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A MODEL FOR CONFRONTING FIRE INVESTIGATION ERRORS

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I. INTRODUCTION

When faced with the challenge of defending someone accused of arson, counsel has several options but unless there is overwhelming evidence to indicate that this was in fact an arson, the first thing counsel should do is retain an expert.

Arson is one of the few crimes for which it is necessary to first prove that a crime was committed.² Over this author's 45-year career, many false accusations of arson have resulted in

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² JOHN J. LENTINI, SCIENTIFIC PROTOCOLS FOR FIRE INVESTIGATION, THIRD EDITION, CRC Press, vxii (2018).

either civil or criminal litigation. As stated in the 2009 National Academy of Sciences (NAS) report:

The simple reality is that the interpretation of forensic evidence is not always based on scientific studies to determine its validity. This is a serious problem. Although research has been done in some disciplines, there is a notable dearth of peer-reviewed, published studies establishing the scientific bases and validity of many forensic methods.³

This description applies to all of the forensic sciences, including fire investigation. Specifically related to fire investigation, the NAS report goes on:

...much more research is needed on the natural variability of burn patterns and damage characteristics and how they are affected by the presence of various accelerants. Despite the paucity of research, some arson investigators continue to make determinations about whether or not a particular fire was set. However, according to testimony presented to the Committee, many of the rules of thumb that are typically assumed to indicate that an accelerant was used have been shown not to be true. Experiments should be designed to put arson investigations on a more solid scientific footing.⁴

The problem is that fires are destructive, and the aftermath of an accidental fire can often look exactly the same as the aftermath of an intentionally set fire. This confounding fact has led to many false accusations, false convictions, and even a wrongful execution.

³ NATIONAL RESEARCH COUNCIL, COMMITTEE ON IDENTIFYING THE NEEDS OF THE FORENSIC SCIENCE COMMUNITY, STRENGTHENING FORENSIC SCIENCE IN THE UNITED STATES: A PATH FORWARD S-6 (2009), available at <https://www.ncjrs.gov/pdffiles1/nij/grants/228091.pdf>.

⁴ *Id.* at page 5-35.

According to the National Fire Protection Association (NFPA), there were about 387,000 residential structure fires in the United States in 2018.⁵ Of these, approximately 25,500 were declared to be incendiary.⁶ That means that every year, there are 25,000 chances for fire investigators to make a serious error. Even if the error rate is only 5%, that amounts to 1,250 miscalls per year. Given this author's experience, a 5% error rate is wildly optimistic.

So the first question that counsel needs to address is "is this actually an arson fire?"

Following that, additional questions arise.

- Is this arson investigator actually qualified to render opinions?
- Did the investigator employ appropriate methodology in reaching his opinions?
- It is origin determination even a valid forensic science discipline? So far, attempts to demonstrate the validity of origin determination have failed.

II. IS THIS REALLY AN ARSON FIRE?

Michael Faraday explained the behavior of a simple candle flame in his Christmas lectures in 1848 and 1860:

There is no more open door by which you can enter into the study of natural philosophy than by considering the physical phenomena of a candle. There is not a law under which any part of this universe is governed which is not come

⁵ NATIONAL FIRE PROTECTION ASSOCIATION, FIRE LOSS IN THE UNITED STATES IN 2018, at 3, available at <https://www.nfpa.org/-/media/Files/News-and-Research/Fire-statistics-and-reports/US-Fire-Problem/osFireLoss.pdf>.

⁶ *Id.* at 11.

into play, and is not touched upon, in these phenomena.⁷

So, on the one hand, science can explain fire but on the other hand, fire is very complicated. The investigation of fires was historically practiced by firefighters and police, rather than scientists. When the first NFPA guide for fire investigation was published in 1992, the discipline was described as “a complex endeavor involving both art and science.”⁸ By the fourth edition of NFPA 921 in 2001, the sentence was changed to read “a fire or explosion investigation is a complex endeavor involving skill, technology, knowledge, and science.”^{9,10}

As more scientists entered the field and more experiments were conducted, we learned that many of the “indicators” of arson that had been relied on to obtain thousands of convictions were largely invalid.¹¹ If an arson determination is based on “low burning” or a fire that burned “hotter than normal” or “faster than normal,” or was based on the appearance of “pour patterns” on a floor without a positive finding of an ignitable liquid in a laboratory test, it needs to be treated with great skepticism.¹²

If the only evidence of arson is the finding of a medium petroleum distillate on a hardwood floor, such a finding is not

⁷ BILL HAMMACK & DON DE COSTE, MICHAEL FARADAY'S THE CHEMICAL HISTORY OF A CANDLE WITH GUIDES TO LECTURES, TEACHING GUIDES & STUDENT ACTIVITIES 3 (2016), available at <http://engineerguy.com/faraday/pdf/faraday-chemical-history-complete.pdf>.

⁸ NATIONAL FIRE PROTECTION ASSOCIATION 921, GUIDE FOR FIRE AND EXPLOSION INVESTIGATIONS 2-1 (1992, 1995, 1998).

⁹ NATIONAL FIRE PROTECTION ASSOCIATION 921, GUIDE FOR FIRE AND EXPLOSION INVESTIGATIONS 2.1 (2001).

¹⁰ NFPA 921 defines fire science as “The body of knowledge concerning the study of fire and related subjects (such as combustion, flame, products of combustion, heat release, heat transfer, fire and explosion chemistry, fire and explosion dynamics, thermodynamics, kinetics, fluid mechanics, fire safety) and their interaction with people, structures, and the environment.”

¹¹ JOHN J. LENTINI, SCIENTIFIC PROTOCOLS FOR FIRE INVESTIGATION 445 (3d ed. 2018).

¹² *Id.* at 485.

meaningful in the absence of a comparison sample that tested negative.¹³

By the turn-of-the-century, it became generally accepted that NFPA 921's approach to fire investigation using the scientific method was the only valid means of determining whether a fire was, in fact, intentionally set.

It is always incumbent upon counsel to make an effort to determine whether there is an accidental explanation for the fire.

III. IS THE INVESTIGATOR QUALIFIED?

The starting point for this inquiry is the investigator's CV and testimony history. This author has seen a fair amount of "puffery" on CVs. Is the investigator certified? Does he double count his certifications by referring to the Pro-Board accreditation of the IAAI-CFI program? Does he claim "certification" each time he got a certificate for attending a training course? Falsifying credentials is a mark of a weak mind. Exposing such puffery or fraud can go a long way in discrediting an expert.

Federal Rules of Evidence Rule 702 applies to testimony by expert witnesses, and except in the rarest of cases, the fact that fire was intentionally set is going to require an expert witness to opine. Rule 702 states:

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

(a) 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;

(b) the testimony is based on sufficient facts or data;

¹³ Lentini, J., "The Persistence of Floor Coating Solvents," 46(6) J. FORENSIC SCI.1470-1473 (2001), available at https://drive.google.com/drive/folders/1d_V2v8q8fkWAmsxCD3icf6Qi-LYziR47.

(c) the testimony is the product of reliable principles and methods; and

(d) the expert has reliably applied the principles and methods to the facts of the case.¹⁴

The qualifications of the expert are thus the first thing that should be explored both for strategic and tactical reasons. A significant number of fire investigators do not meet the definition of someone who is qualified. There is an industry standard known as NFPA 1033, *Standard for Professional Qualifications for Fire Investigator*. This standard applies to anyone who investigates fires. In the introductory chapter, NFPA 1033 lists sixteen topics that a fire investigator is required to have basic up-to-date knowledge beyond the high school level in order to be qualified. The sixteen topics are:

- (1) Fire science
- (2) Fire chemistry
- (3) Thermodynamics
- (4) Thermometry
- (5) Fire dynamics
- (6) Explosion dynamics
- (7) Computer fire modeling
- (8) Fire investigation
- (9) Fire analysis
- (10) Fire investigation methodology
- (11) Fire investigation technology
- (12) Hazardous materials
- (13) Failure analysis and analytical tools
- (14) Fire protection systems
- (15) Evidence documentation, collection, and preservation
- (16) Electricity and electrical systems¹⁵

These topics have not been very well defined so far, and many of them overlap each other. (Who could argue that “fire

¹⁴ Fed. R. Evid. 702.

¹⁵ NATIONAL FIRE PROTECTION ASSOCIATION 1033, STANDARD FOR PROFESSIONAL QUALIFICATIONS FOR FIRE INVESTIGATOR 6 (2014).

chemistry” and “fire dynamics” are not a subset of “fire science”?) The next edition of NFPA 1033 will likely organize this list to make it more coherent, and the topics themselves will be limited. “Thermodynamics” is a huge field, and certain aspects of thermodynamics are not required to understand fire, so specifying the extent of knowledge required will be a useful thing. It is obvious, however, that there are some aspects of fire dynamics and fire chemistry that a fire investigator would be helpless without.

NFPA 921 defines fire as “a rapid oxidation process, which is a chemical reaction resulting in the evolution of light and heat in varying intensities.”¹⁶ Light and heat are forms of energy, so it makes sense that a fire investigator should be able to describe the basic units of energy. Many do not know that the basic units of energy are joules.

Energy can be given off rapidly or slowly, and the *rate* at which energy is given off is known as *power*.¹⁷ Power is measured in watts or kilowatts or megawatts, but there are many fire investigators who cannot off the top of their heads state that one watt is the amount of power equal to 1 joule per second.¹⁸

Just as important as power is the concept of how much *area* that power is spread out over. 36 kilowatts of power spread evenly throughout a structure by a furnace’s circulation fan will keep it comfortable on a cold winter day.¹⁹ Confining or focusing that energy, say to the furnace closet, will result in dramatically different consequences.²⁰ *Heat flux* is defined as power per unit area.²¹ Heat flux is measured in kilowatts per square meter or watts per square centimeter.²² A fire investigator should know that but many of them do not.

¹⁶ NATIONAL FIRE PROTECTION ASSOCIATION 921, GUIDE FOR FIRE AND EXPLOSION INVESTIGATIONS 3.3.66 (2017).

¹⁷ *Id.* at 3.3.143.

¹⁸ *Id.* at 3.3.203.

¹⁹ LENTINI, SCIENTIFIC PROTOCOLS FOR FIRE INVESTIGATION at 24.

²⁰ *Id.*

²¹ NATIONAL FIRE PROTECTION ASSOCIATION 921, GUIDE FOR FIRE AND EXPLOSION INVESTIGATIONS 3.3.103 (2017).

²² *Id.*

Fire investigators should also have some knowledge of common fuel gases such as natural gas and propane. Many fire investigators have no clue that the chemical formula for methane, the main component of natural gas is CH₄ or that the chemical formula for propane (LP gas) is C₃H₈. Investigators who do not know this simple fire chemistry can likely not discuss why propane is heavier than air and why methane is lighter than air or tell you how much air is required to burn a cubic foot of natural gas or how much energy would be released when that happens.

A *simple quiz* that will allow counsel to determine whether a fire investigator is qualified as specified by NFPA 1033 is shown in Sidebar 1. Sidebar 2 contains excerpts of testimony of supposedly qualified fire investigators who do not know what they are talking about.

Exploring an investigator's qualifications is a simple matter in cases where depositions are allowed. This includes almost all jurisdictions with regard to civil cases, but there are only a handful of states that allow depositions in criminal cases, and they are not allowed in federal criminal cases. In cases where depositions are not allowed, an investigator's qualifications can be explored outside the presence of the jury in an evidentiary hearing. Evidentiary hearings are highly recommended whenever there is a question about the origin and cause of the fire.

The Texas Forensic Science Commission (TX FSC), after a multiyear investigation into the cases of Ernest Ray Willis (who was exonerated) and Cameron Todd Willingham (who was executed) made several recommendations to improve the search for truth in fire cases. Recommendation 10 stated:

The FSC recommends that admissibility hearings (also referred to as *Daubert/Kelly* hearings) be conducted in all arson cases, due to the inherently complex nature of fire science and the continuously involving nature of fire investigation standards. The FSC encourages both prosecutors and defense counsel to aggressively pursue admissibility hearings and arson cases. In addition, judges should affirmatively exercise their discretion to hold such hearings in all arson cases as a measure of

ensuring that fire science testimony is reliable and relevant.²³

Once an investigator fails a simple quiz, it is often not even necessary to move to exclude his testimony. Sponsoring counsel will do that when he or she recognizes what a disaster it would be to prevent such a person as an expert.

Only after a fire investigator's qualifications have been explored is it appropriate to explore the methodology used to reach the proposed opinion. Investigators who have demonstrated a lack of qualifications are likely to be somewhat rattled and unsure of themselves, which is why the qualifications challenge should come first. Whether they are qualified or not, fire experts are probably confident. If this confidence can be shaken, the expert will be less convincing to the court and the jury.

IV. DID THE EXPERT USE APPROPRIATE METHODOLOGY?

NFPA 921 has been generally accepted as the appropriate methodology for conducting fire investigations since 2000. It was that year that the International Association of Arson Investigators (IAAI) formally urged the adoption of the new edition of NFPA 921 by the NFPA,²⁴ and it was also in that year that the Justice Department published *Fire and Arson Scene Evidence, A Guide for Public Safety Personnel*. This DOJ guide advises that in any large loss or any loss that is believed to be incendiary,

...the investigator should recognize limitations of his or her own expertise and knowledge and

²³ REPORT OF THE TEXAS FORENSIC SCIENCE COMMISSION, WILLIS/WILLINGHAM INVESTIGATION 48-49 (2011), available at <http://fsc.state.tx.us/documents/FINALWILLINGHAMREPORT0418113.44pm.pdf>.

²⁴ John Lentini, *Fire Investigation: Historical Perspective and Recent Developments*, 31(1) FORENSIC SCI. REV. 37-44 (Jan. 2019), available at <https://storage.googleapis.com/production-constantcontact-v1-0-7/507/175507/IaE9rCjE/528a5fb5af6447abaa3103d135e11505?fileName=2019%20Fire%20Investigation-%20Historical%20Perspective%20and%20Recent%20Developments.pdf>.

determine what personnel may be required to process the scene according to NFPA 921 and other recognize guidelines. Except in the most obvious cases, the determination of a fire's origin may be a complex and difficult undertaking requires specialized training and experience as well as knowledge of generally accepted scientific methods of fire investigators investigation.²⁵

So, counsel should always ask the expert if they followed NFPA 921. The answer will almost always be yes, even if that is not the case.

One of the most common ways that investigators violate the guidance of NFPA 921 is in the use of *negative corpus* methodology. Such thinking usually results in a determination that the fire was intentionally set, although as two of the cases below demonstrate, negative corpus methodology can also be used to reach a conclusion that a fire was accidental. The thinking goes like this: "I can't find any accidental ignition sources that could cause this fire, therefore, it must have been intentionally set with an open flame and the perpetrator took the flame away." In the case of an accidental cause hypothesis the investigator simply states, "Everything else was ruled out," even when there is no affirmative evidence to support the hypothesis.

Negative corpus methodology is a result of expectation bias. NFPA 921 says the following about negative corpus thinking:

This process 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.²⁶

²⁵ TECHNICAL WORKING GROUP ON FIRE AND ARSON SCENE INVESTIGATION, U.S. DEPT. OF JUSTICE, FIRE AND ARSON SCENE EVIDENCE: A GUIDE FOR PUBLIC SAFETY PERSONNEL (2000), available at <https://www.ncjrs.gov/pdffiles1/nij/181584.pdf>.

²⁶ NATIONAL FIRE PROTECTION ASSOCIATION 921, GUIDE FOR FIRE AND EXPLOSION INVESTIGATIONS 19.6.5 (2017).

In addition to negative corpus methodology, other missteps include reliance on unconfirmed canine alerts (See the Carr case, *infra*) and believing that fire patterns in a fully involved room can be attributed to ignitable liquids on the basis of visual appearance alone.²⁷ An erroneous cause determination usually involves believing in more than one discredited “indicator.”

Counsel should explore the investigator’s history to bring out evidence of bias. How many fires has this expert investigated? Were all of those conducted for law enforcement? Or were all of those conducted for insurance companies? Has the expert ever investigated a fire on behalf of a criminal defendant or a plaintiff in a first party arson case? Of the fires they have investigated, how many has the expert determined to have been intentionally set?

One way to probe an investigator’s biases is asking him what opinions he has and *when* were those opinions formed? While it is impossible to “un-see” a “For Sale” sign in the front yard, investigators should not be considering motive until *after* determining that the fire was intentionally set. Table 1 shows two lists of factors, one relevant and the other potentially irrelevant. If the task is simply to determine the origin and cause of the fire, considering irrelevant data prior to determining the cause will frequently result in erroneous findings. Investigators should take steps to shield themselves from biasing information like that in the “potentially irrelevant” column until it is time to develop a suspect. Suspect development should only take place if it is determined that a crime has been committed.²⁸

There have been literally thousands of *Daubert* challenges to fire investigators, more so in civil cases than in criminal cases, but filing a *Daubert* challenge in a civil case is almost considered due diligence and every fire investigator, no matter how qualified, is likely to see such a challenge if he goes to court often enough. Because of the deferential standard for review of a trial court’s admissibility decisions (abuse of discretion), the record of appellate rulings is far smaller than the record of trial court rulings. There is a website, Dauberttracker.com that includes both trial court and appellate

²⁷ *Id.* at 6.3.7.8.

²⁸ *Id.* at 24.4.1.

court rulings in *Daubert* challenges. This article will focus on four seminal appellate court cases that have impacted the admissibility of fire investigation testimony.

TABLE 1

Relevant Data Sources	Potentially Irrelevant Data Sources
Firefighters' observations relevant to the fire, scene security, and suppression activities	Financial records
Witness observations and photos/videos relevant to the fire and building contents	History of fires
Occupancy	Criminal record
History of defects	Claim file
Weather data	Marital strife
Pre-fire activities on the scene	Social media commentary
Ignitable liquid location	Gossip
Physical condition of the fire scene	Motive issues
Utilities	Financial strife
Victim injuries	House for sale - real estate activity
Security, detection, and alarm systems	Indications of deception or emotional state of the victim
Overpressure damage	Personal records

V. STATE OF GEORGIA V. WELDON WAYNE CARR²⁹

This case arose out of an April 7, 1993 fire in Atlanta Georgia at the home of Weldon and Patricia Carr.³⁰ Mr. Carr was a well-off owner of a nursery with a nationwide clientele called Hastings Nursery.³¹ He and his wife were sleeping in the same bed when they were awakened by smoke.³² They attempted to find a chain ladder that had been stored under the bed but were unable to do so.³³ Mr. Carr and his wife attempted to escape but were pushed back by smoke coming up the stairway, so he opened a window to jump out, but he became separated from Mrs. Carr.³⁴ He jumped out the window and cracked a vertebra when he landed. He ran across the street and broke a neighbor's door and got them to call 9-1-1.³⁵

Firefighters were able to enter the house and find Mrs. Carr, but she was unconscious.³⁶ She died three days later at the hospital.³⁷ An anonymous phone call to the fire department advised that they should "investigate very carefully."³⁸ When the fire department's arson investigator came to the scene, he

²⁹ Carr v. Georgia, 482 S.E.2d 314, 314 (Ga. 1997).

³⁰ *Id.* at 323 n.1.

³¹ Kieth Dunnivant, "The Prosecution Never Rests: The Making of Nancy Grace," ATLANTA MAGAZINE (November 1, 1996), <https://www.atlantamagazine.com/great-reads/the-prosecution-never-rests-the-making-of-nancy-grace/>.

³² Carr, 482 S.E.2d at 316.

³³ Maurice Possley, "Weldon Wayne Carr," NATIONAL REGISTRY OF EXONERATIONS, <https://www.law.umich.edu/special/exoneration/Pages/casedetail.aspx?caseid=3936>.

³⁴ *Id.*

³⁵ *Id.*

³⁶ LENTINI, SCIENTIFIC PROTOCOLS FOR FIRE INVESTIGATION at 494-508.

³⁷ *Id.*

³⁸ *Id.*

saw what he described as “pour patterns.”³⁹ He also saw what he thought was a “trailer”⁴⁰ made of newspaper.

To make things much worse, Mrs. Carr was having an affair with a neighbor and Mr. Carr had found out about it a few months earlier. He had purchased recording equipment and tapped his own telephone.⁴¹

An ignitable liquid detection dog (formerly called an accelerant detection canine) was brought to the scene and alerted 12 times, resulting in the collection of 12 samples and their submission to the Georgia Division of Forensic Science.⁴² All 12 samples tested negative.⁴³ The prosecutor, Nancy Grace, working on her last case prior to joining Court TV as a talking head, personally went to the crime laboratory and took possession of the 12 samples and submitted them to a private laboratory in Atlanta.⁴⁴ The private laboratory had the same results, i.e., all 12 samples tested negative.⁴⁵

When the case was tried, the unconfirmed canine alerts were admitted into evidence over the defendant’s objections.⁴⁶ That became the major basis for Carr’s appeal, although the Georgia Supreme Court found numerous other reversible errors in the trial, including the conduct of an illegal search of the Carr residence months after the fire, improper exclusion of a defense witness (me) and prosecutorial misconduct during the case during the trial.⁴⁷

Some of the indicators used by the State to prove that this was a set fire were spurious, but it was not possible to test them during the pendency of the case because the trial court had ruled (again erroneously) that Carr was required to turn

³⁹ *Id.*

⁴⁰ NFPA 921 defines a trailer as “solid or liquid fuel used to intentionally spread or accelerate the spread of a fire from one area to another.”

⁴¹ LENTINI, SCIENTIFIC PROTOCOLS FOR FIRE INVESTIGATION at 494-508.

⁴² *Id.*

⁴³ *Id.*

⁴⁴ *Id.*

⁴⁵ *Id.*

⁴⁶ *Carr*, 482 S.E.2d at 316.

⁴⁷ *Id.* at 316-323.

over any test results, whether they helped him or not, to the State.⁴⁸ Consequently, defense counsel declined to have much testing performed prior to the trial.⁴⁹

After the jury convicted Mr. Carr, testing began in earnest.⁵⁰ The testing demonstrated that none the indicators used by the State were valid.⁵¹ Had this testing been run prior to the trial, a different outcome might have ensued.

The *Carr* case was significant in that it was the first to cite NFPA 921's guidance on unconfirmed canine alerts. That guidance was adopted as a result of the misuse of the unconfirmed alerts in Carr's case. First, the IAAI's Forensic Science Committee issued a position paper stating that unconfirmed canine alerts were not reliable evidence.⁵² Then, in 1996, the NFPA Technical Committee on Fire Investigations adopted the IAAI position and published it as a Tentative Interim Amendment, an emergency declaration.⁵³ Also, five fire debris analysts from the Georgia Bureau of Investigation Division of Forensic Sciences signed an affidavit stating that the admission of the unconfirmed alerts was unreliable.⁵⁴

The Georgia Supreme Court granted Mr. Carr a new trial, but none of the Fulton County prosecutors assigned to the case wanted to try it. They were aware that many holes had been poked in the State's case, and after several years, the actual cause of the fire was determined to be a malfunctioning light switch.⁵⁵ Some four years after the conviction, the indictment

⁴⁸ *Id.* at 318.

⁴⁹ *Id.*

⁵⁰ LENTINI, SCIENTIFIC PROTOCOLS FOR FIRE INVESTIGATION at 494-508.

⁵¹ *Id.*

⁵² IAAI Forensic Science Committee, "Position Paper on Accelerant Detection Canines," FIRE AND ARSON INVESTIGATOR, no. 1 22-23 (1994), available at <https://app.box.com/s/xhxtymcd2rc10zl7eg2gh0slzd98cqls>.

⁵³ Symposium, *NFPA 921: Past, Present and Future*, INT'L SYMP. ON FIRE INVESTIGATION (2006).

⁵⁴ LENTINI, SCIENTIFIC PROTOCOLS FOR FIRE INVESTIGATION at 494-508.

⁵⁵ *Id.*

was dismissed because of the State's failure to provide a speedy trial.⁵⁶

VI. MICHIGAN MILLERS MUTUAL INSURANCE COMPANY V. JANELLE BENFIELD⁵⁷

This was the first *Daubert* challenge of a fire investigator's opinion in an arson case.

The fire occurred on July 6, 1992, at Mrs. Benfield's residence in Sarasota, Florida.⁵⁸ Mrs. Benfield discovered the fire when she returned home from a friend's house.⁵⁹ There were four bags of clothing on the dining room table and that was the only thing that burned.⁶⁰ She was staying at her friend's because her husband had beaten her up two days earlier.⁶¹

Michigan Millers filed a declaratory action to void the insurance policy, and the case went to trial in Federal District Court.⁶² A fire investigator hired by Millers with 30 years' experience determined the fire to be arson, but he was unable to articulate the scientific method, and could not explain how the chandelier over the dining room table where the fire started could be eliminated as the ignition source.⁶³ He did not even have a photograph of the chandelier.⁶⁴ There was an empty bottle of lamp oil in the dining room, which he never had tested.⁶⁵ Mrs. Benfield's lawyers made it clear that they were going to challenge the investigator's reliability, but Miller's counsel decided against holding a *Daubert* hearing, and stated that he would just put his investigator on and let the judge

⁵⁶ *Carr*, 278 Ga. at 128.

⁵⁷ *Michigan Millers Mut. Ins. Co. v. Benfield*, 140 F.3d 915, 915 (11th Cir. 1998).

⁵⁸ *Id.* at 917-918.

⁵⁹ *Id.* at 918.

⁶⁰ *Id.*

⁶¹ *Id.*

⁶² *Id.* at 919.

⁶³ *Id.* at 921.

⁶⁴ *Id.*

⁶⁵ *Id.*

decide whether the testimony was reliable.⁶⁶ At the end of the investigator's testimony, the judge turned to the jury and instructed them to disregard everything they had just heard.⁶⁷ Further, he entered a directed verdict in favor of Mrs. Benfield.⁶⁸

This case was appealed to the 11th Circuit which ruled that the judge did not abuse his discretion by eliminating the testimony, but he did abuse his discretion by entering the directed verdict because there was a firefighter who did not claim to be a fire scientist, who stated that based on his experience, it was his opinion that the fire was intentionally set.⁶⁹

The 11th Circuit ruling had the curious effect of insurance defense attorneys encouraging fire investigators not to use the word "science" in their reports or testimony.⁷⁰ Apparently, the 11th Circuit misread the *Daubert* decision and ruled that if one claimed to be a fire scientist, one was subject to a *Daubert* reliability challenge, but if one claimed only to be a fire investigator, a *Daubert* challenge was not appropriate.⁷¹

This decision was overturned by the Supreme Court's decision in the *Kumho* case, which also originated in the 11th Circuit. In *Kumho*, the Court held that it was not the judge's job to try to figure out whether an expert's testimony was "scientific," "technical," or "other."⁷² It is only the judge's job to determine if the testimony is relevant and reliable.⁷³ The *Benfield* case resulted in the production of an *amicus* brief by the IAAI in 1997 which argued that because fire investigation was a "less scientific" discipline, fire investigators should not be subjected to reliability challenges.⁷⁴ The *Kumho* court

⁶⁶ *Id.*

⁶⁷ *Id.*

⁶⁸ *Id.*

⁶⁹ *Id.* at 921-22.

⁷⁰ *Id.* at 920-21.

⁷¹ *Id.*

⁷² *Kumho Tire Co. v. Carmichael*, 526 U.S. 137, 148-49 (1999).

⁷³ *Id.* at 148-49.

⁷⁴ Brief for the International Association of Fire Investigators et al. as Amici Curiae Supporting Appellants, Michigan Millers Mutual

unanimously rejected that argument.⁷⁵ When this author read the IAAI's *amicus* brief, he found it necessary to file his own, which was submitted to the 11th Circuit but strongly objected to by Michigan Millers.⁷⁶ The case eventually settled, but not before thoroughly shaking up the world of fire investigation.

VII. WEISGRAM V. MARLEY⁷⁷

This case arose out of a December 30, 1993 fire in Fargo, North Dakota.⁷⁸ The fire was discovered around 6 AM and was fatal to Bonnie Weisgram.⁷⁹ The main fuel involved in the fire was an L-shaped sofa in the living room, but a sofa cushion was found in the entryway, where there was additional fire damage.⁸⁰ A disabled smoke alarm was found on the floor with a protection pattern under it, indicating it had been taken down prior to deposition of smoke on the carpet.⁸¹

Three experts were involved in bringing this case against Marley, the manufacturer of an electric baseboard heater.⁸² Despite numerous problems with the case, the jury awarded \$500,000 to Bonnie's son Chad, and \$100,000 to State Farm Fire and Casualty Company for its subrogated loss.⁸³ Marley appealed.⁸⁴

Marley's expert opined that at some time that night, Bonnie Weisgram dropped a lighted cigarette behind a cushion

Insurance Company v. Janelle R. Benfield, 140 F.3d 915 (11th Cir. 1998).

⁷⁵ *Kumho*, 526 U.S. at 151.

⁷⁶ Brief for John J. Lentini, CFI, F-ABC as Amicus Curiae Supporting Appellee, Michigan Millers Mut. Ins. Co. v. Benfield, 140 F.3d 915 (11th Cir. 1998) (No. 97-2138), 1997 U.S. 11th Cir. Briefs LEXIS 6.

⁷⁷ *Weisgram v. Marley Co.*, 169 F.3d 514, 520-21 (8th Cir. 1999).

⁷⁸ *Id.*

⁷⁹ *Id.*

⁸⁰ *Id.* at 516-18.

⁸¹ *Id.* at 516.

⁸² *Id.*

⁸³ *Id.*

⁸⁴ *Id.*

of the sofa, which eventually started a smoldering fire.⁸⁵ The smoke detector activated, and Weisgram disabled it.⁸⁶ Believing she had doused the fire in the couch, she removed the sofa cushion to the entryway.⁸⁷ At some point, she opened the bedroom window and the front door to clear the house of smoke.⁸⁸ The cushion and the sofa continued to smolder, producing the smoke and the carbon monoxide that eventually killed Weisgram.⁸⁹ Under the influence of the alcohol and a sleeping aid, she was unaware that the fire continued to burn until it was too late.⁹⁰ The smoldering cushion in the entryway slowly burned through the floor and eventually caused the flaming fire around the entrance that was spotted at 6:00 a.m.⁹¹

The baseboard heater had been operating without incident for 15 years, and there were other potential ignition sources in the room of origin that were not examined.⁹² Mrs. Weisgram was a smoker with a blood alcohol concentration of 0.15.⁹³ A fire captain, Freeman, was allowed to opine where the fire started and also that the heater was the cause of the fire.⁹⁴ The Eighth Circuit ruled that the judge had not abused his discretion by allowing Freeman to opine as to origin, but he had abused his discretion when he allowed him to give testimony about the cause of the fire.⁹⁵ The sofa that the Captain said was the first fuel ignited was 6 to 8 feet away from the heater.⁹⁶ The Captain admitted he was not an electrical expert and had no

⁸⁵ *Id.* at 526 n.4.

⁸⁶ *Id.*

⁸⁷ *Id.*

⁸⁸ *Id.*

⁸⁹ *Id.*

⁹⁰ *Id.*

⁹¹ *Id.*

⁹² *Id.* at 520.

⁹³ *Id.* at 516.

⁹⁴ *Id.* at 518-19.

⁹⁵ *Id.*

⁹⁶ *Id.* at 518.

idea what caused the malfunction.⁹⁷ The Eighth Circuit held, “Freeman’s qualification as a fire investigator did not give him free rein to speculate before the jury as to the cause of the fire by relying on inferences that have absolutely no record support.”⁹⁸

The second expert was an electrician from Ohio by the name of Ralph Dolence who claimed on more than one occasion to have conducted 15,000 fire investigations in 22 years⁹⁹ (do the math). He testified as a “fire investigator and a technical forensic expert.”¹⁰⁰ His basis for pointing at the baseboard heater was, “There is no other explanation. Everything else is ruled out by Captain Freeman,” a *negative corpus* determination.¹⁰¹ Dolence had never visited the scene but was allowed to opine that after 15 years of operating without incident both the thermostat and the high limit control failed simultaneously and did not function to shut the heater off.¹⁰² He could not identify what caused the heater to run away and he had no idea what caused the thermostat to fail.¹⁰³ He agreed with the proposition that there were no design defects in the heater in part because he could not create a similar overheating episode in the undamaged exemplar heater that had been retrieved after the fire from the apartment adjoining the townhouse where Mrs. Weisgram died.¹⁰⁴ The Eighth Circuit held that the District Court abused its discretion by permitting Dolence to testify as an expert witness regarding matters about which he could only speculate.¹⁰⁵ They stated, “As with

⁹⁷ *Id.*

⁹⁸ *Id.* at 519.

⁹⁹ P. Trexler, *Prosecution Expert Rejects Short as Cause*, ABJ (February 8, 2002).

¹⁰⁰ *Marley*, 169 F.3d at 519.

¹⁰¹ *Id.*

¹⁰² *Id.* at 519-20.

¹⁰³ *Id.* at 520.

¹⁰⁴ *Id.*

¹⁰⁵ *Id.*

Freeman's testimony there is no reasonable factual basis for Dolence's opinion."¹⁰⁶

A third expert was a metallurgist consulted by Dolence.¹⁰⁷ He was qualified as an expert in the properties of metals, but he was not an expert in fire origin and cause, in baseboard heater operation or in the designing of contacts for baseboard heaters.¹⁰⁸ Even so, he was allowed to opine that the heater contacts were defectively designed because they were serrated.¹⁰⁹ The Circuit Court stated that the District Court abused its discretion when it permitted testimony from the metallurgist.¹¹⁰

Weisgram appealed to the US Supreme Court which granted Certiorari to decide if the Eighth Circuit should have granted the plaintiffs a new trial with new experts.¹¹¹ The Eighth Circuit had entered a judgment for Marley as a matter of law, and the Supreme Court had to decide if that was appropriate.¹¹² They stated that it was and that to rule otherwise would have given plaintiffs a second bite at the apple.¹¹³

VIII. TRUCK INSURANCE EXCHANGE V. MAGNETEK¹¹⁴

This was a product liability subrogation case.¹¹⁵ A fire on November 9, 1998, in Lakewood, Colorado, destroyed Sammy's restaurant.¹¹⁶ Upon their arrival, the fire department found only smoke, no fire, until the fire caused the kitchen floor

¹⁰⁶ *Id.*

¹⁰⁷ *Id.*

¹⁰⁸ *Id.*

¹⁰⁹ *Id.*

¹¹⁰ *Id.* at 521.

¹¹¹ *Weisgram*, 528 U.S. at 443.

¹¹² *Id.*

¹¹³ *Id.* at 457.

¹¹⁴ *Truck Ins. Exch. v. Magnetek, Inc.*, 360 F.3d 1206, 1207 (10th Cir. 2004).

¹¹⁵ *Id.*

¹¹⁶ *Id.*

to collapse, indicating a fire in the basement.¹¹⁷ There was a florescent light in the basement and, according to the experts, no other potential ignition sources.¹¹⁸ Thus, the light was the cause.¹¹⁹ (Another *negative corpus* determination.) The ballast in the light, manufactured by MagneTek still contained a thermal cut off (TCO), which still functioned after the fire.¹²⁰ It opened at 232° F.¹²¹ A similar ballast when shorted, i.e., the TCO was bypassed, reached a stable temperature of 300° F.¹²² The ignition temperature of wood is well in excess of 400° F.¹²³

There is a never-proven hypothesis that upon continued exposure to a heat source below its ignition temperature, the ignition temperature of wood is lowered to a point where a heat source of only 200° F might ignite it

MagneTek moved for summary judgment and the exclusion of the plaintiff's electrical engineer.¹²⁴ The trial court granted the motion and Truck appealed to the Tenth Circuit, which upheld the exclusion.¹²⁵

In its ruling, the Tenth Circuit adopted some unfortunate terminology, which points out the problems with having judges act as scientists. They stated:

There appears to be some confusion among the parties, the District Court, and apparently even the scientific community as to the proper terminology for the theory of long-term low temperature wood ignition and the charring it involves. This court is not in a position to decide such questions for the scientific community but for the purposes of this opinion we will refer to this process as "pyrolysis." To the extent we use

¹¹⁷ *Id.* at 1208.

¹¹⁸ *Id.*

¹¹⁹ *Id.*

¹²⁰ *Id.*

¹²¹ *Id.*

¹²² *Id.* at 1209.

¹²³ *Id.* at 1208-09.

¹²⁴ *Id.* at 1209.

¹²⁵ *Id.*

the term “pyrophoric carbon,” we are talking about the substance charred wood.¹²⁶

They held that the District Court did not abuse its discretion when it ruled that under the *Daubert* trilogy, pyrolysis was not yet a sufficiently reliable theory upon which to base an expert opinion about the cause of the Sammy’s fire.¹²⁷

The only problem with this ruling is that the “shorthand” caused much consternation in the fire investigation community. Pyrolysis *always* happens when wood burns.¹²⁸ It has to.¹²⁹ Judges cannot change the laws of chemistry.

Despite the confusion about pyrolysis and pyrophoric carbon, the MagneTek case has been repeatedly cited to counter the hypothesis that long-term low temperature heating can cause ignition.

IX. IS ORIGIN DETERMINATION EVEN A VALID DISCIPLINE?

Origin determination is a fire investigator’s “core competency.” If one cannot determine where the fire started, it is unlikely one will be able to determine why, yet repeated experiments designed to assess fire investigators’ ability to correctly determine the origin have so far not yielded any validation of this skill. The point of origin is defined as the exact physical location within the area of origin where a heat source and the fuel interact resulting in a fire or explosion.¹³⁰ So how good are fire investigators at actually determining where a fire started?

For many years, the Bureau of Alcohol Tobacco Firearms and Explosives (ATF) conducted an exercise at the beginning of its advanced origin and cause school, which it

¹²⁶ *Id.* at 1216 n.2.

¹²⁷ *Id.* at 1216.

¹²⁸ LENTINI, SCIENTIFIC PROTOCOLS FOR FIRE INVESTIGATION at 46.

¹²⁹ *Id.*

¹³⁰ NATIONAL FIRE PROTECTION ASSOCIATION 921, GUIDE FOR FIRE AND EXPLOSION INVESTIGATIONS 3.3.142 (2017).

presented at the Federal Law Enforcement Training center in Brunswick, Georgia.¹³¹

Fire investigators from around the country who had been flown into Brunswick at government expense were presented with a fire scene of known origin.¹³² They were asked on the first day of the course to write down where they thought the fire started and submit their results anonymously.¹³³ Over the years, fire investigators got no more than 8 to 10% of the answers correct.¹³⁴

In 2005, three ATF certified fire investigators decided to take this exercise to the general fire investigation community. They ran their experiment at a fire investigation seminar in Las Vegas.¹³⁵ They set up two rooms like bedrooms and ignited the fire. They let it burn for two minutes beyond flashover.¹³⁶ Then they invited the attendees to choose the *quadrant* where the fire originated.¹³⁷ Relying on nothing but the interpretation of fire patterns, more than 90% of the participants chose the wrong quadrant.¹³⁸ The experiment was repeated in the second room

¹³¹ Symposium, *Improving the Understanding of Post-Flashover Fire Behavior*, PROCEEDINGS OF THE 3RD INT'L SYMP. ON FIRE INVESTIGATIONS SCI. AND TECH. (2008), available at [http://carmanfireinvestigations.com/dl/\(Carman&Associates\)%20-%20Improving%20the%20Understanding%20of%20Post%20Flashover%20Fire%20Behavior.pdf](http://carmanfireinvestigations.com/dl/(Carman&Associates)%20-%20Improving%20the%20Understanding%20of%20Post%20Flashover%20Fire%20Behavior.pdf).

¹³² *Id.*

¹³³ *Id.*

¹³⁴ *Id.*

¹³⁵ John Lentini, "Confronting Inaccuracy in Fire Cause Determinations," Chapter 3 in FORENSIC SCIENCE REFORM 84 (Wendy Koen & C. Michael Bowers eds. 2017).

¹³⁶ NFPA 921 defines flashover as "A transition phase in the development of a compartment fire in which surfaces exposed to thermal radiation reach ignition temperature more or less simultaneously and fire spreads rapidly throughout the space, resulting in full room involvement or total involvement of the compartment or enclosed space."

¹³⁷ Lentini, FORENSIC SCIENCE REFORM at 81.

¹³⁸ *Id.*

and the same results were obtained.¹³⁹ In each case, only three of 53 investigators correctly identify the quadrant of origin.¹⁴⁰

Agent Steve Carman, one of the architects of the experiment, began teaching the fire investigators who would listen that perhaps they were not doing it right.¹⁴¹ He concluded that the old days of finding the origin by using the lowest and deepest char are over, but there was quite a bit of pushback.¹⁴²

In 2007, the ATF conducted a similar exercise in Oklahoma City.¹⁴³ In this case, they set three fires.¹⁴⁴ One fire burned for 30 seconds beyond flashover.¹⁴⁵ The second fire burned for 70 seconds beyond flashover, and the third fire burned for three minutes beyond flashover.¹⁴⁶ Again, participants at a fire investigation seminar were asked to select the quadrant of origin.¹⁴⁷ There were 70 attendees.¹⁴⁸ For the 30-second fire, all 70 ventured a guess as to the quadrant of origin, and 84% got it right.¹⁴⁹ For the fire that burned for 70 seconds beyond flashover, six investigators called the origin undetermined.¹⁵⁰ Of the 64 who ventured a guess, 69% got it

¹³⁹ *Id.* at 82.

¹⁴⁰ *Id.*

¹⁴¹ *Id.* at 84.

¹⁴² Trevor Maynard, Daniel Heenan, & Michael Marquardt, Member Feedback: "Interpretation of the Publications Improving the Understanding of Post-Flashover Fire Behavior and Progressive Burn Pattern Development in Post-Flashover Fires By Steven Carman," F&AI 14 (January 2019).

¹⁴³ Heenan, D. "History of the Post-Flashover Ventilation Study," Presentation to the California Conference of Arson Investigators, November 2010, available at <https://app.box.com/s/bqo78dcs2mf93k9mqaicec1qoku8ldih>.

¹⁴⁴ *Id.*

¹⁴⁵ *Id.*

¹⁴⁶ *Id.*

¹⁴⁷ *Id.*

¹⁴⁸ *Id.*

¹⁴⁹ *Id.*

¹⁵⁰ *Id.*

right.¹⁵¹ For the fire that burned for three minutes beyond flashover (and most fire investigators rarely see fires that burned for that brief a period of time) only 25% correctly identified the quadrant of origin.¹⁵² 25% is no better than random chance.

In 2012, Tinsley and Gorbett published “Fire Investigation Origin Determination Survey.”¹⁵³ In that study, 587 self-selected fire investigators working independently, viewed photos and data from a fire that burned for only one minute after flashover.¹⁵⁴ The error rate was 22 to 26%.¹⁵⁵

As of 2020, *there has not been a single experiment conducted* where fire investigators were able to demonstrate their ability to determine the origin correctly if the fire burned more than three minutes.

The length of burning should always be a question that an expert proposing to opine about the origin is asked, and if he is picking an origin out of a fully involved compartment that burn more than three minutes, counsel should challenge the validity of that finding.

X. EXPERT ASSISTANCE IS ESSENTIAL

Unless they specialize in fire cases, most attorneys will only encounter one or two fire investigations in a career. Thus, it is necessary to engage an expert in almost all cases.

Recent court cases have established that proceeding without an expert is *per se* ineffective, and so getting funding from the court is not the difficult problem that that it once was. Two cases to cite if the court is reluctant to fund an expert are:

¹⁵¹ *Id.*

¹⁵² *Id.*

¹⁵³ Andrew T. Tinsley & Gregory E. Gorbett, *Fire Investigation Origin Determination Survey*, FIFTH INT’L SYMP. ON FIRE INVESTIGATION (2012), available at <https://forensicfireinstitute.com/wp-content/uploads/2018/07/fire-investigation-origin-determination-survey-.pdf>.

¹⁵⁴ *Id.*

¹⁵⁵ *Id.*

(1) *Dugas v. Coplan* from the First Circuit and (2) *Richey v. Bradshaw* from the Sixth Circuit.

In the *Dugas* case, the Appeals Court found that counsel had been ineffective even though he toured the scene with his client, did some reading, and took the depositions of the State's experts.¹⁵⁶ They found that it fell below the constitutional requirement for effective assistance because counsel failed to consult with an expert, even though he planned to challenge the State's experts regarding their determination that the fire was intentionally set and not accidental.¹⁵⁷

The *Richey* case is even more instructive. Richey's attorney hired an expert, but one who was determined by the Sixth Circuit to be incompetent.¹⁵⁸ They held that effective assistance required hiring not just any expert but a competent expert.¹⁵⁹

In the past, this author was often asked to provide services *pro bono* because counsel could not afford to hire an expert. That has not generally been the case since 2010. In fact, even in cases where the arson is obvious, this author gets retained to review them because counsel feels that having the scientific case looked at by an expert is a matter of due diligence. Even in the obvious cases, questioning of the expert's qualifications has resulted in benefits to the accused. Qualifications challenges have also resulted in substantial reductions in the settlement value of civil cases.¹⁶⁰

XI. CONCLUSIONS

Fire litigators need to know that fire investigation, as a profession, has changed dramatically over the past three decades and it continues to advance today. Challenges to

¹⁵⁶ *Dugas v. Coplan*, 428 F.3d 317, 332 (1st Cir. 2005).

¹⁵⁷ *Id.* at 331.

¹⁵⁸ *Richey v. Bradshaw*, 498 F.3d 344, 356-57 (6th Cir. 2007).

¹⁵⁹ *Id.*

¹⁶⁰ John. W. Reis, *Suppressing the Burn: Why the NFPA's Revised 1033 is the Next Big Thing in Fire Claims Investigations*, CLAIMS MANAGEMENT (Oct. 29, 2015), available at

<https://clmmag.theclm.org/home/article/Suppressing%20the%20Burn>.

experts are becoming more common and generally expected. Counsel should question the qualifications of experts because the fire investigation profession contains a substantial cadre of unqualified investigators. Despite the confidence of many experts, fire investigation is very difficult, and the error rate is unknown, but potentially very high. Many of the people practicing fire investigation do not meet the qualifications for fire investigator set forth in NFPA 1033, and even those who get past a test of their knowledge are likely to have engaged in questionable methodology. If you do not vet your expert, adverse counsel surely will.

Methodology should follow NFPA 921 and if it does not, investigators need to be able to explain why not.

The core competency of fire investigators, origin determination, has not been demonstrated to be valid, even though courts are unlikely to exclude it on that basis.

Because of recent court decisions, getting funding for your expert is not as difficult as it once was. The judge should understand that refusing to supply funding is the same thing as causing you to render ineffective assistance.

SIDEBAR 1. A QUALIFICATIONS CHALLENGE

Because NFPA 1033 lists sixteen areas that a fire investigator is required to be knowledgeable about, challenging an expert's qualifications to testify is a straightforward exercise. Begin with one hard series of questions, and if the expert is capable of answering correctly, that might be the end of it, especially if you have to do this in front of the jury. If, on the other hand, the expert cannot speak intelligibly about heat flux, it is time to circle around and go back to the basics.

You are not asking these questions because you want to know. You are asking because you want to see what the expert knows. "I can look that up for you" is a common but unacceptable answer. The witness should not be allowed to do this "open book" style. You want to find out what he knows *off the top of his head*.

Here are the hard questions:

Q. What is heat flux?

A. Heat flux is a measure of the rate of heat transfer to a surface.

Q. What units are used to measure heat flux?

A. Heat flux is measured in kilowatts per square meter or watts per square centimeter.

Here are the basic questions:

Q. Are you familiar with NFPA 1033?

Q. Do you agree that NFPA 1033 applies to everyone who investigates fires?

Q. Do you agree that NFPA 1033 applies to you?

Q. Do you believe that you meet the requirements of NFPA 1033?

Q. Do you agree that NFPA 1033 contains a list of subject matter areas that fire investigators should be knowledgeable about?

Q. Do you agree that that list of subject matter areas includes fire science, fire chemistry, and fire dynamics?

Q. Do you agree that fire is a chemical reaction that gives off energy in the form of heat and light?

Q. Do you agree that a person who investigates fires, therefore, should know something about energy?

Q. In the metric system, what are the basic units of energy?

A. Joules. (Kilowatt hours and Calories are acceptable answers. BTU (British Thermal Unit) is a less acceptable answer, because it's not a metric unit.)

Q. What is the definition of power?

A. Power is a measure of the amount of *energy* given off *per unit time*.

Q. In the metric system, what are the basic units of power?

A. Watts (W), or kilowatts (kW), or megawatts (MW).

Q. What is a watt?

A. One watt equals one joule per second.

Q. If I walk outside on a sunny day at noon, approximately what is the radiant heat flux that I would experience?

A. Approximately 1 kW per square meter.

Q. In a typical compartment fire, what is the radiant heat flux at floor level at the onset of flashover?

A. Approximately 20 kW per square meter.

Q. What is the concentration of oxygen in the air we breathe?

A. 20.95%. (20% or 21% is close enough.)

Q. Do you agree that the combustion of hydrogen is the simplest of all combustion reactions?

A. It is. (If the witness will not agree, ask him if he can name a simpler combustion reaction.)

Q. What is the chemical symbol for hydrogen?

A. H.

Q. What is the chemical formula for hydrogen gas?

A. H₂.

Q. What is the chemical formula for the combustion of hydrogen?

A. $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$.

Q. Do you agree that the combustion of methane, which is the main component of natural gas, is the simplest of all *hydrocarbon* combustion reactions?

A. It is. (If the witness will not agree, ask him if he can name a simpler hydrocarbon combustion reaction.)

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

A. CH_4

Q. Is methane lighter than air or heavier than air?

A. Lighter.

Q. Can you describe the combustion reaction of methane?

A. $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$ (One volume of methane plus two volumes of oxygen produces one volume of carbon dioxide plus two volumes of water vapor.)

Q. How many volumes of air are necessary to completely burn one volume of methane?

A. 10. (Because air is only ~20% oxygen.)

Q. How many BTUs is a cubic foot of methane going to produce when it burns?

A. 1,000

Q. Do you know what the chemical formula for propane (the main component of LP gas) is?

A. C_3H_8 .

Q. Is propane lighter than air or heavier than air?

A. Heavier.

Q. How many volumes of air are necessary to completely burn one volume of propane?

A. 25

Q. How many BTUs of is a cubic foot of propane going to produce when it burns?

A. 2,500

Q. What is heat release rate?

A. The rate at which heat energy is generated by burning.

Q. What units are used to describe the heat release rate of a fire?

A. Kilowatts (kW), or megawatts (MW).

Although it may be uncomfortable, you should apply this simple quiz to *your own expert*. If he is unable to pass this quiz, you might want to think about finding an expert who has this really basic knowledge.

SIDEBAR 2. THE VALUE OF CHALLENGING AN EXPERT'S QUALIFICATIONS

Here are five examples of the value of challenging an expert's qualifications that resulted in cases being dismissed or settling for a pittance because the fire investigator demonstrated a lack of knowledge that is required by NFPA 1033. The author has many transcripts like these but will refrain from identifying names.

1. Investigator who claims a B.S. in Fire Science, testifying in a Tennessee *capital murder* case that he alleged was started with a propane-fired weed burner:

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. 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.

...

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.

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

A. Unsure.

Q. Have you ever tried to set wood on fire using a propane torch?

A. No, sir.

Q. Do you agree that there's both a liquid phase and a vapor phase inside the propane tank?

A. Yes, sir.

Q. Do you know how much vapor a given volume of liquid produces?

A. No, sir, unsure at this time.

The charges were dismissed and all records of the indictment were purged from the record.

2. Professional Engineer testifying in a North Carolina wrongful death case involving carbon monoxide:

Q. How much -- what percentage of air is oxygen generally speaking?

A. Best I remember around 89 percent -- oh, that's nitrogen, probably 10, 11 percent. I don't remember exactly.

The case settled immediately after the transcript arrived.

3. Fire investigator who claims an associate's degree in fire science testifying in a Michigan civil arson case:

Q. What's radiant heat flux?

A. The -- I know what radiant heat is. I don't know the specific definition of radiant heat flex.

THE REPORTER: Flux or flex?

COUNSEL: Flux, F-L-U-X.

THE WITNESS: Flux, okay.

...

Q. What's the concentration of oxygen in air?

A. What's the concentration of it?

Q. Yeah.

A. Like the air we breathe? 92 percent. I don't know if that's right or not but it's in that area. *(Not on this planet!)*

The case settled.

4. Fire investigator retained by the plaintiff insurance company testifying in a slam dunk subrogation case in Texas.

The fire was caused by the defendant's negligent installation of a water heater.

Q. Can you tell the jury what the difference between energy and power is?

A. I don't know.

Q. Can you tell the jury what the basic units of power are?

A. I don't know.

Q. Can you tell the jury what the definition of "heat release rate" is?

A. The heat release rate is the rate of – the amount of fuel that's burning in comparison with the temperature and amount of heat it's producing.

Q. Can you tell the jury what the definition of "energy release rate" is?

A. No.

Q. Well, how is heat release rate measured? Let me ask you that.

A. I don't know.

Q. Do you know what factors influence the heat release rate of a particular fuel?

A. I don't know all the things to it. There's many different variables into it.

Q. Can you tell me any of the variables?

A. The type of material being -- that is being consumed, atmosphere. Is it a sealed room? Is it open air?

Q. But you don't know how heat release rate is typically measured?

A. No.

Q. Do you know what a watt is?

A. I know the basics of a watt, ohms and – I don't know -- no.

Q. Do you know what radiant heat flux is?

A. No.

The case settled for a small fraction of its true value.

5. City fire marshal testifying in a D.C. arson case.

Q. Do you agree that the combustion of hydrogen in the presence of air to form water is the simplest of all chemical combustion reactions?

A. I don't know.

Q. What is the chemical symbol for hydrogen?

A. I don't know.

Q. Can you tell me the formula for the combustion of hydrogen?

A. I don't know.

The Judge, *sua sponte*, announced, "I'm sorry. If you don't know H_2O , you will not be rendering opinion testimony in my courtroom." He later acquitted the defendant for lack of evidence.