr. Anstey's guilt. *Id.* at 875–80.

Moreover, even courts that do treat NFPA 921 as controlling in fire investigations are abdicating their gatekeeping function under *Daubert*. This is because NFPA 921 continues to permit various flawed investigatory methodologies that have led to notable miscarriages of justice.<sup>232</sup> A fire investigation that limits its analysis to the quadrant of presumed origin is sufficient. NFPA 921 also fails to acknowledge the simple truism that oftentimes fire evidence is simply too damaged to provide an investigator with a reasonable opportunity to conduct a credible analysis of the scene. Finally, while NFPA 921 pays lip service to cognitive bias concerns, it nonetheless condones the practice of fire investigators conducting eyewitness interviews prior to performing any independent examination of the crime scene.

*B. Linear Sequential Unmasking*

Fortunately, various forensic-discipline-related practices and processes have been developed to address some of the error-related problems persistent to those disciplines. For example, bias is mitigated and minimized in other forensic disciplines through a context management tool entitled “Linear Sequential Unmasking” (“LSU”).<sup>233</sup> LSU “not only requires examiners to first examine the trace evidence in isolation from the reference material, but also provides a balanced restriction on the changes that are permitted postexposure to the reference material.”<sup>234</sup> The AAAS recently advocated for the incorporation of LSU in fire-science investigations.<sup>235</sup>

As the AAAS *Quality and Gap Analysis—Fire Investigation* concedes, fire investigators have minimal training in research and statistical methods. As such, the AAAS contends that,

[g]iven what is known about the role of cognitive bias in interpretation and decision making, the work by fire scene investigators should be separated from other components of the fire investigation. Those who gather and prepare evidence should focus on scientific analysis and be as neutral as possible in deciding what evidence to collect and how to interpret it.

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232. See *supra* Section III.C (discussing how faulty fire investigation methods result in wrongful convictions).

233. Dan E. Krane et al., Letter to the Editor, *Sequential Unmasking: A Means of Minimizing Observer Effects in Forensic DNA Interpretation*, 53 J. FORENSIC SCI. 1006, 1006 (2008).

234. Itiel E. Dror et al., Letter to the Editor, *Context Management Toolbox: A Linear Sequential Unmasking (LSU) Approach for Minimizing Cognitive Bias in Forensic Decision Making*, 60 J. FORENSIC SCI. 1111, 1112 (2015).

235. HANGER, *supra* note 10, at 7.

This would help to minimize bias that might affect fire scene investigation.<sup>236</sup>

Ultimately, the AAAS recommends that “[c]ase management interventions should be adopted that shield fire scene investigators from information that is irrelevant and potentially biasing” and that fire “investigators should only consider scientific evidence that is critical to determining a fire’s origin and cause.”<sup>237</sup> LSU would ensure the masking of eyewitness accounts until investigators complete an independent assessment of the fire scene. It would also provide for the redaction of eyewitness accounts to limit their content to relevant, material information.

Fire expert Paul Bieber and the Midwest Innocence Project are currently creating a program to provide LSU for arson cases on postconviction review.<sup>238</sup> This novel forensic audit program intends to permit different parties to perform evaluative functions independently and only then to share information. The program will send pertinent—yet bias-stripped—fire scene information to two independent fire investigators for review. Moreover, the independent auditors reviewing the case will only be provided information as needed subsequent to their initial review. This auditing program promises to identify errors in forensic expert conclusions in fire-science cases.<sup>239</sup> Hopefully, the program’s findings and conclusions motivate fire-investigation teams across the country to consider the adoption of LSU in an attempt to mitigate cognitive bias concerns that infect fire-science investigations and can lead to wrongful convictions.

### C. Error Rates

We further propose that courts demand that fire science develop origin and cause error rates much like courts require of other types of causation evidence, such as epidemiological and toxicological causation evidence in civil toxic tort and products liability litigation.

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236. *Id.* at 9.

237. *Id.*

238. Relativity, *The DFNDER Project to Improve Review of Wrongful Convictions in the United States*, PR NEWSWIRE (Oct. 24 2017), <https://www.prnewswire.com/news-releases/the-dfnder-project-to-improve-review-of-wrongful-convictions-in-the-united-states-300541020.html> [<https://perma.cc/URD5-5SCW>]; see also *Contact Us*, ARSON RESEARCH PROJECT, <http://the arsonproject.org/contact-us/> [<https://perma.cc/K6PA-D6HY>].

239. Kelly Twigger, *The DFNDER Project: Leveraging eDiscovery Technology to Do Good for the World*, ABOVE L. (Nov. 14, 2017, 4:43 PM), <https://abovethelaw.com/2017/11/the-dfnder-project-leveraging-ediscovery-technology-to-do-good-for-the-world/> [<https://perma.cc/64PB-NCVX>].

As has been pointed out repeatedly in this Article, the ability of fire investigators to accurately determine fire origin and cause decreases dramatically as fires become more fully involved over time. For example, “[i]n a 2007 unpublished study conducted by the ATF, only 13 of 53 investigators were able to correctly identify the quadrant of origin in a fire that burned for 180 seconds beyond flashover; this is no better than random chance.”<sup>240</sup> One of the primary reasons why fully involved fire origin error rates are so extravagant is because the fire itself destroys much, if not all, of the viable evidence at the scene that might assist investigators in determining origin and cause.

As the PCAST Report explains, courts are precluded under *Daubert* from admitting forensic evidence testimony, such as fire science, that lacks “any meaningful scientific validation, determination of error rates, or reliability testing to explain the limits of the discipline.”<sup>241</sup> The proposition that forensic evidence ought to be inadmissible where, as is the case with fire science, the field at issue has failed to develop any reliable error rates is uncontroversial in the scientific community. Indeed, “an expert’s expression of *confidence* based on personal professional experience or expressions of *consensus* among practitioners about the accuracy of their field is no substitute for error rates estimated from relevant [and replicable] studies.”<sup>242</sup>

*D. Development of an Objective Standard Regarding the Quality of the Fire-Related Evidence*

In addition to LSU and the development of evidence-based error rates, we recommend that the field of fire science develop a standardized tool that determines whether the evidence at the scene is in a condition such that any reasonable determination of cause and origin can be ascertained. That is to say, there should be an objective measure of whether the quality of fire-science evidence is sufficient to make reliable and valid cause and origin determinations. Fire science could take its lead here from fingerprint examiners, who have developed the ACE-V methodology (analysis, comparison, evaluation, and verification) to determine, as a threshold matter, whether a fingerprint is of adequate quantity or quality of features to be used in a comparison.<sup>243</sup> Where a fingerprint examiner determines

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240. HANGER, *supra* note 10, at 19.

241. PCAST REPORT, *supra* note 39, at 4.

242. *Id.* at 6.

243. See David L. Faigman, *Anecdotal Forensics, Phrenology, and Other Abject Lessons from the History of Science*, 59 HASTINGS L.J. 979, 983 (2007) (“The ACE-V

under ACE-V that a print is inadequate, the examination ends and the print is reported as not suitable.<sup>244</sup> Given the anecdotally high cause and origin error rates that attend to postflashover fires due to near-complete evidence degradation, we advocate that fire investigators develop an objective threshold standard, which demands they stop a fire investigation where the fire-related evidence is inadequate to make reliable and valid cause and origin determinations.

*E. Increased Utilization of Court-Appointed Experts*

Federal Rule of Evidence 706 and comparable state rules of evidence permit judges to appoint an independent expert to assist the court.<sup>245</sup> Unfortunately, federal judges appear reticent to invoke Rule 706 and appoint an independent expert even where the case at hand seems to demand such testimony to reach a just result.<sup>246</sup> According to a recent study, 80% of federal judges have never appointed a Rule 706 expert and only approximately 10% have ever done so more than once.<sup>247</sup> This data is somewhat surprising given that the overwhelming majority of judges reported that they found such experts helpful.<sup>248</sup> Given the courts' low utilization—yet high satisfaction—rates regarding Rule 706 expert witnesses, we advise defense counsel to make it a practice to request that the trial court appoint an independent and qualified fire expert where, as is frequently the case, the state relies exclusively on unqualified law enforcement officers to

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method is the backbone of latent print identification, and the cogency of the entire enterprise pretty much depends on it.”)

244. See Boaz Sangero, *Safety from Flawed Forensic Sciences Evidence*, 34 GA. ST. U. L. REV. 1129, 1172 (2018).

245. See, e.g., FED. R. EVID. 706; CAL. EVID. CODE §§ 730–733; ILL. SUP. CT. R. 215(d). For a list comparing state rules to Federal Rule of Evidence 706, see *Rules of Evidence on Expert Testimony*, NCSTL.ORG, <http://www.ncstl.org/resources/702> [https://perma.cc/3D79-VQNB].

246. CHRISTOPHER B. MUELLER & LAIRD C. KIRKPATRICK, *EVIDENCE UNDER THE RULES: TEXT, CASES, AND PROBLEMS* 645 (8th ed. 2015) (explaining that the appointment power under Rule 706 is “rarely used”); 1 JACK B. WEINSTEIN & MARGARET A. BERGER, *WEINSTEIN’S EVIDENCE* § 13.06[2], LEXIS (database updated Apr. 2018) (asserting that federal judges have appointed experts in remarkably few cases); Carol Krafka et al., *Judge and Attorney Experiences, Practices, and Concerns Regarding Expert Testimony in Federal Civil Trials*, 8 PSYCHOL. PUB. POL’Y & L. 309, 326 tbl.5 (2002) (noting that 16% of judges appoint experts “[e]xclusively in cases with difficult or complicated [science or technology] evidence,” and only 10% of judges appoint an expert “[i]n cases with various types of expert evidence”).

247. JOE S. CECIL & THOMAS E. WILGING, FED. JUDICIAL CTR., *COURT-APPOINTED EXPERTS: DEFINING THE ROLE OF EXPERTS APPOINTED UNDER FEDERAL RULE OF EVIDENCE 706*, at 7–8 (1993).

248. See *id.* at 11–12, 19.

provide “expert” fire-science testimony in arson cases. We further contend that, even when defense counsel fails to make such a motion, courts ought to appoint said experts on their motion to protect the defendant’s right to due process and thereby attempt to avoid a potential wrongful conviction.

#### CONCLUSION

“[F]ire investigation suffers from two major challenges to its reliability: unqualified practitioners and invalid methodology.”<sup>249</sup> *Daubert* demands that judges exclude unqualified fire experts and unreliable findings in both civil and criminal cases. Our Article argues that courts must enforce their gatekeeping function in criminal cases by excluding faulty fire science in order to avoid significant miscarriages of justice. We specifically contend that courts should reject expert testimony based on negative corpus reasoning, as well as fire-expert methodologies that have been thoroughly debunked and discredited by the relevant scientific community. We further advocate that fire investigators determine error rates, develop a standardized evidence quality assessment tool, and adopt LSU to mitigate tunnel vision, role effect, and other cognitive biases, which can instigate unreliable findings and result in significant miscarriages of justice. Finally, we propose that courts appoint their own experts in arson cases where the State relies exclusively on law enforcement testimony or other questionably reliable fire-science evidence.

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249. Lentini, *Confronting Inaccuracy*, *supra* note 219, at 67.