

A Case Study in Old and New Junk Science in Fire Investigation:
The Raphael Holiday Case

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EXECUTIVE SUMMARY

The nearly simultaneous publication of NFPA 921, *Guide for Fire and Explosion Investigation*, in 1992 and the *Daubert* decision of 1993 was a turning point in fire investigation. Pre-921 investigators rejected the concept that fire investigation was science at all. NFPA 921, *Daubert*, and more directly *Kumho Tire* made it clear that fire investigation is an applied science. The *Holiday* case is illustrative of both the pre- and post-921 problems in fire investigation. While the fire investigation occurred in 2000 when NFPA 921 was part of the Texas State Fire Marshal's standard operating procedures, the investigation by the State Fire Marshal's Office was characteristic of pre-921 investigation and had much in common with the *Willingham* and *Willis* investigations. The State Fire Marshal's investigation was largely set aside by the prosecutor who instead used the original investigator in a fact witness type of role to tell the jury about the fire scene and early interviews. The prosecutor sought to make the case that Holiday ignited the gasoline he had forced his mother-in-law to spread around the home. Ignoring the BATF which told the prosecutor that it was not possible to exclude electrical and pilot flames in the home as the actual ignition source, the prosecutor looked further. The prosecutor chose to use the services of Dr. John DeHaan who was willing to testify that he was able to scientifically exclude all accidental ignition sources.

Dr. DeHaan's opinions were based merely upon his say-so. He did not employ the scientific method and provided no scientific basis for his opinions. The opinions were not based upon the application of any methodology. His testimony was of exactly the nature that NFPA 921 and *Daubert* were designed to eliminate. His testimony did great damage to the judicial proceedings. Since he was allowed to proffer opinions with the appearance of science without any actual scientific basis. He was presented as an authority figure upon whom the jury could reasonably rely. The fact is that his testimony was highly unreliable and had no legitimate place in the judicial proceedings based upon the *Daubert* standards. He did great harm to the place of science in the courtroom by parading his say-so opinions as if they were scientifically based.

The data collection failures of the SFMO investigation had a significant impact on the quality of the science available to present to the jury. The investigation by the SFMO was characteristic of fire investigations in the pre-921 era. The fire investigation myths concerning irregular floor patterns played a prominent role in the SFMO investigation. The SFMO investigation utterly failed to identify and evaluate potential ignition sources. The interviews conducted by the SFMO were inadequate and resulted in incomplete information. The flaws in the early investigation had a serious negative impact on the quality of the evidence available to the jury.

The fire investigations of this fire did not comport with NFPA 921. The scientific method, the cornerstone of 921, was not used to determine the cause of the fire. Alternate potential ignition sources were not identified and eliminated as required by NFPA 921. Under NFPA 921, given the poor quality of the investigation undertaken, there was no basis for the finding that the fire cause was incendiary because the ignition source was unknown.

The court failed in its gatekeeping role in allowing the expert testimony to be presented to the jury. The *Daubert-Kelly* hearing was held within the period of the trial, rather than well ahead of trial. The court took little interest in the hearing, treating it in a *pro forma* fashion, failing to even announce a determination at the end of the hearing. The failure of the system with respect to assuring good science is put before the jury failed due to shortcomings of all involved; investigators, prosecutors, defense counsel, and the court. It is impossible to know how the case would have been decided if the system had worked as the Supreme Court intended. What we can say is that the conduct of the case with respect to inclusion of junk science did great harm to our system of justice.

The irony is that NFPA 921 and *Daubert* have had a significant impact on fire and explosion investigation testimony in civil litigation. Sufficient judges in civil matters have excluded all or part of an investigator's testimony such that plaintiff and defense attorneys do not hire and will not proffer experts who do not pass muster under *Daubert* and follow NFPA 921. The quality of reports by experts in civil matters is significantly higher than those in criminal proceedings. The prototypical fire investigation report from public sector investigators used in criminal proceedings is a two-page narrative report. There will typically be other materials like photos (with or without a log), lists of witnesses and their contact information, maybe even a sketch or two. There is no practical way that the use of the scientific method to formulate and test all the required origin and cause hypotheses can be done in a few of pages.

The fact of the matter is that the acceptance of NFPA 921 in the criminal justice system today is *pro forma*. Two-page narrative reports reflecting investigations that fail to fulfill the requirements of NFPA 921 are proffered and accepted in criminal matters every day. Investigators often don't even sign their reports. In other instances they do and their supervisor signs off as a reviewer. Either way, the prototypical report reflecting an investigation that fails to fulfill the requirements of NFPA 921 is accepted by the investigator, the investigator's supervisor, the prosecutor, and the judge. In hearings judges simply do not exclude testimony by investigators in criminal matters. Investigators and prosecutors alike know this, so they are unmotivated to assure high quality investigations. Everyone who has a role in the judicial system has some responsibility for the problem, but let's be honest, responsibility starts at the top. When judges take their gatekeeping role as seriously as they do in civil matters, we will see improvement in the quality of fire investigations. Where judges fail to exclude defective investigation findings in criminal matters, poor quality investigations will continue.

We should not image that these problems are unique to fire investigation. The National Academy of Sciences (2009) had identified many serious problems with the quality of the forensic sciences in general. They made several recommendations to congress for legislative action and none of these recommendations have been acted upon. The only concrete governmental response to the NAS report is joint action of DOJ and NIST to form OSAC (<https://www.nist.gov/forensics/organization-scientific-area-committees-forensic-science>). The goal of OSAC is to facilitate the development and acceptance of consensus standards in forensic science. While this is a needed and worthwhile enterprise, in fire we already have such documents in NFPA 921 and NFPA 1033 and it has not been enough to improve the quality of fire investigation practice (Beyler 2015). We continue to see seriously defective fire investigations and we see them accepted by the courts.

*This paper is dedicated to the memory of Dr. Gerald Hurst
for all he did to bring scientific rigor to fire investigation.*

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- **INTRODUCTION**

Sometime after the death of Dr. Gerald Hurst, I was approached to review Dr. Hurst's affidavits in the Raphael Holiday case. As I have in the past, I found Dr. Hurst's affidavits technically sound and agreed to write a report to be used in Raphael Holiday's appeal in essence to stand in for Dr. Hurst after his death. I was slower than usual in getting the report done and I emailed my apology for the lateness. The response I got floored me! The reply was that it doesn't matter anymore because Raphael Holiday has been executed.

I subsequently learned of the egregious legal representation problems that allowed the execution to go forward without further appeal. As a citizen, I was appalled at the legal system failures, but I knew that I needed to leave those issues to others with appropriate skills to address the systemic failure with regard to his legal representation. However, I kept thinking about the case. I knew that there had been significant junk science put before the jury during the trial and that simply was not ok with me. If we can't prevent the use of junk science in a capital murder case, exactly when can we rely on the system to assure that only good science reaches the courtroom? After all, what higher stakes are there than a person's life?

In the end, I found that I needed to write about the fire investigation and expert testimony that found its way into the courtroom. Remaining silent would simply be condoning the forensic science abuses. I have gotten some questioning looks from colleagues at my decision to take on this task. After all, this is not a pretty case. On September 6, 2000 Raphael Holiday had forced his mother-in-law at gunpoint to spread gasoline around the house with his three children sitting on the couch; Justice, his blood daughter, and Tierra and Jasmine, his adopted children, all children of his estranged wife. A fire ensued, killing all three children. At trial, he was accused of causing the gasoline to be spread and using a lighter to ignite the fire that killed his children. One can ask, who cares if he actually ignited it? His children were dead by a fire fueled by the gasoline he forced his mother-in-law to spread. If that is how the court case proceeded, you would not be reading this. The prosecution felt a need to say that Raphael Holiday lit the gasoline vapors with a lighter. This is a claim not made by his mother-in-law to investigators after the fire. She was the only one who had direct knowledge of what went on in the house that night and she did not tell investigators that Raphael Holiday had ignited the fire. She said she saw him in the kitchen when she first saw the fire from the bedroom, where she had poured the last of the gasoline.

In what follows you will find no discussion of Raphael Holiday's representation problems and you will not find discussions of the broader tragic events surrounding the fire incident. You will find a detailed description of the fire incident itself, the investigations, and the expert testimony at trial by the prosecutor's expert. You will see that the Texas State Fire Marshal's Office (SFMO) did the fire investigation in a manner similar to the *Willingham* and *Willis* cases. They relied upon fire investigation myths to determine that Holiday had poured additional gasoline, with the pour leading to the door of the home and that he ignited the fire at the doorway to the home. They were so confident of their "irregular pour pattern" finding and its meaning based on

myths that they persisted in their theory of the fire even though it was contradicted by Holiday's mother-in-law's observations of him in the kitchen. This investigative finding never reached the courtroom.

Prosecutors sought additional assistance from the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) in the preparation for trial. ATF is the premier fire investigation organization at the federal level. The ATF informed the prosecutors that it was not possible to show that Holiday had actually ignited the fire and recommended a course of action that did not involve this claim. Rather than accept the ATF's determination, the prosecutors sought another expert who did appear at trial. Unlike the ATF, Dr. DeHaan was willing to provide expert testimony that Holiday had started the fire. While the SFMO investigation involved old junk science, Dr. DeHaan brought new forensic abuses to bear. Despite violations of the standard of care in fire investigation methodology and failures under the Supreme Court's *Daubert* Standard for scientific and technical evidence, the new junk science reached the courtroom. You will find no discussion of the impact of the junk science on the jury, because there is no way to know what would have occurred had the testimony been prevented.

- **THE FIRE INCIDENT DESCRIPTION**

The fire incident was reported at 1203 am on 6 September, 2000 at the log cabin with an attached mobile home owned by Louis Mitchell and occupied by Tami Wilkerson and her three children, Tierra, Jasmine, and Justice. The fire was formally reported by Deputy Ivan Linebaugh, who was responding to the location for a police 911 call. As the Deputy Linebaugh approached the home, he saw that the fire was well developed and involved the entire home. Fire department units were called and responded, but there was no interior attack possible as the building was fully engulfed in fire on arrival.

Based upon the SFMO report, the home was a two-story log cabin-type building built on a concrete slab foundation, approximately 23' x 30' (see Figure 1). There was a screened-in front porch located on the north side of the main building measuring approximately 10' x 19'. A mobile home was attached to the log cabin with a doorway leading to the southeast bedroom of the log cabin. The mobile home was singlewide, measuring approximately 12' x 34'. The log cabin contained four rooms, kitchen, utility room, bedroom and a bathroom. The partition walls were sheet rock on wood studs. The second story section of the residence was used primarily for storage. The structure faced north and encompassed approximately 1168 square feet including the mobile home, permanent structure and screened porch.

On the scene at the time of the fire incident were Raphael Holiday, Beverly Mitchell, and the three children. Tammy Wilkerson heard a prowler outside her home and called Beverly Mitchell to come to the home. Mrs. Mitchell was accompanied by Terry Keller, who had a shotgun with him. On their arrival, they began loading the children into the car to go to the Mitchell residence. Raphael Holiday appeared with a gun when the two older children were in the car. He picked up a gas can and poured gasoline onto the ground in front of the car and ignited the gasoline. He forced Mr. Keller to surrender his shotgun and forced everyone into the home. He took Mrs. Mitchell and her car to pick up additional gas cans. Once they left the property Mr. Keller left the children on the couch and went for help. On the return of Mr Holiday and Mrs. Mitchell, Mr. Holiday forced Mrs. Mitchell to bring both gas cans into the kitchen and to pour the contents of one of the gas can around the log cabin portion of the home. She was clear that she did not pour gasoline on the children or the couch on which they sat. The can was thought to contain 3.5 to 5 gallons of gasoline and all of the contents were distributed by Mrs. Mitchell, ending in the bedroom. She poured gasoline onto the two recliners in the living room, continued into the utility room, pouring gas onto the washer and dryer. She continued into the bedroom and completed the pour on the dresser and bed.

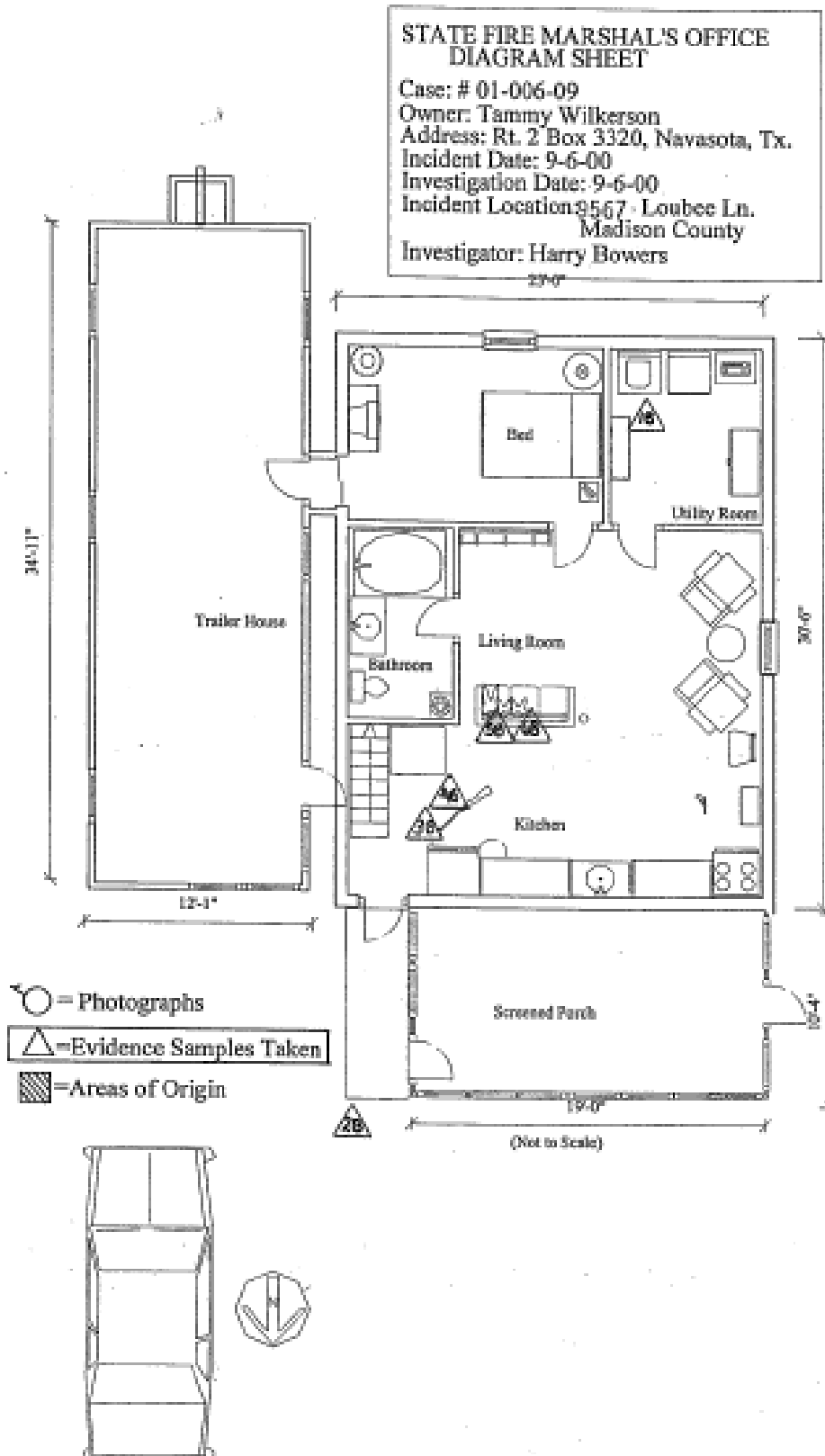


Figure 1. Diagram of the home developed by TSMF.

At the time the fire started, Mrs. Mitchell was in the bedroom. She was unable to enter the living room and was forced to retreat, leaving out the bedroom door to the mobile home. Mrs. Mitchell reported that Mr. Holiday was in the kitchen at the time of the ignition and he was able to flee the home, leaving both weapons behind. The weapons were found in the debris. When she encountered Mr. Holiday outside the home he said "what happened?" and Mrs. Mitchell responded "you killed my grandbabies." The children's bodies were found on top of the springs of the couch on which they sat. Apparently, they succumbed to the fire without leaving the couch. Mr. Holiday suffered second-degree burns to both hands and minor burns on his neck. Mrs. Mitchell did not suffer any burns, but was injured escaping the fire. Mr. Holiday took Mrs. Mitchell's car to escape and hit the police car responding to the 911 call. Mr. Holiday was apprehended after a chase.

- **FIRE INVESTIGATION BY THE TEXAS STATE FIRE MARSHALL'S OFFICE**

The fire investigation was conducted by a team of investigators under the direction of Chief Investigator (CI) Bowers. Due to the magnitude of the investigation he obtained assistance from other SFMO Investigators: Glen Harris, Kyle Morris, and Canine Handler Tommy Pleasant.

CI Bowers was requested to investigate the fire by Madison County Sheriff Dan Douget. Sheriff Douget advised that these deaths were believed to be the result of an intentional act of arson and murder. After meeting with Sherriff Douget, Canine Handler Pleasant began the investigation by having the K-9 examine Mr. Holiday's clothing. Canine Handler Pleasant created a clothing line up, including clean jail uniforms, Mr. Holiday's clothing, Mrs. Mitchell's clothing. The canine indicated on Mr. Holiday's tennis shoes. The shoes were submitted for laboratory analysis at the SFMO Arson Lab, along with his pants, T-Shirt, socks, and undershorts. The lab identified that the shoe sample contained gasoline and the other samples were negative. The investigation team then proceeded to the fire scene.

The scene examination began with an exterior examination. The structure had been reduced to ground level by the fire. The heaviest fire damage was noted to have been in the living room/kitchen area. The bodies of the three children were found on the east end of the couch. The canine alerted at this location and samples were taken (Lab Finding 5b, 6b -negative). The canine made a detailed search of the premises before any debris removal was undertaken. The canine alerts in the laundry room (lab finding- negative), on the ground on the north side of the building (lab finding- negative), kitchen floor (lab finding- gasoline), a second location in the kitchen (lab finding- gasoline).

Debris was removed from the concrete foundation floor of the log cabin and the floor was washed. "Pour patterns" were identified on the concrete slab. The patterns traversed from the front door in a westerly direction to the area of the couch, behind the couch, then to the area of the space heater. The patterns continued to the lounge chairs, then to the laundry, and back into the living room toward the bedroom. The patterns were diagramed by CI Bowers (included as Figure 2). In addition to these floor patterns, CI Bowers identified a demarcation char burn pattern on the vertical wallboards of the bathroom wall adjacent to the couch in the living room. He identified that this pattern substantiated a low burn coming from the area of the couch.

During the scene examination on this date and on September 19th, 62 photographs were taken. A photo log was produced and diagrams of the photograph locations were produced. The report was unsigned and undated. There was no specific reference to the procedures and findings of the September 19th scene examination.

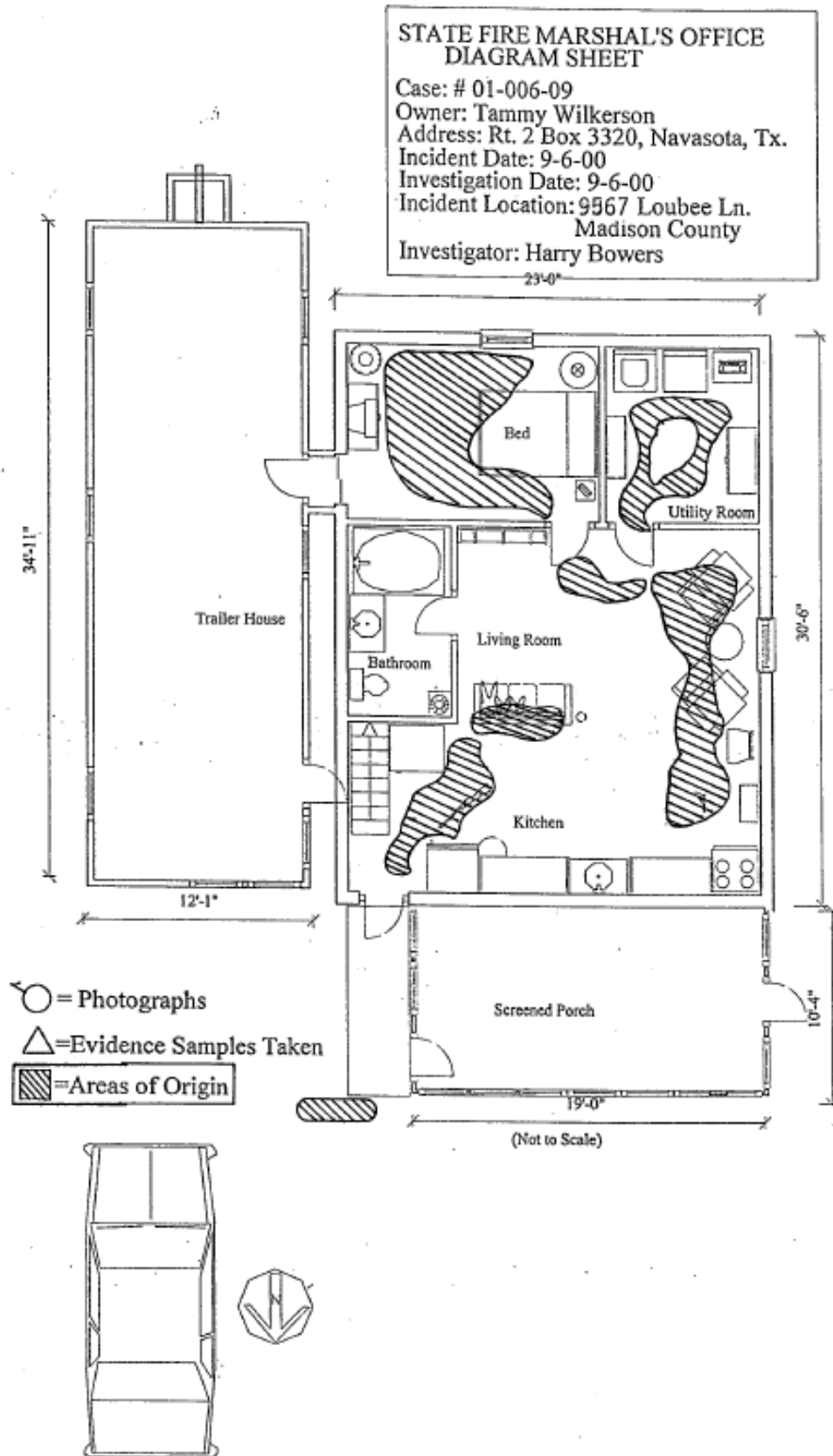


Figure 2. Diagram of "pour patterns" on the concrete slab, labeled as areas of origin.

On September 8th, Deputy Lindbaugh, Ranger Malinak, and CI Bowers interviewed Beverly Mitchell. Mrs. Mitchell described that Mr. Holiday came to the residence and held the family at gun point. She reported that Mr. Holiday forced her to pour gasoline throughout the house. The three children were on the couch during this process and Mrs. Mitchell reported that she did not pour gasoline on the children. She reported that she poured the gasoline starting at the lounge chairs and proceeded south over these two lounge chairs to the laundry room, out of the laundry room to the bedroom. While in the bedroom, she ran out of gas. As she turned around in the bedroom to go back into the living room, the living room area burst into flames. She stated she tried to see the children, but couldn't. She then escaped through the bedroom door leading into the mobile home. Mrs. Mitchell specifically reported that she did not pour gasoline near the couch, kitchen or front entrance area.

Terry Keller was also interviewed on September 8th. He reported that Mr. Holiday had poured gasoline onto Tammy Wilkerson's car and onto the ground. He bent down and ignited the line of gasoline on the ground outside the home using a butane lighter.

Based upon the scene examination, the interviews, and the laboratory findings, CI Bowers concluded Mrs. Mitchell was forced to introduce gasoline to the residence. Based upon the "pour patterns" on the floor and (contrary to Mrs. Mitchell's interview statement), he concluded that while she was in the bedroom of the residence, Raphael Holiday poured gasoline in the area of the couch, refrigerator and trailed the pour pattern near the front door. He ignited the gasoline, burning himself in the process of ignition. Based on these factors, it was his professional opinion this fire was intentional set and was INCENDIARY IN NATURE. The investigation report was unsigned and there was no indication that any SFMO review of the investigation or the report had been undertaken. Based upon information provided by the current SFM at the time of this writing, the investigation will now be reviewed using its Science Advisory Workgroup (SAW) (<http://www.tdi.texas.gov/fire/fmfsc.html>). I have not been notified by the SFM that this process has begun. It is of note that in the initial screening of cases to be reviewed neither the SFMO nor the Texas Innocence Project identified this case as one that should be subjected to SAW review and analysis.

- **TRIAL TESTIMONY**

The trial began on 28 May, 2002 in the District Court of Walker County, Texas, 278th Judicial District. Raphael Holiday was charged with capital murder, murder, and arson causing death in connection with the deaths of Tierra, Jasmine, and Justice.

Testimony regarding the cause of the fire was limited to Beverly Mitchell. Additional expert testimony was given by Chief Investigator Harry Bowers (SFMO) and Dr. John DeHaan (for the prosecutor), and Judd Clayton (for the defense). Rebuttal testimony was given by David Reiter (private fire investigator) and David Opperman (ATF).

Beverly Mitchell Testimony Related to the Fire Cause

Beverly Mitchell had been interviewed by CI Bowers as described above. She was also interviewed by a Texas Ranger in the early morning hours after the fire. She reported that Mr. Holiday had forced her to pour gasoline in areas of the residence. The three (3) children were sitting together on a sofa in the living room. She reported that the gasoline ignited in the area of the sofa, preventing Beverly Mitchell from reaching the children.

At trial Mrs. Mitchell recounted the gasoline pour she was forced to make, indicating that she started at the recliner, went to the washer room (laundry), poured onto the washer and dryer, and went to the bedroom, dousing the dresser and bed before running out of gasoline.

At trial she reported that while she was in the bedroom she saw Mr. Holiday with his foot on the high chair and the pistol in his hand. She saw him bend down with his right hand and the fire started. She reported that she saw no matches or lighter. She reported that the fire started at the recliner. At trial was the first time that she had reported seeing Mr. Holiday bend down at the time of the initiation of the fire. In her interviews she did not report this, in her September 6th statement she did not report this, and at a pre-trial hearing she did not report this.

Expert Testimony of Chief Investigator Bowers

At trial CI Bowers was not subjected to a *Daubert-Kelly* hearing as would often be done for an expert witness. At trial CI Bowers told the jury that NFPA 921 was strongly suggested by the SFMO SOP's. NFPA 921, published by the National Fire Protection Association is the standard of care document for fire and explosion investigation. It has been widely accepted by the courts as the standard of care (Lentini 2007). He described the building and the scene investigation. In particular, he described the identification and collection of samples. He reported the irregular floor pattern found on the concrete slab. He also reported the recovery of two butane lighters from Mr. Holiday's person at the police station.

On cross-examination he agreed that the refrigerator could ignite gasoline vapors. He also admitted he had not recorded the location of appliances in the house. CI Bowers provided no opinions regarding the origin or cause of the fire.

Expert Testimony of Dr. John DeHaan

The state called Dr. John DeHaan as an expert to provide opinion testimony regarding the cause of the fire. Just before Dr. DeHaan was called to testify, the court conducted a *Daubert-Kelly* hearing outside the ears of the jury. The hearing focused on the prosecutor eliciting Dr. DeHaan's opinions to be proffered. The defense asked questions about the opinions and did probe the bases for his opinions. There was no testimony provided by any expert for the defense. The judge presided over the hearing, but was not an active participant. That is, he did not pose questions to aid him in making his determination of whether all or part of Dr. DeHaan's testimony should be prevented from being presented to the jury. The entirety of the proffered testimony was allowed without judicial commentary.

Before the jury Dr. DeHaan described the elements of his methodology in terms of collecting data, forming ways the damage could have occurred, and eliminating various possibilities until we finally come down to a "best fit" that fits all the data. NFPA 921 did not arise in his testimony except that he was asked if he was familiar with the document. At no point did Dr. DeHaan testify that he conducted his investigation according to NFPA 921 and at no time did Dr. DeHaan indicate that he used the scientific method in his investigation.

There was no direct identification of the origin of the fire prior to the consideration of potential causes. Dr. DeHaan identified the water heater, room heater, refrigerator, stove and air conditioners as potential causes of the fire.

Dr. DeHaan eliminated the water heater because it was located in the bathroom which he identified as in a separate room with a solid wall. He did not address the open/closed status of the bathroom door. He asserted that he could eliminate the water heater because the ignition delay would be too long. He did this with no analysis, no methodology, and no identification of the time delay to ignition. His elimination was nothing more than an assertion.

The stove pilot in the broiler was considered as a potential ignition source. This ignition source was eliminated based upon the fact that the stove was several feet from the actual gasoline

pour, the pilot was within the broiler drawer, the pilot was six inches above the floor, and Dr. DeHaan identified no blast damage to the broiler door. He argued that the location of the stove and the closed but not air-tight nature of the broiler door would lead to too long an ignition delay. Again, he did not identify the length of the ignition delay, provided no analysis or methodology for assessing the movement time of gasoline vapors to the pilot location. He opined that the height of the pilot six inches above the floor was too high to be ignited by gasoline vapors. He cited a demonstration he had done for the Australian Fire Service as the basis for this conclusion. The test was done in a room with carpeting but no furnishings with a 6-inch candle burning on the floor in the center of the room. A gallon of gasoline was poured onto the carpeted floor. No ignition of the gasoline vapors occurred in 20 minutes, at which time the candle was knocked over and a flash fire ensued. He further opined that if the gasoline vapors had been ignited by the pilot, there would have been an explosion within the broiler drawer that would have blown the drawer out of the stove. In photos of the stove he identified that the drawer was only open slightly (ajar). He cited only his personal experience as the basis for his opinion that the door would have been blown out of the stove. On these bases, Dr. DeHaan eliminated the stove pilot as the ignition source.

The room heater was considered as a potential ignition source. Mr. Mitchell had testified that the gas supply to the heater had been turned off months before the incident. Dr. DeHaan did not perform any physical assessment of whether the heater gas supply was in the off position and did not cite any such assessment performed by any other investigator. Solely based upon the testimony that the gas supply had been turned off months before, Dr. DeHaan eliminated the heater as the cause of the fire.

The refrigerator was considered as a potential ignition source. The compressor motor was eliminated based upon the fact that it is sealed. The starter relay was noted to have been housed in a plastic, non-explosion proof enclosure. This relay was eliminated based upon Dr. DeHaan's "expectation" that there would be a significant delay in ignition due to the time needed for vapors to move into the plastic housing. He did this with no analysis, no methodology, and no identification of the time delay to ignition. His elimination was nothing more than an assertion.

The window air conditioner was considered as a potential ignition source. The compressor motor was eliminated because it is sealed. The fan motor was deemed to be the only potential ignition source within the unit. Dr. DeHaan eliminated the air conditioning unit due to the height of the unit above the floor as well as the dilution of the gasoline associated with air flow into the fan motor in the air conditioning unit. He further expected that if ignition occurred within the air conditioner, an explosion within the air conditioner would blow it out of the window. He noted that the air conditioner remained in the window, so that no explosion occurred. He eliminated the air conditioner with no analysis, no methodology, and no identification of the extent of air dilution that would have occurred. His elimination was nothing more than an assertion. He provided no basis for his expectation that ignition would lead to an explosion which would have dislodged the air conditioner.

Dr. DeHaan acknowledged that a fan would distribute gasoline vapors more quickly than in a quiescent room and that people movement would lead to gasoline vapor movement. He noted that while the vapors would be distributed more quickly, the air flow would dilute the gasoline vapors such that they will be so dilute they are almost impossible to ignite at any position. He provided no basis, methodology, or justification for this opinion.

Dr. DeHaan also described the ignition of a layer of gasoline vapors at floor level in the room. He noted that a flame would quickly spread in the upper region of the layer where a flammable mixture of gasoline vapors in air existed. He noted that the flame propagation rate would be 6-

10 feet per minute, citing only his own testing experience as the basis. He noted that he had published the results, giving the impression it is only he that had made that discovery. He noted that this initial premixed flame was very short lived and would only result in scorching, melting, singeing, or first degree burns. He provided no basis for his conclusion. He described that after the premixed burning, the fire would transition to diffusion flame burning. First, the gasoline layer would be consumed and then the fire would recede to the surfaces where the liquid gasoline had been poured. The fire would then grow to cause flashover in the room. He opined that a couple of minutes would be required to reach flashover. He did not provide a basis for his opinion or describe any analysis or methodology that was used to develop the conclusion.

Dr. DeHaan went on to opine that Mr. Holiday's burn injuries were consistent with someone who is bent down and ignites the fire. He did not provide a basis for his opinion or describe any analysis or methodology that was used to develop the conclusion beyond his professional experience. He did not determine the fire heat release rate, the heat flux distribution from the fire, nor the thermal injuries that would result from the heat flux history. He cited no empirical or theoretical basis for the opinion.

On cross-examination Dr. DeHaan agreed that the door status (open/closed) and the operation of the air conditioners are significant with respect to gasoline vapor movement. These are factors that Dr. DeHaan did not know, yet he developed opinions that rely upon the information he did not have. He also acknowledged that people moving within the home would have an effect on gasoline vapor movement. He described the Australian fire service demonstration in which one gallon was poured with the door open, with a couple windows partially open, no furnishings, carpeted floor, with no fan or air conditioner. He acknowledged that had someone walked through the room, it might have resulted in ignition at the candle six inches above the floor. He further acknowledged that the building code requires that pilots in garages be elevated to mitigate against ignition of fuel spills in a garage. He provided no rationale why the underlying basis for the requirement in the building code was not relevant to this case.

Dr. DeHaan agreed that his interpretation that Mr. Holiday's burn injuries were consistent with Mr. Holiday bending over to light the fire would also be consistent with him merely bending over without lighting the fire. He acknowledged that he assumed Mr. Holiday suffered singeing without any basis. He also acknowledged that there were other ways that Mr. Holiday could have sustained the burn injuries.

In considering accidental ignition sources, Dr. DeHaan acknowledged that he only looked at the exterior of the refrigerator and did not examine the inner workings of the refrigerator. He found the refrigerator outside the building and did not move it. He stated his belief that there were no exposed arcing sources, even though he acknowledged that relays do create arcs and the refrigerator was in his view too damaged to determine the exact conditions within the refrigerator.

In considering the heater pilot as a potential ignition source, Dr. DeHaan acknowledged that neither he nor the SFMO examined the heater to determine if the pilot had been operating. He felt that this was not necessary because a witness had said he had turned it off months before. He felt no need to confirm that the pilot had not been restarted in the intervening months or to confirm the testimony.

In considering the stove broiler pilot, Dr. DeHaan acknowledged that the condition of the broiler door was only known from a general photograph and that neither he nor the SFMO had examined the broiler door directly.

Dr. DeHaan acknowledged that after eliminating all the potential accidental ignition sources, he concluded that the fire must have been deliberately ignited by Mr. Holiday.

- **ANALYSIS OF THE FIRE INVESTIGATION**

The modern standard of care in fire investigation is NFPA 921, *Guide for Fire and Explosion Investigations*. First published in 1992, it took 10 years for 921 to be generally accepted in the fire investigation community. NFPA 921 was originally undertaken to dispel fire investigation myths and develop a scientifically based fire investigation methodology. Today both the IAAI and NAFI, the two professional organizations for fire investigator certification, accept 921 as the standard of care. Both organizations acknowledge that NFPA 1033, *Standard for Professional Qualifications for Fire Investigator*, describes the qualifications for fire investigators and the job tasks based upon NFPA 921. Courts have widely accepted NFPA 921 as the standard of care in fire investigation (see Lentini (2007) for a summary). The current editions of both NFPA 921 and 1033 are the 2014 Editions. These are the documents that express how fire investigation should be undertaken and as such form the basis for an evaluation of a fire investigation. Expanded from an original length of 100+ pages, the current edition of NFPA 921 is approximately 400 pages. NFPA 921 continues to be expanded and enhanced based on ongoing developments in fire investigation methods and in the underlying fire science.

Arson is somewhat different from other crimes in that fires most often start accidentally. There is a need to first determine if an intentional act of fire starting was involved. This is done by determining the origin and cause of a fire using the scientific method (NFPA 921 (2014) §4.3). The steps are the same for all fires, whether or not the investigator suspects an incendiary fire (NFPA 921 (2014) §4.3.7).

The basic methodology of fire investigation is the scientific method, including data collection, hypothesis generation, and hypothesis testing (NFPA 921 (2014) Chapter 4, NFPA 1033 (2014) §4.1.2). Data collection includes information obtained from the fire scene observations, from testing physical artifacts, from witness statements, and other forms of documentation. The data is used to first formulate hypotheses concerning the origin of the fire ((NFPA 921 (2014) §18). Potential areas of the building are considered as origin hypotheses and may be eliminated if the origin is inconsistent with the data obtained or if the origin is not possible based upon the principles of fire science, our knowledge of the dynamics of fire, and its interaction with the environment. Within the area of origin, all potential ignition sources need to be considered to develop cause hypotheses (NFPA 921 (2014) §19.2.3). A fire cause hypothesis includes the ignition source, the first materials ignited, and how these came together to result in a fire (NFPA 921 (2014) §19.3). All three elements must be included in a fire cause hypothesis. A fire cause is determined when one and only one fire cause hypothesis survives hypothesis testing against case information (data) and our knowledge of fire science ((NFPA 921 (2014) §19.6,7).

Both NFPA 921 and 1033 call for investigators to prepare reports that include their opinions and conclusions along with bases for these findings and conclusions (NFPA 921 (2014) §16.5.3 and NFPA 1033 (2014) §4.7.1). This amounts to describing the steps taken within the scientific method. All data collected in the investigation should be reported. The bases are the case facts determined during the investigation and the application of this data to form opinions and conclusions based upon the scientific method.

The 1998 editions of NFPA 921 was available and in use at the time of the scene examination. The 2001 edition was available and in use at the time of trial. The use of the scientific method in fire investigations was included in these editions.

The SFMO was asked to conduct the investigation because the Sheriff's Office had identified that the fire was believed to be the result of an intentional act of arson. A canine team was employed in the investigation. The first activity of the canine team was to pick out samples with an ignitable liquid from a clothing line-up. This is a nonstandard use of a canine. The role of the canine is to identify locations where samples should be taken for chemical analysis for ignitable liquids (NFPA 921 (1998) §9-5.3.4). In the case of the line-up, clean prison clothing and clothing samples from Mr. Holiday were included in the line-up. The canine indicated the presence of an ignitable liquid on Mr. Holiday's shoes. All Mr. Holiday's clothing was submitted for chemical analysis. The lab results indicated gasoline on Mr. Holiday's shoes and were negative on other clothing items. There was no point in using the canine for the line-up as all Mr. Holiday's clothing was chemically analyzed as it would have been without using the canine line-up. The finding of gasoline on his shoes and not on his other clothes is consistent with him walking where gasoline had been poured. This is consistent with Mrs. Mitchell's testimony that he was in the living room during and after the time she poured gasoline.

At the fire scene the canine was used throughout the fire area before the scene was disturbed. The canine indicated at the couch, in the laundry, and the kitchen. Laboratory results were positive for gasoline in the laundry and in the kitchen area (two samples). The sample from the area of the couch was negative. The detection of gasoline was consistent with Mrs. Mitchell's testimony that she was forced to pour gasoline within the home.

Upon completion of the canine work, the fire debris was removed from the concrete floor of the fire area and the floor was washed. "Pour patterns" were observed and documented via a sketch (see Figure 2 above). The removal of the fire debris to expose the floor early in the investigation is a practice not normally employed in modern fire investigations. At the time of the investigation NFPA 921 reflected the recognition that fully developed room fires generated irregular floor patterns termed "pour patterns" without the use of any ignitable liquids in the fire (NFPA 921 (1998) §4-16.1.4, §4-17.7.2). CI Bowers interpreted the "pour patterns" as having been created by the pouring of gasoline despite the fully developed nature of the fire. He also identified low burn patterns at the couch area which he erroneously identified as being caused by gasoline. The burning of padded furniture results in pooling of polymer melt on the floor which result in low burn patterns (NFPA 921 (2014) §6.3.7.8 Irregular Patterns). Comparing his "pour patterns" with Mrs. Mitchell's testimony concerning where she poured gasoline, CI Bowers concluded that Mr. Holiday must have poured additional gasoline in the area of the couch and refrigerator as well as trailing the gasoline pour to near the front door. He concluded that Mr. Holiday had ignited the trailing gasoline pour near the front door, burning himself in the process. The pouring of gasoline is not consistent with Mrs. Mitchell's testimony and is based on a misinterpretation of the irregular floor patterns as gasoline pour patterns. No gasoline pour is required to explain the floor patterns in this fire. The attribution of irregular floor patterns after a fully developed fire as an indicator of a pour pattern is a myth of fire investigation from the pre-921 era. It was exactly this type of myth that motivated the development of NFPA 921. It was that kind of discredited evidence that was used in the severely flawed Willingham and Willis investigations (Beyler (2009)).

CI Bowers treated the fire debris in the fire area as materials to be removed to reveal floor patterns, rather than materials to be examined to understand the fire. He failed to examine the floor for the remains of a lighter. Rather, he simply assumed that Mr. Holiday placed the lighter in his pocket. He did this in full knowledge that Mr. Holiday had abandoned the rifle and handgun Mrs. Mitchell saw him carrying in the kitchen area near the location of the high chair (see Figure 1). CI Bowers' determination that Mr. Holiday had poured additional gasoline, trailing it to the front door is inconsistent with Mrs. Mitchell's testimony and inconsistent with the location where the handgun was dropped. CI Bowers assumed that Mr. Holiday would pocket his lighter, while dropping and abandoning his handgun at the high chair location. It is much

more likely that if Mr. Holiday ignited the gasoline, he would have retained the gun and dropped the lighter. Dropping the handgun where Mrs. Mitchell saw him is consistent with Mr. Holiday being surprised by the flame propagation through the gasoline vapors. It would have been important for CI Bowers to perform a detailed examination of the fire debris in the area where Mr. Holiday had stood and abandoned his handgun. While finding the metallic parts of the lighter, if present, is routinely done in fire investigations, it requires a fine examination, normally with sieving the debris and using magnets to find the metallic parts. No such examination was undertaken.

While CI Bowers cited NFPA 921 as part of the SFMO Standard Operating Procedures, his report does not reflect the use of the scientific method, which is the core of the 921 methodology. He failed to identify and examine each potential ignition source in the fire area. The extent of this consideration of potential ignition sources was his questioning of Mrs. Mitchell about the status of the room heater. Upon being told it had been turned off months before, CI Bowers did not even bother to examine the condition of the heater gas valve and pilot assembly. The only other potential ignition source he identified was the stove and he failed to determine the operational status of the kitchen stove. The refrigerator and air conditioners were not considered as potential ignition sources at all. They were not examined or retained for laboratory examination. Thus, he failed to explore the two potential ignition sources he did identify and failed to identify two other potential causes. The fact that he did nothing to exclude the identified potential ignition sources should have, under NFPA 921, caused him to conclude that there were multiple potential ignition sources so that the fire cause was undetermined.

The interview of Mrs. Mitchell was poorly documented and did not include significant factors that should have been explored. In particular, while the room layout was explored, the status of doors and windows was not. The operational status of the air conditioner and the ceiling fan were not established. Ventilation and air flows are important factors in fire situations. Nonetheless, these were not explored with Mrs. Mitchell. Most importantly, the interview of Mrs. Mitchell failed to elicit details of the actions and conditions before the fire started. Her interview did not even mention that she had seen Mr. Holiday at the high chair from her position in the bedroom after she completed her pour. Nonetheless, at trial Mrs. Mitchell described her observations of Mr. Holiday at the high chair and his bending over. Clearly, if she did indeed see Mr. Holiday at that time, it should have come out in their questioning of the sequence of events associated with the fire start. Clearly, the 14-line summary of the interview was wholly inadequate. It is well known that people's memories fade and change with time. It is essential that detailed interviews document the observations at an early date and in detail. Because CI Bowers failed to properly interview Mrs. Mitchell, the jury relied upon recollections made years after the incident which were never shared during the investigation or in pretrial proceedings. The interviewing of Mrs. Mitchell did not follow NFPA (2014) §7-4 and the documentation of the interview did not follow NFPA (2014) §7-4.7.

The investigation conducted by the SFMO did not comport with NFPA 921, despite the fact that NFPA 921 was a part of the organization's SOP. The interviews conducted were seriously flawed and resulted in the jury receiving years old recollections never documented during the investigation or pretrial proceedings. The scene examination and cause determination process did not follow the scientific method as described in NFPA 921. Accidental potential causes were not identified and investigated. The fire cause determination that Mr. Holiday had poured additional gasoline and ignited the gasoline is based upon discredited, fire investigation folklore from the pre-921 era. In this respect, the investigation shares significant elements with the Willingham and Willis investigations (Beyler 2009). The presence of "pour patterns" that could not be attributed to Mrs. Mitchell were taken to have been assumed to be the result of a subsequent pour by Mr. Holiday. The ignition of this nonexistent pour was assumed to have been accomplished by Mr. Holiday with no analysis and no basis. In its use of folklore and

failure to use the scientific method, the investigation is substantially similar to investigations in the pre-921 era and as such does not represent a modern investigation.

The reason for the prosecutor's decision not to use CI Bowers to provide expert testimony regarding the cause of the fire cannot be determined from the record. However, the manifest problems of the investigation certainly are a basis for not using CI Bowers to explain the cause of the fire. However, simply changing experts cannot cure many of the deficiencies of the investigation. The defective nature of the SFMO investigation had significant impacts on the quality of the expert testimony available to the jury.

Dr. John DeHaan

Because he was brought into the case well after the fire, Dr. DeHaan needed to rely upon the SFMO for many aspects of the investigation. The scene examination and the initial interviews were performed by the SFMO. Dr. DeHaan was able to examine the fire scene well after the fire and after contents had been moved and handled significantly. For example, the refrigerator was found outside the home at the time of his inspection.

There were problems with Dr. DeHaan's analysis of the fire at several levels. At the highest level, Dr. DeHaan never identified NFPA 921 as his methodology and never made reference to the scientific method. This is quite unusual in a modern fire investigation, since NFPA 921 and the scientific method are well established as the standard of care in fire investigation.

Dr. DeHaan's testimony did call out what appear to be references to elements of the scientific method. For example he identified data collection and elimination of potential causes of the fire. However, his testimony also contradicts a central tenet of the scientific method. He described his methodology as finding the best fit potential cause that fits all the data. The concept of "best fit" does not arise in the scientific method. In the scientific method a specific conclusion regarding the cause of the fire can only be made if **one and only one** hypothesis is consistent with the case facts and our knowledge of fire science. If two potential causes are possible, then the cause of the fire is undetermined. The investigator does not have the option of selecting the potential cause he believes is a better fit as the cause of the fire. Dr. DeHaan's methodology as he described it and used it was much less rigorous than the scientific method as identified in NFPA 921.

This lack of rigor is significant in this case because Dr. DeHaan's "elimination" of the accidental ignition sources is quite equivocal. That is, the "eliminations" are not proof that the potential accidental cause is not possible, but rather that Dr. DeHaan did not believe that any of potential accidental causes were likely. He does not require the rigor of true elimination in his process of discarding accidental potential causes. This can best be illustrated by addressing each of the potential causes he considered. Dr. DeHaan identified the water heater, room heater, refrigerator, stove and air conditioners as potential ignition sources for the gasoline vapors.

Dr. DeHaan "eliminated" the water heater because it was located in the bathroom which he identified as in a separate room with a solid wall. The bathroom was directly adjacent to the living room and had a door separating it from and the living room. He did not address the open/closed status of the bathroom door. He asserted that he could eliminate the water heater because the ignition delay would be too long. Dr. DeHaan cited no methodology for his determination. He simply provided his opinion. He did not determine the open/closed status of the bathroom door, he did not calculate or otherwise assess the travel time of gasoline vapors to the water heater. He did not report a specific time of the ignition and made no assessment of the time from the pouring of gasoline to the ignition of the gasoline in his consideration of the water heater. Without these elements, his opinion that the time to ignition would have been

longer than the actual ignition time is rank speculation on his part. It is inappropriate for an investigator to provide an opinion based solely on his say-so (*ipse dixit*). This is exactly the type of expert testimony that the Supreme Court's *Daubert* decision and NFPA 921 seek to prevent. It's exactly the type of fire investigation testimony that was common in the pre-*Daubert* and pre-921 era (Beyler 2009). Under modern fire investigation methods, there is no basis provided for the elimination of the hot water heater. As such, the hot water heater remained as a viable potential ignition source of the fire.

In 1975 CPSC reported that over 1200 persons per year were treated for burn injuries involving flammable liquid vapor ignition by gas-fired hot water heaters. Later, CPSC examined incident data for the period 1985-1994 and found on average that 1440 fires per year were caused by ignition of flammable vapors by gas-fired water heaters, resulting in the deaths of 182 people per year. This real world experience clearly shows that pilot flames on gas-fired appliances as installed in homes are potent ignition sources for flammable vapors.

Various codes and standards govern the installation of gas-fired appliances in spaces where gasoline spills may be expected to occur (e.g. garages) (Hoffman et al. 2003). Prior to the time of Dr. DeHaan's testimony at least eight different codes and standards required that gas appliances installed in areas where gasoline spills may occur be installed **at least 18 inches** above the floor to mitigate against ignition of gasoline vapors resulting from a spill. As such, it was widely known that ignition hazards were significant at the height of the pilot flames in gas appliances. The significance of the codes, standards, and fire incident data goes beyond gas-fired hot water heaters. It applies equally to any ignition source near floor level, including both electrical and flame sources.

In 1993, A. D. Little did testing for presentation to the CPSC. They used gasoline spills from 0.5 to 2 gallons in closed rooms 8 by 8 feet up to 10 by 20 ft. They found 100% ignitions by floor mounted gas-fired hot water heaters with ignition times in the range 15 to 123 seconds. In tests with elevated gas-fired hot water heaters they found ignition occurred in 3 to 109 minutes with no ignition in 10 of 27 tests. These tests were done in rooms with no mechanical ventilation and no movement by people within the room. They were quiescent. Further testing was reported by Hoffman et al. (2003), which confirmed that gas-fired water heaters can ignite vapors from gasoline spills. This body of work confirms the importance of the height of the ignition source and clearly indicates rapid ignitions are to be expected for ignition sources near floor level.

The stove pilot in the broiler was considered as a potential ignition source. This ignition source was "eliminated" based upon the fact that the stove was several feet from the actual gasoline pour, the pilot was within the broiler drawer, the pilot was six inches above the floor, and Dr. DeHaan identified no blast damage to the broiler door. None of these factors was shown to exclude the stove pilot as a potential ignition source. The location of the stove pilot was not shown to preclude ignition of the gasoline vapors. Like with the hot water heater, there was no analysis performed and the research discussed above concerning the hazards of gas-fired water heaters applies to the stove broiler oven as well.

Indeed, Dr. DeHaan went so far as to assert that the location of the pilot made ignition of the gasoline vapors impossible. His basis for this assertion was a demonstration test he had performed for the fire service in Australia. He placed a candle flame six inches above the floor in the center of a carpeted but otherwise empty room with both a door and window openings. He poured gasoline into the floor and after 20 minutes, the gasoline vapor had not been ignited. He asserted that because the candle flame six inches above the floor had not ignited the gasoline in his demonstration, it followed that the stove pilot could not have ignited the gasoline vapors in this case. In doing so, Dr. DeHaan is proffering a single demonstration test as a scientific inquiry and is further asserting that the particular conditions of the test are relevant to the case

particulars. Clearly, the single test does not constitute any form of scientific inquiry. The finding that gasoline vapors were not ignited in this single test cannot be used to predict the outcome in a broader set of conditions than those of the test. Further, it is obvious that the test does not represent the conditions present in the fire incident. The volume of gasoline used is different, the means of distributing the gasoline is different, the floor covering and room contents are much greater, the ventilation of the space is different, the movement of people is different, to name a few obvious differences.

Dr. DeHaan acknowledged that a ceiling or air conditioner fan would affect the movement of gasoline vapors, yet he relied upon a test in which these factors were missing. He also acknowledged that door openings affect gasoline vapor movement, but yet relied upon a test with door and window openings that cannot be taken to represent the conditions in the fire incident. He acknowledged that the method of distributing the gasoline can impact the movement of vapors, but relied upon a test in which the gasoline was placed gently on a carpeted floor rather than pouring the gasoline onto furniture items via a gas can as occurred in the fire incident. He acknowledged that in his single test that a person walking through the room might have caused the vapors to be ignited by the candle, while he knew that there were people moving through the room in the fire incident. Dr. DeHaan did not and could not show that the results of his single test had any relevance to the particulars of this case. Nonetheless, he inappropriately cited the test as a basis for his opinion. His opinion is in direct contradiction of the data available in the fire science literature discussed above. The location of the pilot within the confines of a water heater are substantially similar to the location of the broiler pilot in the stove. Both pilots are about six inches above the floor, both are in enclosures designed to allow air ingress for combustion, and both are by design competent ignition sources. Dr. DeHaan makes the serious scientific error of relying upon a single test to represent the universe of potential conditions. In this and other instances he takes the position if it is possible that an ignition might not occur that his proposition is proved. It is true that pilot flames near the floor may not always cause an ignition. This, however, does not mean that they never do so. Beyond the fact that this approach violates the scientific method, we know by painful and deadly experience that pilot flames near the floor can and do ignite gasoline vapors.

Dr. DeHaan opined that had the pilot flame ignited the gasoline vapors that the broiler door would have been blown open. He points to a photo that shows the broiler door ajar, but not blown out as evidence that ignition did not occur in the broiler. His assumption that there would be a major overpressure that would blow out the door is implicitly dependent upon the majority of the broiler enclosure having gasoline vapors within the flammable range. Indeed, this can occur and Dr. DeHaan cites it as a certainty based on having observed this behavior in a demonstration test. Again, he takes a single instance of a behavior and blindly asserts that it applies to all situations and in particular the conditions in this fire incident. As admitted elsewhere in his testimony, Dr. DeHaan knows that the gasoline vapors near the floor are too rich to burn and it is only the portion of the vapor layer near the top that can be ignited and support premixed burning. Thus, it is most likely that only a small portion of the broiler compartment would be within the flammable range. This, being the case, the flame can propagate out of the broiler compartment without significant overpressures and without blowing open the door. Dr. DeHaan has no way of knowing what the vapor concentration distribution is within the broiler compartment because he performed no analysis of the vapor flow. He simply says that he has seen it happen so it must always happen. This is neither true nor is it science. It is just another example of Dr. DeHaan's opinions that are based solely upon his say-so. What he may simply believe is not appropriate finding under NFPA 921 nor appropriate expert testimony under *Daubert*. There is no basis for Dr. DeHaan's elimination of the stove broiler pilot as a potential ignition source for this fire.

The room heater was considered as a potential ignition source. Mr. Mitchell had testified that the gas supply to the heater had been turned off months before the incident. Dr. DeHaan did not perform any physical assessment of whether the heater gas supply was in the off position and did not cite any such assessment performed by any other investigator. Solely based upon the testimony that the gas supply had been turned off months before, Dr. DeHaan “eliminated” the heater as the cause of the fire. He failed to test the hypothesis that the heater pilot was indeed off. He simply accepted Mr. Mitchell’s say-so. Mr. Mitchell might or might not have recalled correctly that he had turned off the pilot in the spring. His testimony raises the hypothesis that the pilot was off. However, as a fire investigator, Dr. DeHaan (and the SFMO) have a responsibility to test this hypothesis by examining the condition of the valves within the heater. No fire investigator examined the heater to determine the condition of the valves. Mr. Mitchell might have been wrong in his recollection or someone else may have restarted the heater due to a late spring cold snap. Failure to test a hypothesis is a violation of the scientific method and NFPA 921. As such, it is incorrect to opine that the heater pilot could not have started the fire.

The refrigerator was considered as a potential ignition source. The compressor motor was eliminated based upon the fact that it is sealed. The starter relay was noted to have been housed in a plastic, non-explosion proof enclosure. This relay was “eliminated” based upon Dr. DeHaan’s expectation that there would be a significant delay in ignition due to the time needed for vapors to move into the plastic housing. He did this with no analysis, no methodology, and no identification of the time delay to ignition. His “elimination” was nothing more than an assertion. Dr. DeHaan’s expectation that there would be a significant delay is nothing more than his belief and say-so. It is not the result of the application of the scientific method and is a violation of NFPA 921. The refrigerator cannot be eliminated as a potential ignition source under NFPA 921.

The window air conditioner was considered as a potential ignition source. The compressor motor was eliminated because it is sealed. The fan motor was deemed to be the only potential ignition source within the unit. Dr. DeHaan “eliminated” the air conditioning unit due to the height of the unit above the floor as well as the dilution of the gasoline associated with air flow into the fan motor in the air conditioning unit. He further expected that if ignition occurred within the air conditioner, an explosion within the air conditioner would blow it out of the window. He noted that the air conditioner remained in the window, so that no explosion occurred. He provided no basis for this expectation. He “eliminated” the air conditioner with no analysis, no methodology, and no identification of the extent of air dilution that would have occurred. His elimination was nothing more than an assertion. Dr. DeHaan asserted that the fan motor would not ignite gasoline vapors, based upon his expectation that such an ignition would lead to a significant overpressure within the air conditioner that would propel it out of the window. He cited no scientific source for this assertion and performed no analysis to test the hypothesis. Here again, he identified what might happen and asserted that because it might happen it must happen. This is not the application of the scientific method and does not form the basis for elimination of the air conditioner as a potential ignition source. The simple say-so of an expert is not an appropriate finding under NFPA 921 and is not appropriate testimony of an expert witness under *Daubert*.

While Dr. DeHaan considered each of the five potential accidental ignition sources present, he did not provide a basis for elimination of any of these ignition sources. All his “eliminations” were simply asserted based merely upon his say-so. He did not properly test the hypotheses as required under NFPA 921. He often based his opinions upon his prior observation of a particular outcome, i.e. non-ignition. He then opined that because he had observed an ignition not occurring, that an ignition could not have occurred in this case. In each of these instances this was either based upon a test that did not comport with the case facts or upon a vague statement that he had seen this in the past. While such anecdotal knowledge is useful in

developing hypotheses for testing, it is not an appropriate basis for eliminating hypotheses. The hypothesis can only be eliminated if it does not conform to the case facts or if the hypothesis is found to be inconsistent with our knowledge of fire science.

Dr. DeHaan expressed his methodology as evaluating hypotheses and selecting the best fit hypothesis. This is not the scientific method and is inconsistent with NFPA 921. Under NFPA 921, a final hypothesis must be the one and only hypothesis to survive the rigors of hypothesis testing. It is not the hypothesis that the investigator believes best fits the case facts. It must be the **only** hypothesis that can fit the case facts and our knowledge of fire science. He “eliminated” potential ignition sources simply because he believed them to be unlikely. This is not an application of the scientific method and is a violation of NFPA 921.

Dr. DeHaan opined that Mr. Holiday’s burn injuries indicated that he had set the fire. He performed no analysis of the heating process or the burn injury formation. His opinion was, again, merely based upon his say-so. He admitted that the burns had nothing to do with actually igniting the fire, but that his opinions were simply related to Mr. Holiday having bent over at the time of the ignition. Significantly, Dr. DeHaan admitted that there were other ways that the burn injuries could have been caused. As such, he admitted that his interpretation of the burn injuries was consistent with simply bending over and that the burns could have occurred without even bending over. In short, the burns prove nothing beyond the fact that Mr. Holiday was in a fire. This much a jury could judge for themselves without the speculative opinions of an expert witness. Dr. DeHaan’s testimony with respect to burn injuries had no scientific basis and was simply based upon his say-so.

- **ANALYSIS OF THE ROLE OF THE FIRE INVESTIGATION IN THE JUDICIAL PROCEEDINGS**

Clearly, the investigation of this fire was seriously defective. The expert opinions proffered at trial were inappropriate based upon NFPA 921, the standard of care methodology in fire investigation, and were at substantial odds with the requirements under the U.S. Supreme Court’s *Daubert* criteria.

The SFMO failed to conduct an appropriate investigation under NFPA 921. These serious deficiencies apparently came to the attention of the DA’s. More than six months after the fire, assistance was sought from ATF to review the fire and the case information. On 26 April 2001 CFI Opperman from the Houston ATF Field Office met with Madison County District Attorney Bennett and Sergeant Mitchell of the Texas Attorney General’s Office. CFI Opperman was asked to assist in determining the cause of the ignition of the gasoline fumes. **CFI Opperman advised that the stove pilot and other appliances could not be ruled out as ignition sources.** It was after this that the DA’s reached out to Dr. DeHaan for his assistance. At trial CFI Opperman appeared as a rebuttal witness for the prosecutor and endorsed Dr. DeHaan’s testimony in total.

CFI Opperman also re-interviewed Beverly Mitchell and the only documentation of that interview was in the report CFI Opperman wrote that Mrs. Mitchell reported that Mr. Holiday was holding a handgun and rifle as he leaned on a table in between the recliner and the stove. She said nothing about Mr. Holiday leaning over according to the report. Both weapons were abandoned by Mr. Holiday as he left the building, as the weapons were found in the debris in the room. As such, Mr. Holiday abandoned the weapons that gave him control of the situation, but would have put the lighter he allegedly used to start the fire securely in his pants pocket. This information was never put before the jury. At trial, CFI Opperman testified that Mrs. Mitchell had told him that Mr. Holiday was bending over at the time the fire started. He admitted at trial that

he had no documentation of her having told him that Mr. Holiday was bending over. His only documentation of the interview was the report and it was absent from that report.

The judge chose to conduct the *Daubert-Kelly* hearings in the middle of the trial with each expert considered just before his intended testimony. Thus, had he excluded any testimony or any expert entirely, the party would be substantially blindsided in the middle of the trial. No exclusions were made by the judge on any testimony of any expert. The record of the trial is clear. The judge was uninterested in the hearings and treated them in a *pro forma* manner. He was openly disdainful of the time being taken in the hearing and clearly acted to cause the attorneys to foreshorten their examinations. He did not ask questions to assist him in making his determinations. At the end of the hearing period, the judge made no findings with respect to the methodology employed. He simply indicated that the trial proceedings should continue.

The *Daubert-Kelly* hearings were more like short expert depositions, designed primarily to assure that the opposing party was not blindsided by the intended testimony. The judge made no explicit determinations of the suitability of the proposed testimony based upon an evaluation of the expert's methodology. There was no gatekeeping. The defense counsel did not put forward NFPA 921 as the standard of care and did not question Dr. DeHaan regarding his failures to follow NFPA 921. It would also be fair to say that the defense counsel's questioning was not squarely focused on the *Daubert* criteria. It is also fair to say that the prosecutor who had the burden of proof that his experts' testimony would be reliable did not use NFPA 921 in his questioning to establish the reliability of his expert's testimony.

With respect to Dr. DeHaan's testimony before the jury, he made no reference to the use of the NFPA 921 methodology, made no reference to his use of the scientific method, and generally provided opinion testimony based only upon his say-so. Using the NFA 921 methodology, the cause of this fire is undetermined. There are multiple hypotheses that arise out of the case data that cannot be eliminated. As such, no determination of cause is possible under the NFPA 921 methodology.

- **CONCLUSIONS**

The fire investigation of this fire did not comport with NFPA 921. The scientific method was not used to determine the cause of the fire. Alternate potential ignition sources were not identified and eliminated as required by NFPA 921. Under NFPA 921, given the poor quality of the investigation undertaken, there is no basis for the finding that the fire cause was incendiary because the ignition source was unknown.

The investigation by the SFMO was characteristic of fire investigations in the pre-921 era. The fire investigation myths concerning irregular floor patterns played a prominent role in the SFMO investigation. The SFMO investigation failed to identify and evaluate potential ignition sources. The interviews conducted by the SFMO were inadequate and resulted in incomplete information. The flaws in the early investigation had a serious negative impact on the quality of the evidence available to the jury.

Dr. DeHaan's opinions were based merely upon his say-so. He did not employ the scientific method and provided no scientific basis for his opinions. The opinions were not based upon the application of any methodology. His testimony was of exactly the nature that NFPA 921 and *Daubert* were designed to eliminate. His testimony did great damage to the judicial proceedings. He was allowed to proffer opinions with the appearance of science without any actual scientific basis. He was presented as an authority figure upon whom the jury could reasonably rely. The fact is that his testimony was highly unreliable and had no legitimate place in the judicial proceedings based upon the *Daubert* standards. He did great harm to the place of science in

the courtroom by parading his say-so opinions as if they were scientifically based. The system failed in accepting this testimony.

- **THE BROADER PICTURE**

When the NFPA 921 committee was formed in the late 1980's, the expectation was that 921 would eliminate the old myths of fire investigation and put fire and explosion investigation on firm scientific footings. It took 8-10 years for the community to generally accept 921. Sadly, we have now discovered that having the profession and the courts accept 921 as the standard of care has not solved our problems with the quality of fire investigations.

In the Holiday investigation, the Texas State Fire Marshal's Office had included NFPA 921 as part of its standard operating procedure and Dr. DeHaan fully acknowledged the existence of 921 even though he did not even purport to follow it. Ironically, Dr. DeHaan had served on the NFPA 921 committee. He apparently was happy to tell others how to conduct fire investigations but was not willing himself to be bound by it.

The irony is that NFPA 921 and *Daubert* have had a significant impact on fire and explosion investigation testimony in civil litigation. Sufficient judges in civil matters have excluded all or part of an investigator's testimony such that plaintiff and defense attorneys do not hire and will not proffer experts who do not pass muster under *Daubert* and follow NFPA 921. The quality of reports by experts in civil matters is significantly higher than those in criminal proceedings. The prototypical fire investigation report from public sector investigators used in criminal proceedings is a two-page narrative report. There will typically be other materials like photos (with or without a log), lists of witnesses and their contact information, maybe even a sketch or two. There is no practical way that the use of the scientific method to formulate and test all the required origin and cause hypotheses can be done in a few of pages.

The fact of the matter is that the acceptance of NFPA 921 in the criminal justice system today is *pro forma*. Two-page narrative reports reflecting investigations that fail to fulfill the requirements of NFPA 921 are proffered and accepted in criminal matters every day. Investigators often don't even sign their reports. In other instances they do and their supervisor signs off as a reviewer. Either way, the prototypical report reflecting an investigation that fails to fulfill the requirements of NFPA 921 is accepted by the investigator, the investigator's supervisor, the prosecutor, and the judge. In hearings judges simply do not exclude testimony by investigators in criminal matters. Investigators and prosecutors alike know this, so they are unmotivated to assure high quality investigations. Everyone who has a role in the judicial system has some responsibility for the problem, but let's be honest, responsibility starts at the top. When judges take their gatekeeping role as seriously as they do in civil matters, we will see improvement in the quality of fire investigations. Where judges fail to exclude defective investigation findings in criminal matters, poor quality investigations will continue.

We should not image that these problems are unique to fire investigation. The National Academy of Sciences (2009) had identified many serious problems with the quality of the forensic sciences in general. They made several recommendations to congress for legislative action and none of these recommendations have been acted upon. The only concrete governmental response to the NAS report is joint action of DOJ and NIST to form OSAC (<https://www.nist.gov/forensics/organization-scientific-area-committees-forensic-science>). The goal of OSAC is to facilitate the development and acceptance of consensus standards in forensic science. While this is a needed and worthwhile enterprise, in fire we already have such documents in NFPA 921 and NFPA 1033 and it has not been enough to improve the quality of fire investigation practice (Beyler 2015). We continue to see seriously defective fire investigations and we see them accepted by the courts.

As a society, we have not come to grips with the serious affront to our judicial system posed by junk science. We must all do what we can and that includes speaking out against the abuses.

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CRAIG L. BEYLER, PhD



Craig Beyler, PhD, has 36 years' experience in the fire science and fire protection engineering fields, in private industry as well as academia. He has managed numerous fire science research and development programs in which he develops and uses analytical methods in the areas of fire dynamics, fire chemistry, fire detection, fire suppression, smoke and heat venting. He has planned and conducted investigative, experimental and technical studies for a wide range of fire protection problems for federal, military, civilian, and private sector clients. Dr. Beyler is an elected fellow of the Society of Fire Protection Engineers. He was an editor of the first four editions of the SFPE Handbook of Fire Protection Engineering. He is the founding editor of Fire Science Reviews and the founding editor for the SFPE Journal for Fire Protection Engineering. He currently chairs the NIST OSAC subcommittee on fire and explosion investigation and serves on the NIST OSAC committee on crime scene investigation.

Education

- Ph.D., Engineering Science, Harvard University, 1983
- M.S., Mechanical Engineering, Cornell University, 1980
- M.Sc., Fire Safety Engineering, University of Edinburgh, 1978
- B.S., Fire Protection Engineering, University of Maryland, 1976
- B.S., Civil Engineering, Cornell University, 1975

Professional Highlights

Technical Director, JENSEN HUGHES (formerly Hughes Associates), 1990–2014. Responsible for technical quality of fire protection design, research, and development projects and professional development of engineering staff. Forensic fire analysis. Project manager for a variety of fire protection R&D/T&E programs. Development and use of analytical methods in fire dynamics, fire chemistry, fire detection, fire suppression, smoke and heat venting. Development of mathematical fire models and modeling techniques for specialized applications, including zone and field models. Risk and hazard analysis for a wide range of specialized applications.

Principal, Fire Science Technologies, 1987–1990. Development of compartment fire models including computer-based models and simple correlationally-based models for ships and buildings. Preparation and presentation of a five-day short course for the HAZARD I hazard analysis package. Litigation support for a range of fire situations.

Assistant Professor of Fire Protection Engineering and Mechanical Engineering, Worcester Polytechnic Institute, 1985–1987. Taught graduate courses in Combustion, Fire Dynamics, and Fire Chemistry. Advised MS thesis work for FPE graduate students. Research in fire dynamics including compartment fire growth, smoke movement, pool fire radiation as well as fault tree approaches to link fire growth predictions to performance-based fire safety

objectives.

Visiting Scientist, Fire Research Station at Borehamwood, England, 1984–1985. Conducted experimental and theoretical investigations of piloted ignition of solid fuels. Prepared a review paper of the state-of-the-art of knowledge of plume and ceiling jet flows.

Postdoctoral Fellow, Harvard University, 1983–1984. Conducted an extensive experimental program to study the effect of oxygen starvation effects on the generation of products of combustion, especially carbon monoxide, in a compartment fire environment. Experimental and theoretical studies of hot layer ignition in compartment fires.

Committees, Boards, and Panels

International Association for Fire Safety Science

Chairman, International Association for Fire Safety Science, 2005-2011

Vice Chair, International Association for Fire Safety Science, 2002-2005

Program Committee Chair, International Association for Fire Safety Science–8th International Symposium, 2003-2005

Program Committee, International Association for Fire Safety Science–7th International Symposium, 2001-2002

Awards Committee, International Association for Fire Safety Science–4th and 5th International Symposia

Society of Fire Protection Engineers

SFPE Standards-Making Committee on Calculating Fire Exposures to Structures, 2016-present

Chair, SFPE Standards-Making Committee on Thermal Response of Structures to Fire, 2008- present

Member, SFPE Technical Steering Committee, 1998-2012

Chair, SFPE Task Group on Engineering Practices: Radiation from Fires, 1996- present

Member, Research Committee, Society of Fire Protection Engineers, 1988-1995

Member, Engineering Education Committee, Society of Fire Protection Engineers, 1983-1995

National Fire Protection Association

Toxicity Technical Advisory Committee, National Fire Protection Association, 2002- present

Member, Guide for Fire and Explosive Investigations, NFPA 921, 1998-2011

Task Group for NFPA 204: Guide for Smoke and Heat Venting, 1996-2010

Smoke Management Systems, National Fire Protection Association 1996-2011

Task Group for NFPA 92B: Guide for Smoke Management in Malls, Atria, and Large Spaces, 1992-2010

Member, Contents and Furnishings Committee, National Fire Protection Association, 1992- present

Member, Subcommittee on Fire Detection Design Methods, 72 EM, National Fire Protection Association, 1983-1988

Academic Advisory Boards

Advisory Board, University of Maryland, Dept. of Fire Protection Engineering, 2003-present

Advisory Board, Worcester Polytechnic Institute, Center for Firesafety Studies, 2000-2008

Industrial Advisory Board, Oklahoma State University, Fire Prot. & Safety Engr. Technology Dept., 1998-2006

Government Evaluation Boards

Panel Member, Board on Assessment of NIST Programs, National Research Council, 1999-2005

National Academy of Science, Committee to Identify Innovative Research Needs to Foster Improved Fire Safety in the US, 2001-2002

Crime Scene/Death Investigation Scientific Area Committee, Organization of Scientific Area Committees (OSAC), 2015-present

Chair, Fire and Explosion Investigation Subcommittee, Organization of Scientific Area Committees (OSAC), 2015-present

Technical Journals and Books

Editor, *Fire Science Reviews*, 2012-present
Founding Editor, *Journal of Fire Protection Engineering*, 1988-1992
Associate Editor, *Fire Technology*, 2009-2015
Member, Editorial Advisory Board, *Fire Technology*, 1984-present
Member, Editorial Advisory Board, *Fire Safety Journal*, 2004-2010
Member, Editorial Advisory Board, *Journal of Fire Protection Engineering*, 1992-2013
Co-editor, *SFPE Handbook of Fire Protection Engineering*, 1st, 2nd, and 3rd and 4th editions
Reviewer, *Combustion and Flame*, *Fire Safety Journal*, *Journal of Fire Science*, *Fire and Materials*, *IAFSS International Symposia*, and *Combustion Institute International Symposia*

Associations

- Member, National Fire Protection Association (NFPA)
- Member, International Association for Fire Safety Science (IAFSS)
- Member, Society of Fire Protection Engineers (SFPE)
- Member, Combustion Institute
- Member, Salamander Honorary Fire Protection Engineering Society

Honors

Kunio Kawagoe Gold Medal, Int. Assoc. for Fire Safety Science, to be presented June 2017
Dougal Drysdale Award, Int. Assoc. for Fire Safety Science, 2014.
Rasbash Medal, Institution of Fire Engineers, 2009
Arthur B. Guise Medal, Society of Fire Protection Engineers, 2000
NASA Space Flight Awareness Award-VAB Quantity Distance WG, 2011
Harold E. Nelson Service Award, Society of Fire Protection Engineers, 2005
Fellow, Society of Fire Protection Engineers, 1999
Hat's Off Award, Society of Fire Protection Engineers, 1995
Jack Bono Engineering Communications Award, with Curt Ewing and Homer Carhart, 1995
Special Commendation Award, Society of Fire Protection Engineers, 1995
Special Commendation Award, Society of Fire Protection Engineers, 1993
President's Award, Society of Fire Protection Engineers, 1990
Director's Award, Society of Fire Protection Engineers, 1989

Patents:

Multi-signature Fire Detection, Roby, R.J., Gottuk, D., Beyler, C., Patent Number 5,691,703, November 25, 1997.

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