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Report on the Peer Review of the Expert Testimony in the Cases of

State of Texas v. Cameron Todd Willingham

and

State of Texas v. Ernest Ray Willis

Innocence Project

Arson Review Committee (ARC) Report

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Executive Summary

Neither the fire that killed the three Willingham children nor the fire that killed Elizabeth Grace Belue and Gail Joe Allison were incendiary fires. The artifacts examined and relied upon by the fire investigators in both cases are the kind of artifacts routinely created by accidental fires that progress beyond flashover.

The State's expert witnesses in both cases relied on interpretations of "indicators" that they were taught constituted evidence of arson. While we have no doubt that these witnesses believed what they were saying, each and every one of the indicators relied upon have since been scientifically proven to be invalid.

To the extent that there are still investigators in Texas and elsewhere, who interpret low burning, irregular fire patterns and collapsed furniture springs as indicators of incendiary fires, there will continue to be serious miscarriages of justice.

Continuous (and in some cases, remedial) training and professional development of fire investigators is required. Additionally, participants in the justice system need to become better educated, and more skeptical of opinion testimony for which there is no scientific support, and need to ensure that defendants in arson cases are afforded the opportunity to retain independent experts to evaluate charges that a fire was incendiary.

In the cases of individuals already convicted using what is now known to be bad science (or no science), the Courts should treat the "new" knowledge as "newly discovered evidence." It was resistance to this concept that allowed the State to execute Mr. Willingham, even though it was known that the evidence used to convict him was invalid.

Introduction

The undersigned fire investigators have been requested by the Innocence Project to examine the outcomes of two Texas arson convictions, those of Cameron Todd Willingham and Ernest Ray Willis.[1] The Willis fire occurred in Iraan, Texas, on June 11, 1986, and the Willingham fire occurred in Corsicana, Texas on December 23, 1991. Both cases reached their ultimate conclusion in 2004. On February 17, Cameron Todd Willingham was executed by lethal injection. On October 6, Mr. Willis was freed from the same facility where Mr. Willingham was executed.

Fire is governed by the laws of physics. In order to reach valid determinations, therefore, the investigation of fires must follow the Scientific Method as all other physical science investigations do. After a review of the scientific basis for the determination of arson, the prosecutors in the Willis case acknowledged that his conviction was based on faulty science and unreliable indicators of arson. Even though, for all practical purposes, the interpretations of the physical evidence as testified to in the Willis trial were the same in the Willingham trial and after

[1] None of the authors have received any compensation for this *pro bon*o review, nor will any compensation be accepted.

a similar review determined that the conviction was also based on unreliable indicators, no such acknowledgment has come forward from the prosecutors in that case. While any case of wrongful conviction, acknowledged or not, is worthy of review, the disparity of the outcomes in these two cases warrants a closer inspection.

The primary goal of this review is to identify the factors that led to the conviction of Mr. Willingham and Mr. Willis and to provide recommendations that, if followed, will lead to the undoing of other miscarriages, and prevent future miscarriages of justice with respect to the crime of arson.

Methodology

In any prosecution of arson, there is a bifurcation associated with the burden of proof. Unlike bank robberies or murders, arson prosecutions require that the State first prove beyond a reasonable doubt that the fire was, in fact, intentionally set. In many cases, once this hurdle is overcome, the identity of the perpetrator is obvious. If the fire is intentionally set and the perpetrator is not obvious, the State must further prove beyond a reasonable doubt that the fire was intentionally set by a specific individual(s). If the fire is not intentionally set, however, the potential for a miscarriage of justice does not just lie in the false determination of a set fire. The miscarriage extends to the accusation and potential conviction of an innocent person for a crime that never occurred. Certainly, in the case of the Willingham fire, if the fire was set, Mr. Willingham most likely was the perpetrator. Thus, a threshold question for the jury is not whether the defendant committed the crime, but whether in fact a crime was committed. The jury's determination of the cause of the fire usually rests on the interpretation of post-fire artifacts by expert witnesses.

Beyond the expert's determination of the cause of the fire, however, there is the communication of that opinion to a jury. In effect, the jury is making a second determination, or ratifying the fire investigator's determination. Thus, while looking at photographs of the fire scene and the fire investigator's report will help us to understand how a fire investigator could be mistaken, it is the testimony of the fire investigator that causes a jury to reach its conclusion. Because it is the jury's decision that ultimately determines the outcome of a case, our focus will be mainly on the sworn testimony of the investigators[2] who persuaded the jury to believe that the fires in both cases had been intentionally set.

[2] The testimony under study is both lengthy and repetitive. Thus, the review of the testimony will be somewhat tedious. Because it is so repetitive, however, there is little chance that we have misconstrued the witnesses' meaning.

Review of Testimony and Reports

State of Texas v. Cameron Todd Willingham

Trial Testimony of Manuel Vasquez

Manuel Vasquez was a Deputy State Fire Marshal who was the lead expert witness in the case against Cameron Todd Willingham. After eight years of service in the Army, Mr. Vasquez worked for the Grand Prairie Fire Department for thirteen years, spent three years with the Dallas County Fire Marshal's Office, seven years as the Fire Marshal for the City of Lancaster, and seven years with the Texas State Fire Marshal's Office. Trial transcript at page 227 begins on line 24 with the following:

> Q: And how many fires have you investigated since becoming a Certified Fire/Arson Investigator?
>
> A: Perhaps in the range of 1,200 to 1,500 fires.
>
> Q: Of these 1,200 to 1,500 fires, how many turned out to be arson in your opinion?
>
> A: With the exception of a few, most all of them.
>
> Q: And how many—again, based on your experience, how many arson fires that you investigated involved injuries or deaths?
>
> A: Unfortunately, fires injure a lot of people—kill a lot of people. It's about 50%.

While it is true that State Fire Marshals frequently do not receive requests to investigate fires that are known to be accidental, "most all of them" is an extremely high percentage of fires to have been determined to be arson. There are many organizations including the National Fire Protection Association (NFPA), the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF), the United States Fire Administration (USFA), and the Federal Bureau of Investigations (FBI) that collect and compile statistics on the crime of arson that can be used to compare Mr. Vasquez's estimates. The most relevant data with respect to this case is from the Texas State Fire Marshals Office (TSFMO). Table 1 provides the number of fires investigated by the TSFMO versus the number of fires investigated that were determined to be arson. From the period of 1980 to 2005, the average percentage of fires determined to be arson by the TSFMO was 50%. A 50% arson rate would not be considered to be "most all of them," as testified to by Mr. Vasquez.

Furthermore, the injury rate estimated by Mr. Vasquez is exceptionally high when compared with national fire statistics. Table 2 provides the number of fires reported annually and the number of fire-related deaths and injuries from data compiled by the U.S. Fire Administration.

YEAR	SET FIRES / INVESTIGATIONS	PERCENT
2004	229 of 507	45%
2003	274 of 550	50%
2002	343 of 678	51%
2001	217 of 487	45%
2000	241 of 556	43%
1999	216 of 481	45%
1998	219 of 531	41%
1997	209 of 433	48%
1996	352 of 754	47%
1995	333 of 624	53%
1994	311 of 552	56%
1993	276 of 524	53%
1992	269 of 486	55%
1991	247 of 415	60%
1990	227 of 428	53%

Table 1 – Number of Set Fires versus the Number of Fires Investigated (Source: Texas State Fire Marshal's Office, Department of Insurance). Copyright 2006, Chicago Tribune

From the period of 1995 to 2005, the average annual percentage of fires that resulted in deaths was 0.23% and the average annual percentage of injuries was 1.22%. Again, Mr. Vasquez's overestimation of the death and injury rates shows a lack of knowledge in this area. Such comparisons highlight his bias towards arson determinations and a lack of knowledge of the death and injury rates in his home state. Of course this overestimation may simply have been an attempt to prejudice the jury. Mr. Vazquez's characterization that "most all" of his fire investigations are arsons alerts the jury that this case must also be an arson case because Mr. Vasquez has investigated it. He should have been challenged in cross-examination on these estimates with respect to his credibility as an expert witness.

YEAR	FIRES	DEATHS	INJURIES	DIRECT DOLLAR LOSS IN MILLIONS
1995	1,965,500	4,585	25,775	$9,182
1996	1,975,000	4,990	25,550	$9,406
1997	1,795,000	4,050	23,750	$8,525
1998	1,755,000	4,035	23,100	$8,629
1999	1,823,000	3,570	21,875	$10,024
2000	1,708,000	4,045	22,350	$11,207
2001[3]	1,734,500	3,745	20,300	$10,583
2001[4]	1,734,500	2,451	800	$33,440
2002	1,687,500	3,380	18,425	$10,337
2003	1,584,500	3,925	18,125	$12,307
2004[5]	1,550, 500	3,900	17,785	$9,794

Table 2 - Number of fires, deaths, injuries and dollar loss in the United States from 1995 to 2004. (Source: United States Fire Administration)

On page 232 of the trial transcript, Mr. Vasquez provided the kind of testimony very typical of under-trained fire investigators in that time period.

> "All fire goes up. All water goes down. Or any liquid goes down unless man changes the course."

At page 238, Mr. Vasquez's testimony moves into the interpretation of alleged "pour patterns" on the floor in a compartment (room) fully involved in fire. The following testimony begins at line 16.

> "So this area right here are what I call burn trailers. Burn trailers is like a trailer, you know like a little path, a burnt path. A pour pattern, which is a pattern like somebody put some liquid on the floor or wherever; and, of course, when you pour liquid, then it creates a puddle. Liquids create puddles.[6] When it rains, you get puddles. When the baby drops its milk, you create puddles. If you ever drop a Coke, you create puddles. All this area has that, has the burn trailer pour patterns and configurations.
>
> This area right here, which is right here almost in front of this bed, is deep charred. The floor, it didn't burn through the floor but it burned the three layers of

[3] Excludes the events of September 11, 2001.
[4] These estimates reflect the number of deaths, injuries and dollar loss directly related to the events of September 11, 2001.
[5] The decrease in direct dollar loss in 2004 reflects the Southern California wildfires with an estimated loss of $2,040,000,000 that occurred in 2003.
[6] The transcript actually reads "Liquids **creates** puddles." Because of the possibility that many grammatical errors are actually transcription errors, this report will not gratuitously reprint grammatical errors, unless failing to do so would alter the meaning of the testimony.

> the floor. And a pour pattern and trailer is an indication that somebody poured something, you know, either going in or going out."

Later, on page 239 at line 15, he states:

> "It indicates—you are beginning to see the puddle configurations, the pour patterns right here in this area in front of the bedroom, but in the hallway—again, now, we are looking at this area right here just before you go into the bedroom, you are still in the hallway. This picture right here, that's Exhibit #27. And you got a char burning, like for example, this is the bottom here is burned down here at the bottom. That is an indicator in my investigation of an origin of fire because it's the lowest part of the fire."

When a fire occurs inside a compartment (i.e. a compartment fire[7]), the fire behaves differently than if it is burning in the open[8]. Following ignition, while the fire in a compartment is still relatively small, it will be burning freely[9,10]. If it can grow in size, either through flame spread across the first ignited fuel or by spreading to adjacent fuels, a stage will be reached when the compartment boundaries influence the development of the fire[11]. Due to buoyancy, the heated products of combustion from a fire in the open rise as a column of hot gas referred to as a *thermal plume*. When the rising thermal plume impinges on the ceiling of a compartment, the flow of hot gases is forced to spread horizontally in all directions until the flow is redirected by any intervening walls. When the hot products of combustion can no longer spread horizontally, a layer will start to develop, descend, and become relatively uniform in depth. This layer is referred to as the *upper layer*, also known as the *ceiling laye*r. Mass and energy are transported from the fire source to the upper layer through the thermal plume. If the fire continues to grow in size, the upper layer will increase in depth and temperature. In the early stages of a compartment fire, convection is the most significant mode of heat transfer in the room of origin and throughout the building. As the temperature of the upper layer increases, thermal radiation becomes the dominant mode of heat transfer.[12].

When the temperature of the upper layer reaches approximately 1,100-1,200 ^{o}F, there is sufficient thermal radiation (i.e. 20 kW/m^2) reaching the fuel packages within the compartment to ignite every exposed and "easily-ignitable" combustible surface in the room. This level of thermal radiation has been defined as the onset of *flashover*, which is a transitional event that marks a change from a condition where the fire is dominated by the burning of the first item ignited to a condition where the fire is dominated by the burning of all combustible items in the compartment. The post-flashover condition is referred to as a *fully developed fire* or *full room involvement*. Flashover also marks a transition from a fuel-controlled fire to a ventilation-

[7] The term "compartment fire" is defined as a fire that is confined within an enclosure such as in a room or building.
[8] Drysdale, D., *An Introduction to Fire Dynamics*, second edition, John Wiley & Sons, New York, 1999.
[9] The term "burning freely" is defined as a fire whose pyrolysis rate and heat release rate are affected only by the burning of the fuel itself and not by the presence of any boundaries of a compartment.
[10] Walton W. D., and Thomas, P. H., "Estimating Temperatures in Compartment Fires," in *The SFPE Handbook of Fire Protection Engineering*, 2nd edition,, Society of Fire Protection Engineers, Quincy, MA, 1995.
[11] Drysdale, D., *An Introduction to Fire Dynamics*, second edition, John Wiley & Sons, New York, 1999.
[12] NFPA 921, *Guide for Fire and Explosion Investigations*, National Fire Protection Association, Quincy, MA, 2004.

controlled fire. The size of the fire (i.e. the heat release rate) in the fuel-controlled phase is dependent on how much of the surface area of the fuel package(s) is burning at any given time. In the ventilation-controlled phase, the size of the fire is dependant on the rate of inflow of air into the compartment. The post-flashover compartment fire is characterized by the entire volume of the compartment being filled with flames, and any unburned fuel produced within the compartment can be burned at ventilation openings (e.g. open doors and windows) where the fuel can be mixed with available air. This burning regime will produce conditions sufficient to burn and consume materials lining the compartment, such as floors, ceilings, and walls. This process can create patterns on those surfaces of the type described by Mr. Vasquez as "puddle configurations" and "pour patterns." More importantly, these patterns can be created in compartment fires where no flammable liquids were introduced. Surprisingly, such knowledge of compartment fires was readily available to the fire investigation community in the *Fire Investigation Handbook*[13] published in 1980, more than a decade before the Willingham fire.

In order for any investigator, including Mr. Vasquez, to credibly identify the fire pattern as being the result of an ignitable liquid, he would have had to possess knowledge that would allow him to distinguish the characteristics of patterns on the floor that resulted from a fully involved compartment fire where flammable or combustible liquids were introduced from patterns on the floor created by a fully involved compartment fire where no such flammable or combustible liquids were introduced. Such knowledge exists only in the imagination of certain fire investigators. While Putorti[14] documented the patterns resulting from the burning of flammable and combustible liquids on different flooring materials, the purpose of his work was to provide a method for predicting the quantity of spilled fuel required to form a burn pattern of a given size. In addition, these tests were not conducted in an enclosed compartment that produced post-flashover burning. Putorti[15] also conducted full-scale tests of compartment fires to provide data for the study of burn patterns. The goal of the project was to produce data that would support conclusions on the impact of the fire ignition method (accidental vs. arson) on the formation of burn patterns. Based on this work, significant differences in the condition and appearance of the fire compartments and contents were observed between experiments with the same method of ignition. Simply stated, **the patterns produced could not be used to discriminate an arson fire from an accidental fire.**

The United States Fire Administration also conducted a study of fire patterns in compartments with and without the use of an accelerant[16]. One of the findings of the study was that the presence of floor patterns in a compartment, which experienced post-flashover conditions, is not a reliable indicator of the presence of an ignitable liquid introduced as an accelerant. Thus, the knowledge required to discern patterns produced by ignitable liquids from those in un-accelerated compartment fires was not available at the time of this fire, and subsequent experimental testing has shown that it is not possible to correctly evaluate a fire in a fully

[13] Brannigan, F. L., Bright, R. G., and Jason, N. H., *Fire Investigation Handbook*, National Bureau of Standards Handbook 134, National Bureau of Standards, Washington, D.C., August, 1980.
[14] Putorti, A. D., "Flammable and Combustible Liquid Spill/Burn Patterns," NIJ Report 604-00, National Institute of Justice, Washington, D.C., March 2001.
[15] Putorti, A. D., "Full Scale Room Burn Pattern Study," NIJ Report 601-97, National Institute of Justice, Washington, D.C., December 1997.
[16] Shanley, J. H., "Report of the United States Fire Administration Program for the Study of Fire Patterns," FA 178, Federal Emergency Management Administration, United States Fire Administration, July 16, 1997.

involved compartment as being the result of ignitable liquids on the basis of the appearance of the floor. Yet, that is exactly what happened time after time prior to the early 1990s. Unfortunately, some of these same misinterpretations still happen today.

In order to credibly identify the fire pattern as being the result of an ignitable liquid, it is necessary for a laboratory to find the ignitable liquid residue in samples of the debris. Laboratory techniques that were available to the State of Texas in 1992 were sufficient to detect quantities of ignitable liquid residue as small as 0.1 ml, or 1/500 of a standard drop.

The misconception that he could identify the cause of a fire pattern based on visual inspection was not Mr. Vasquez's only error. Describing the condition of bedsprings, on page 241, he states:

> "The springs were burned from underneath. This indicates there was a fire under this bed because of the burn underneath the bed."

Perhaps the fire did, at some point, burn underneath the bed, but this is a natural progression in a fully involved compartment fire, especially when polyurethane foam is involved, which can melt, drip and form a pool fire on surfaces under furniture. This is demonstrated in the USFA study of burn patterns[17]. In Test 7, the compartment went to flashover and was allowed to burn for a couple of minutes before manual suppression was initiated. Based on the post-fire observations, it was evident that the fire was able to spread and cause damage to the floor under a bed.

Mr. Vasquez indicates that he understands the nature of expert testimony: that of interpreting fire artifacts for the jury. At page 244, he states:

> "The fire tells the story. I am just the interpreter. I am looking at the fire, and I am interpreting the fire. That is what I know. That is what I do best. And the fire does not lie. It tells me the truth."

Unfortunately for Mr. Willingham, while the fire may not have "lied," Mr. Vasquez misinterpreted what it was telling him. Such willingness to offer "expert" testimony, while lacking the knowledge to present accurate information to the jury, may excuse Mr. Vasquez's many serious errors. The judicial system that allows such testimony to be presented, however, is clearly flawed and in need of reform.

At page 249, Mr. Vasquez provided some truly remarkable (and seriously mistaken) testimony that may have convinced the jury that this fire burned "hotter than normal." He stated, beginning at line 7:

> "This is the same area except I'm outside. I'm taking the picture looking inside, and this time I'm looking at the aluminum threshold. And aluminum melts at

[17] Shanley, J. H., "Report of the United States Fire Administration Program for the Study of Fire Patterns," FA 178, Federal Emergency Management Administration, United States Fire Administration, July 16, 1997.

> 1,200º normal. Wood fire does not exceed 800º. So to me, when aluminum melts, it shows me that it has a lot of intense heat. It reacts to it. That means its temperature is hot. The temperature cannot react. Therefore the only thing that can cause that to react is an accelerant. You know it makes the fire hotter. It's not normal fire. It's Exhibit #43."

First, there exists no such entity as a "normal" fire. Hostile fire in a structure is by definition an "abnormal" event. There is only the fire's behavior and the investigator's expectations of fire behavior. If the investigator's expectations about fire behavior are not properly "calibrated," the investigator will make misinterpretations. For example, the notion that an accelerated fire burns at higher temperatures than an unaccelerated fire is an appealing one, but it is simply incorrect. It can be easily demonstrated that this notion is verifiably false using classical thermodynamic analysis techniques. Adiabatic flame temperature calculations[18] have been well established for more than a century and clearly demonstrate that a well-ventilated gasoline fire produces flame temperatures virtually the same as a well-ventilated wood fire. Further, controlled burns where fire investigators "tested" various principles in fire science have produced repeatable results in which the range of temperatures attained by unaccelerated fires were of the same magnitude as those in which ignitable liquids were used. In 1992, unfortunately, such knowledge was relatively new to the fire investigation community, having been published in the first edition of NFPA 921[19]. The proposition that wood fires do not exceed 800º is an incredible one.[20] Aluminum has a melting point in the range of 1000 to 1200 °F and regularly melts in un-accelerated compartment fires, which can achieve average temperatures in the range of 1,000 to 2,000 ºF[21]. Thus, there is nothing unusual about finding melted aluminum, or even melted copper, in a compartment fire when the room becomes fully involved. The statement, "Therefore the only thing that can cause that to react is an accelerant," would be sufficient in itself to cause a trusting jury member to believe that the fire was intentionally set.

All of the authors have reviewed a 52-minute videotape showing the scene of the fire. Mr. Vasquez claimed, beginning at page 255, that there were multiple points of origin. This is another assertion that has no support. Because of the convincing nature of the proposition that accidental fires are only supposed to have one point of origin, if the jury believes there are multiple points of origin, they are likely to believe the fire was intentionally set. He says:

> "So there were three areas of origin."

He further stated:

> "Multiple areas of origin indicate—especially if there is no connecting path, that they were intentionally set by human hands."

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[18] Holman, J. P., *Thermodynamics*, Fourth Edition, John Wiley & Sons, New York, 1988.

[19] NFPA 921, *Guide for Fire and Explosion Investigations*, National Fire Protection Association, Quincy, MA, 1992.

[20] Because he was using the Fahrenheit melting temperature of aluminum, we infer that he was also using the Fahrenheit scale when he stated that wood fires do not exceed 800 degrees.

[21] Drysdale, D., *An Introduction to Fire Dynamics*, second edition, John Wiley & Sons, New York, 1999.

In fact, as shown in the videotape, all of the burned areas in this residence were contiguous. There is a "connecting path." That path might not always be visible on the floor, simply because fire is a three-dimensional phenomenon. Even if we assume for the sake of argument that Mr. Vasquez's repeated assertions that there was liquid accelerant used in this fire are correct, the distance between the three alleged areas of origin would not constitute an effective separation for a flammable liquid because the vapor would simply flash across the intervening space between the alleged pools of liquid fuel. In essence, there could only have been one origin given Mr. Vasquez's determination.

When asked to explain what "indicators" mean, he states:

> "The first incendiary indicator is the auto-ventilation. The inconsistency of the fire going out of this window and the fire going out of the door and this window here that's inconsistent with fire behavior. That's an indicator it's a possible incendiary fire.
>
> Okay. Puddle configurations, pour patterns, low char burning, charred floor, the underneath burning of the baseboard, the brown stains on the concrete, the underneath of the bed, because of the fire right underneath the bed, puddle configurations in that area, and the total saturation of this floor is indicated with pour patterns, because that's all I'm doing is looking at the facts, at the evidence. That's all I'm using."

The "first incendiary indicator," i.e., auto-ventilation, is a term of art used by fire fighters to describe ventilation paths not created by the actions of those fighting the fire. Window breakage is a common example of "auto-ventilation" and is consistent with unaccelerated compartment fires. A classic example of window breakage in an un-accelerated compartment fire is shown in the NFPA video Fire Power[22], which was produced in 1985. The mechanism of window breakage in fires due to thermal exposure was first studied experimentally by Bart and Sung[23] at Harvard University in 1977. Subsequent papers have been published that have verified and expanded on this research.[24,25,26,27,28,29,30,31] The conclusion of this extensive research is that glass

[22] Fire Power (Video), NFPA, Quincy, MA, 1985.
[23] Barth, P.K., and Sung, HT, "Glass Fracture under Intense Heating," Senior Project ES96, Harvard University, 1977.
[24] Emmons, H. "The Needed Fire Science," *Fire Safety Science – Proceedings of the First International Symposium*, 1986.
[25] Skelly, M. J., Roby, R. J., and Beyler, C. L., "An Experimental Investigation of Glass Breakage in Compartment Fires, *Journal of Fire Protection Engineering*, 3 (1), pp 25 – 34, 1991.
[26] Pagni, P.,J., "Thermal Glass Breakage," *Fire Safety Science – Proceedings of the Seventh International Symposium*, 2002.
[27] Hassani, S. K. S., Shields, T. J., and Silcock, G. W. H., "An Experimental Investigation into the Behavior of Glazing in Enclosure Fire," Chapter 1, *The Behavior of Glass and Other Materials Exposed to Fire*, Volume 1, Applied Fire Science in Transition Series, Baywood Publishing Company, Amityville, NY, 2002.
[28] Hassani, S. K. S., Shields, T. J., and Silcock, G. W. H., "Thermal Fracture of Window Glazing: Performance of Glazing in Fires," Chapter 2, *The Behavior of Glass and Other Materials Exposed to Fire*, Volume 1, Applied Fire Science in Transition Series, Baywood Publishing Company, Amityville, NY, 2002.

exposed to a fire breaks due to the temperature differential between the exposed and unexposed areas of the window glass.

In addition, it is undisputed that Mr. Willingham himself created most of the initial ventilation paths. Mr. Willingham stated that he exited the house through the front door. The rear exterior door located in the kitchen was found to be obstructed by a refrigerator preventing the use of this door as an exit by occupants. Mr. Willingham stated that he broke out the two front windows on the front porch using a pool cue. This information was apparently disregarded in Mr. Vasquez's analysis of this fire, but had significant implications with respect to any determination that "auto-venting" was the "first incendiary indicator". Aside from the lack of attention paid by Mr. Willingham's counsel to such inconsistencies, disregarding data that does not fit one's hypothesis is a clear violation of the scientific method. The scientific method requires that **all** of the data gathered be used to test any developed hypothesis. Again, such knowledge is relatively new to the fire investigation community. Although the scientific method had its origins and acceptance in the mid-1600s [32] and has been used in forensic analyses in other disciplines for more than a century, it was not explicitly recommended for use in fire investigations until the first edition of NFPA 921 was issued in 1992.[33]

Each and every one of the "indicators" listed by Mr. Vasquez means absolutely nothing, and, in fact, is expected in the context of a fire that has achieved full room involvement, as this fire clearly did. Low burning, charred flooring and burning underneath items of furniture are common characteristics of a fully involved fire.[34] They mean nothing with respect to the origin and cause of the fire, and they absolutely do not support any hypothesis that the fire had been accelerated by liquid fuels.

On the next page of the transcript (256) Mr. Vasquez stated:

> "So when I found that the floor is hotter than the ceiling, that's backwards, upside down. It shouldn't be like that. The only reason that the floor is hotter is because there was an accelerant. That's the difference. Man made it hotter or woman or whatever. Human being made it hotter."

Such reasoning shows a lack of knowledge of compartment fire dynamics and the response of building materials when exposed to fire. It is impossible during a compartment fire for the

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[29] Hassani, S. K. S., Shields, T. J., and Silcock, G. W. H., "In Situ Experimental Thermal Stress Measurements in Glass Subjected to Enclosure Fires," Chapter 3, *The Behavior of Glass and Other Materials Exposed to Fire*, Volume 1, Applied Fire Science in Transition Series, Baywood Publishing Company, Amityville, NY, 2002.

[30] Hassani, S. K. S., Shields, T. J., and Silcock, G. W. H., "The Behavior of Single Glazing in an Enclosure Fire," Chapter 4, *The Behavior of Glass and Other Materials Exposed to Fire*, Volume 1, Applied Fire Science in Transition Series, Baywood Publishing Company, Amityville, NY, 2002.

[31] Hassani, S. K. S., Shields, T. J., and Silcock, G. W. H., "The Behavior of Double Glazing in an Enclosure Fire," Chapter 5, *The Behavior of Glass and Other Materials Exposed to Fire*, Volume 1, Applied Fire Science in Transition Series, Baywood Publishing Company, Amityville, NY, 2002.

[32] Lentini, J., *Scientific Protocols in Fire Investigation*, CRC Press, 2006.

[33] NFPA 921, *Guide for Fire and Explosion Investigations*, National Fire Protection Association, Quincy, MA, 1992.

[34] See USFA Fire Burn Pattern Tests. Patterns on floor surfaces were produced in fire tests where post-flashover conditions were produced without the use of ignitable liquids. Examples include Tests 2, 5, 7, and 9.

temperatures to be greater at the floor than at the ceiling with the exception of the volume within the fire plume. Prior to flashover, buoyancy drives the hot products of combustion to the ceiling through the thermal plume, where a hot upper layer at the ceiling forms. As a first approximation, the lower layer is at ambient temperatures. During post-flashover conditions, flames fill the volume of the compartment, so for all practical purposes, the temperature is the same at the floor as at the ceiling. Thus, the temperatures at the floor are never higher than at the ceiling.

With respect to the response of the building materials, the walls and ceiling of the front bedroom were constructed of gypsum wallboard, while the floor was constructed of wood overlaid with tile, padding and carpet. The major component of gypsum wallboard is calcium sulfate dihydrate, ($CaSO_4 \cdot 2H_2O$). Because of the chemically bound water, gypsum wallboard has the ability to absorb a significant amount of heat, which drives off the water before the wallboard experiences calcination and eventually, structural failure.[35] Gypsum wallboard is able to withstand post-flashover conditions for a significant period of time (tens of minutes) before failure occurs, and is one of the more reliable materials used in the construction of fire-resistant barriers. Carpet, padding, floor tile, and wood, on the other hand, are easily ignitable fuels, when exposed to post-flashover conditions. Thus, given full room involvement, one would **expect** that the flooring materials would be more heavily damaged than the less combustible walls and ceilings. To interpret this natural fire progression as evidence of incendiarism is false and extremely misleading. Mr. Vasquez might not have known better, but his testimony was misleading nonetheless.

Fire investigators who reach false conclusions, then hear descriptions of events from fire survivors that do not comport with their conclusions, frequently have testified that only the killer or the arsonist has a motive to lie. The undersigned investigators, having been involved in cases of fires misattributed to arson, are familiar with this phenomenon. Mr. Vasquez first formed the conclusion that the fire was intentionally set. Then he was allowed to tell the jury:

> "I've talked to the occupant of this house and I let him talk and he told me a story of pure fabrication."

Mr. Vasquez's only basis for reaching that conclusion was his own misinterpretation of the meaning of the fire artifacts that he observed. He stated over and over:

> "He just talked and he talked and all he did was lie." (Page 260)

> "He said what he said he had done is inconsistent with the burn patterns in the house." (Page 261)

Mr. Vasquez testified at page 262 that Mr. Willingham's injuries were self-inflicted. Based on his misinterpretation of the fire artifacts and the "inconsistent" description of events provided by

[35] McGraw, J. R., Jr., and Mowrer, F. W. Flammability and Dehydration of Painted Gypsum Wallboard Subjected to Fire Heat Fluxes," *Fire Safety Science – Proceedings of the Sixth International Symposium*, International Association for Fire Safety Science, Boston, MA, pp 1003-1014, 2000.

Mr. Willingham, Mr. Vasquez was allowed to testify to the ultimate issue on page 268 when the following exchange took place:

> Q: Do you have an opinion as to who started fire?
>
> A: Yes, sir.
>
> Q: What is that opinion?
>
> A: The occupant, Mr. Willingham.

Later, on redirect examination, he not only was able to testify that the fire was intentionally set by Mr. Willingham, but that his intent was to kill his children. Mr Vasquez stated:

> "The fire, itself, tells me that it's a very aggressive fire; and, therefore, the fire was not a planned fire. It was a spur-of-the-moment fire."

Thus, while Mr. Vasquez claims the ability to divine intent, he can provide no motive other than a "spur-of-the-moment" decision.

Trial Testimony of Douglas Fogg

Douglas Fogg was the Assistant Fire Chief for the Corsicana Fire Department. He had worked for the fire department for a little over 22 years at the time of his testimony. That was the only qualification presented prior to the Mr. Fogg being allowed to present expert opinion testimony. Although no testimony was elicited indicating that he had been trained in fire investigation, there was no objection from the defense.

Mr. Fogg seemed to harbor many of the same misconceptions held by Mr. Vasquez, particularly the notion that without the use of accelerants, fire will only burn upward. He stated, at page 159,

> …and as we started removing debris from the floor, as we had low burn, we started finding configurations of puddling effects, pouring effects of a liquid or what we would consider a liquid being used to accelerate a fire.

In this testimony, Mr. Fogg was describing fire patterns on the floor, which have been scientifically proved to be the natural result of fires in fully involved compartments.

At page 160, he eliminates the electrical wiring as an ignition source. He stated:

> The electrical, you look at the electrical wiring for evidence of shorts from the outlets, from fixtures, so forth. There again, those were eliminated.
>
> Q: Do you feel that you eliminated gas as a cause or an electrical cause as the origin of this fire?

A: Yes.

Mr. Fogg did not explain how he was trained to examine electrical systems in appliances, nor was there any significant cross-examination on the subject.

On the next page (161) he again referred to "pour patterns, puddling effects – were evidenced on the floor."

On page 165, he described an unusual burning characteristic in State's Exhibit 6.

Q: Does that photograph exhibit an unusual burning characteristic?

A: Yes, it does.

Q: Can you explain what it is?

A: Yeah. When a fire normally burns, it burns up. As heat rises, flames go up. This burning characteristic had fire going under the threshold plate, which is very unusual in that it should have been protected from flame itself under that base plate.

This is the central misconception held by many fire investigators at that time, i.e., that fire burns up and does not burn downward without "help." Mr. Fogg was asked, "To what do you attribute that?" and answered, "Liquid being used to accelerate the fire."

The threshold plate was constructed of aluminum, which was fixed on top of a wooden base plate. During post-flashover conditions (i.e. an under-ventilated fire), all of the fuel being produced within the bedroom and hallway is not able to burn within the compartment. The flow of unburned hydrocarbons (i.e. gaseous fuel) through compartment openings, such as open doors and windows, allows the fuel to mix with the surrounding air and burn. This is commonly referred to as *vent burning*. This phenomenon can produce significant thermal radiation exposure to the threshold of an open doorway. In this case, the aluminum threshold, which has a relatively high thermal conductivity, allows the heat that is radiated to its surface from above to be transferred through the aluminum to the wood surface below. Such heat transfer is capable of significant heating of the wood below, resulting in the charring of the wood. The wood does not have to burn to produce such damage—it only has to char. In addition, the burning of the base plate below the threshold is precluded by the lack of access of air sufficient to produce flaming combustion. Thus, ignitable liquids would not be capable of producing the charring on the wood base plate.

Testimony about the flammable liquids was repeated several more times. At page 166, Mr. Fogg stated, "The staining left is very characteristic of liquid burning on the concrete." He was asked further, "Did you find evidence of an accelerant in this fire?" and answered, "Yes we did."

At page 167, describing the overall impression from the photographs he was asked,

Q: In your opinion are these clear examples of accelerants?

A: Very clear. Yeah.

It was widely taught that "puddle shapes" and "liquid-type" patterns were unequivocal evidence of accelerants in 1992 when NFPA 921 was first issued. By 2004, it was well known and generally accepted in the fire investigation community that such patterns were subject to misinterpretation in fully involved compartments, and that the only way to credibly identify a flammable liquid induced fire pattern was to obtain a positive laboratory result. What was generally accepted in 1992 is no longer generally accepted, and has not been generally accepted for most of the last ten years, except by a dwindling group of die-hard "experts," who refuse to accept the scientific data in front of them.

Report of the Texas State Fire Marshal

While the report of Fire Marshal Manuel Vasquez was not part of the trial record, an examination of the report aids in the understanding of his testimony. Even when an investigator does not convey all of his findings to the jury, the misinterpretations that an investigator believes may result in stronger, more confident and therefore more believable testimony.

Page 2 of Mr. Vasquez's report is particularly instructive when he describes the hallway. He states:

> The view of the hallway towards the south disclosed that the east and west walls on the north end had burn patterns from the base of the floor to the ceiling. The fire did not burn through the ceiling. The burn pattern on the east and west wall of the hallway disclosed a gradual climb in a 45º angle toward the south end and clearly showed a 'V' pattern. This 'V' pattern is an indicator that the fire originated on the floor near the north end. An examination of the baseboards on the north end on the east and west wall disclosed a low char burn pattern. The examination of the aluminum threshold at the base of the entrance door from the porch into the center hallway disclosed a burn pattern underneath. This is an indication that a liquid accelerant flowed underneath and burned.

'V' patterns are routinely observed in compartment fires during post-fire investigations and are recognized and discussed in NFPA 921. A 'V" pattern only establishes that a fuel package (e.g. upholstered chair) burned during the course of the fire, resulting in the development of an identifiable pattern. The pattern provides no information as to the time of ignition and thus, cannot be used as an indicator of the origin of the fire.

Further, as stated earlier, it is impossible for flammable liquid to flow underneath a threshold and burn, because there is a lack of available oxygen under the threshold to support flaming combustion. The threshold is, however, capable of absorbing thermal radiant energy and conducting that energy downward through the aluminum, resulting in the charring of the wood below. The description of the baseboards being burned all the way to the floor level is a classic indication of a fully involved compartment, wherein one would expect to find irregular patterns

burned into the floor. Instead of interpreting this pattern as the result of full room involvement, however, Fire Marshal Vasquez interpreted it as "a burn trailer, pour pattern, and puddle configuration." Throughout his report, Fire Marshal Vasquez continues to use the phrase "the burn trailers, pour patterns, and puddle configurations" when describing what are nothing more than irregular patterns burned into the floor as the result of full room involvement. His report, however, states that these patterns constitute "evidence that the floor was poured with a combustible liquid accelerant and ignited."

In addition to his misconceptions about the causes of burning on the floor level and the shape that burning might take, Fire Marshal Vasquez held another belief, about crazed glass. He stated at page 4,

> The pieces of broken window glass on the ledge of the north windows to the northeast bedroom disclosed a crazed 'spider webbing' condition. This condition is an indication that the fire burned fast and hot.

Actually, this condition is an indication that the glass was at one time hot and was rapidly cooled. Crazed glass is not caused by rapid heating and cannot be caused by rapid heating. It is **always** caused by rapid cooling. The misconception about crazed glass was widely held in the United States and widely published in fire investigation texts. Additionally, this misconception was taught at the National Fire Academy.[36] In addition, the 'spider webbing' condition can also be the result of the mechanical breakage of window glass, which is consistent with Mr. Willingham's statement that he used a pool cue to break out the bedroom windows on the front porch.

In describing the concrete floor of the front porch, Fire Marshal Vasquez wrote, "The examination of the porch concrete floor disclosed an area of brown discoloration at the base of the north wall and in front of the door to the central hallway. This discoloration, or brown condition, is also an indication that a liquid accelerant burned on the concrete." This statement by Mr. Vasquez has absolutely no basis in fact. The behavior of concrete in fires, including the development of various colors, has been extensively studied.[37] There is no scientific basis for Mr. Vasquez's statement about the brown discoloration being an indication of the presence of accelerants.

Fire Marshal Vasquez goes on to describe his determination that the fire had "multiple origins." It is generally accepted by the public that a fire having more than one origin was intentionally set, because accidental fires almost always begin in one and only one place. The only credible way to determine multiple origins, however (barring the existence of a surveillance video tape), is to find areas of burning that are completely disconnected from other areas of burning in all

[36] The myth of crazed glass indicating rapid heating was published in the NBS *Fire Investigation Handbook* in 1980, in Section 1.1, entitled "Cause and Origin." The only individuals given the "credit" in the list of contributors for this paragraph in the *Handbook* were Steve W. Hill and Victor U. Palumbo, both of whom were employed by the National Fire Academy.

[37] For a more extensive discussion of the mythology of arson investigation, including myths about the behavior of concrete in fires, see Lentini, J. J., *Scientific Protocols for Fire Investigation*, CRC Press, 2006, Chapter 8.

three dimensions. No such separated areas of unconnected burning existed in the Willingham residence.

At page 5, Fire Marshal Vasquez arrives at the ultimate issue in this case by stating that because his determination of the cause of the fire is different from the story told by the survivor, the survivor must be lying. He states:

> Further, based on the more than 20 indications of incendiarism and the behavior of fire the account given by the occupant of how he escaped the fire is not consistent with the facts. The account is determined to be pure fabrication. A fire does not lie."

All of the authors have seen reports like this one. If the Fire Marshal's determination is wrong, his identification of the "lies" told by the defendant is equally wrong. The statement that "a fire does not lie" is true, but we have all seen numerous instances where a fire was grossly misinterpreted. This, sadly, is such an instance.

State of Texas v. Ernest Ray Willis

Trial Testimony of Edward Cheever

On July 28, 1987, Edward Cheever testified in the case of Texas v. Ernest Ray Willis. At that time, he had been certified by the State of Texas as an arson investigator for less than two years. LeRoy Brown was the lead investigator for the State of Texas on the Willis fire, but he was not presented as a witness. The record is not clear as to why Mr. Cheever was presented instead of Mr. Brown, but the record is clear that the prosecution wanted to avoid having the jury see Mr. Brown's report, or having either Mr. Cheever or Mr. Brown cross-examined on its contents.

On the day of Mr. Cheever's attendance at the fire scene, he had been a certified arson investigator for eight months. He was still in training and was not allowed to handle cases on his own. Mr. Brown was his trainer. On *voir dire,* Mr. Cheever did not take responsibility for investigating the fire scene but stated, "I assisted in the investigation." Nonetheless, he was allowed to give opinion testimony. He stated that he concentrated his investigation in the living room and dining room, and did not even take photographs of some of the bedrooms. He stated:

> Initially, when we had finished the view of the exterior of the building and walked into the inside of the structure, there were a couple of things that caught our attention right off. First of all, the low burning on the walls almost to floor level.

Mr. Cheever, having been trained as most fire investigators were at that time, believed that low burning was an indicator of accelerants on the floor when actually, in a room that is fully involved, low burning is simply evidence that the room was fully involved.[38]

Mr. Cheever considered the low burning to be the most significant fire pattern that he saw. The following exchange takes place on page 14 of his testimony.

> Q: Okay. Well, of all the burn patterns, what is the most significant to you, sir?
>
> A: The most highly significant would be the low burning to the floor level on some of the walls, and the burn patterns that I observed on the floor itself.
>
> Q: Low burning on walls?
>
> A: Yes, sir.
>
> Q: And the floor?
>
> A: The burn patterns that I observed on the floor, yes, sir.

[38] See the previous discussion of low burn patterns in post-flashover compartment fires. Such lengthy discussion will not be repeated here.

Q: Alright. Now let me make a note of that, sir. Low burning on walls, what does that indicated to you, sir?

A: The heat source that caused the burn pattern was at a low level.
Q: Okay. So that if you have one room that's burned floor to ceiling and another room that's not, what does that indicate to you?

A: Indicates that the heat level in the room that burned from floor to ceiling was at a much lower level in the room.

Q: Which might support the idea that was liquid combustibles there?

A: That's true.

Q: Alright. Now burn patterns on the floor. Burn patterns on the floor you say are another part of the significant burn patterns on which you are relying to base your opinion; is that correct, sir?

A: Yes, sir.

Q: Alright. What are those burn patterns on the floor? What do you think about those? What do they mean to you?

A: In this particular case they indicate to me the use of a flammable liquid.

Q: How much flammable liquid?

A: I have no idea.

As happened in the Willingham case, the State's investigators in the Willis case relied on their alleged ability to visually interpret the significance of irregular patterns on the floor in a fully involved compartment fire. At the time of his testimony in 1987, such interpretations, although wrong, were common. It is now well known now that in post-flashover compartment fires, irregular patterns on flooring are commonly observed. Examples of such patterns were found in tests conducted for the United States Fire Administration's Burn Pattern Study[39]. As previously discussed, the ability to distinguish patterns produced by ignitable liquids from those in un-accelerated compartment fires was not available at the time of this fire and subsequent experimental testing has shown that it is not possible to correctly evaluate a fire in a fully involved compartment as being the result of ignitable liquids on the basis of the appearance of the floor.

Demonstrating his complete lack of understanding of compartment fire dynamics, the following exchange occurred on page 21 of Mr. Cheever's testimony.

[39] Shanley, J. H., "Report of the United States Fire Administration Program for the Study of Fire Patterns," FA 178, Federal Emergency Management Administration, United States Fire Administration, July 16, 1997.

Q: Assume for a moment, Mr. Cheever, that the fire had started at a high point inside the house.

A: Yes, sir. Inside the house.

Q: Do you have an opinion as to how long it would take for the fire inside the house to reach a point as low as is depicted in that photograph, and to cause the damage it caused, as evidenced by those photographs?

A: Burning from a high level, just burning the fuel level, and coming down to floor level?

Q: Yes, sir.

A: I don't know anything about how long it would take, but there wouldn't be anything left of the house.

Q: Why would that be?

A: Because the fuel above the fire would burn first. And, as it burned up the fuel, there would be nothing left behind.

Q: What do you mean by the use of the word, 'fuel'?

A: Whatever it is that the fire itself is burning.

Q: Could that be the wood in the house?

A: Wood; yes, sir.

Q: Or any of the products inside the house?

A: Yes, sir. Anything that would burn.

Q: So in order for it to burn that low, it would have had to burn the house down?

A: Assuming that it was burning from a high level, and burning the fuel as it went. Yes, sir.

Certainly, the concept of flashover, as well as the characteristics of post-flashover compartment fires was well established at the time of this fire in 1986 as summarized by Drysdale[40] in his book on fire dynamics, first published in 1985. Also, the NFPA video *Fire Power*, produced in 1986, clearly shows the ignition and burning of carpet three minutes after flaming ignition of an upholstered chair. The video also shows the compartment walls and ceiling still intact after ignition of the carpet on the floor and subsequent post-flashover burning conditions within the

[40] Drysdale, D., *An Introduction to Fire Dynamics*, John Wiley & Sons, New York, 1985.

compartment. More recently, the USFA burn pattern tests also showed that the test compartments were still intact with significant burn damage to the floors in fire tests involving both ignitable liquids and no ignitable liquids. Clearly, an accurate understanding of the behavior of compartment fire dynamics was not part of Mr. Cheever's training.

Mr. Cheever later expressed an opinion about a low burn at a doorway, which, although widely accepted at the time, has since been shown to be a false interpretation.[41] At page 27, he testifies as follows:

> A: Okay. This is State's Exhibit 42. In the doorway you will notice that the doorjamb is burned completely down to the bottom of the doorjamb. This would be referred to as a low burn.

Actually, this is a normal phenomenon when one of the rooms on either side of the doorjamb achieves full room involvement. 'V' patterns at doorways, once thought to indicate that the arsonist had trailed liquid accelerant through that doorway, are now known to be the result of normal fire extension.[42]

At page 31, in describing irregularly shaped edges of a fire pattern, Mr. Cheever provided the following testimony.

> Q: What does it appear to be, to you?
>
> A: It appears to be burned areas resembling how a liquid would have run and burned on that surface.

Again, in the context of a fully involved compartment, irregularly shaped patterns have no meaning with respect to the potential of the introduction of an ignitable liquid, although in 1987 it was common for fire investigators to refer to irregularly shaped edges of patterns as evidence of such. Sadly, there still exists a cadre of fire investigators who make similar false interpretations today.

At page 34, Mr. Cheever is shown a photograph of "low burns" on a carpet and is asked if there is an explanation.

> "Q: Do you have an explanation as to what may have caused the low burn on the wall and on the floor level?

[41] The 1992 edition of NFPA 921 at page 24, section 3-7.2, discusses ventilation-generated patterns. It states: "In a fully developed room fire where hot gases extend to the floor, the hot gases may extend under the door and cause charring under the door and possibly through the threshold." This language has appeared in all of the editions of NFPA 921. In the 2004 edition, it is found on page 32, at section 6.2.3.2.

[42] See NFPA 921, 2004 edition at page 32, section 6.2.3.4.2. "Where fresh air ventilation is available to a fire, it is not uncommon to find locally heavy damage patterns on combustible items close to the ventilation opening, patterns which may have no relevance to the point of origin."

> A: Yes, sir. My opinion is that there was a flammable liquid applied to the floor in that location, and, as it burned, the heat and flame rising from it burned the wall in that manner.

Apparently, the constant repetition eventually persuaded the jury to believe the testimony, even though, as previously discussed, it was seriously flawed. Low burn patterns are a normal artifact in any compartment fully involved in fire.

Another question on page 35 was put to Mr. Cheever.

> Q: Do you have an opinion as to how the fire could have burned the doorjamb at that lower point?
>
> A: In my opinion, there was some type of flammable liquid applied there. There was no other fuel source there that would have indicated it would have burned in that manner.

Actually, all that is required to generate this type of pattern is for the room to be on fire on one side of that doorjamb. The only way to conclusively identify the existence of a flammable liquid in the Willis situation is for the laboratory to report a positive result. All of the samples submitted to K-Chem Laboratories, which at the time was one of the leading laboratories in the country, came back negative. (In the Willingham case, all but one sample came back negative. This sample was collected from the front porch, where there was known to be a container of charcoal lighter fluid.) Other than Mr. Cheever's “opinions” and those of Mr. Dailey, who suffered from all of the same misconceptions, there was no credible evidence presented to the jury that flammable liquids were involved in any way in the Willis fire.

At page 37, a line of questioning begins about burning underneath furniture. As previously discussed in the analysis of the Willingham testimony, burning under furniture is actually a normal consequence of full room involvement. Mr. Cheever, however, opined that burning was the result of the flammable liquid running underneath the furniture. His testimony in several places states that he believed the floor was sloped somehow though he neither made any measurement of the slope, nor did he document the behavior of liquids on the alleged slope. He simply assumed that the burning under the furniture was the result of flammable liquid running to that location. In a disingenuous attempt to discredit another hypothesis for the burning under the furniture, the prosecutor asked Mr. Cheever about falling debris, for example burning ceiling tiles. Mr. Cheever of course states “falling debris would have fallen on top of the couch, not under.” Like most fire investigators at the time, Mr. Cheever had no concept that flashover and full room involvement would cause burning underneath a piece of furniture, or that the furniture item may have been made of polyurethane foam which can melt, flow into a pool below the furniture and burn as a liquid on the floor.

Mr. Cheever, at page 46 of his testimony stated that he believed because of the extent of damage on the couch in the Willis residence, someone must have poured liquid accelerant on it. Again, this was never validated by a positive laboratory analysis.

In a shocking admission of an inadequate investigation, Mr. Cheever was asked at page 55 whether he had investigated beyond the living room and dining room.

> Q: How much more investigation did you do into the house?
>
> A: Beyond those two rooms?
>
> Q: Yes sir.
>
> A: We didn't.

The conventional wisdom at the time was that a fire should be investigated from the area of the least burning to the area of the greatest burning. Even though, on cross-examination, Mr. Cheever admitted that photographs of one of the bedrooms indicated damage in excess of the damage to the living room and dining room, he admits that he investigated only the living room and dining room.

In another inappropriate investigative technique, Mr. Cheever failed to document his investigation. At page 57 the following exchange took place:

> Q: Okay. So you are testifying from memory today without the assistance of any notes other than the Fire Marshal's report?
>
> A: Basically, yes sir.

Mr. Cheever stated that he did not take any photographs nor did Mr. Brown take any photographs at the fire scene. Even by 1986 standards, this failure to document his observations evidenced a negligent and unprofessional approach to his work.

At page 66, when the Defense Counsel attempted to cross-examine Mr. Cheever about the contents of Mr. Brown's report, the Prosecutor objected to "any testimony from a document that's not in evidence" and the objection was sustained.

In a remarkable mirror of the Willingham case, Mr. Cheever testified about burning on the porch. He stated at page 76:

> My opinion would be limited strictly to the fact that the porch was burning at floor level, and I saw no evidence of any kind of fuel other than the porch itself that would have burnt at that low level and it doesn't normally do that.

Actually, porches like the Willingham and Willis porches frequently burn at floor level when the rooms adjacent to the porch flashover and the windows break out. The under-ventilated conditions within the adjacent compartment result in the outflow of unburned hydrocarbons through such openings (i.e. the windows). When sufficiently mixed with the outside air, the unburned fuel can ignite, resulting in flames extending from the opening. Such flames can transfer heat to as well as ignite adjacent combustible surfaces such as wood ceilings or floors of

porches. Thus, it is not at all uncommon to see porch and deck floors burned or discolored by fires emanating from adjacent rooms.

During his cross-examination, Mr. Cheever was confronted with the fact that he had not photographed bedroom #2, but someone else had. He was asked:

> Q: If bedroom #2, by photographic evidence, were shown to be at least as heavily damaged as the living room, would that change your opinion about the origin of this fire?
>
> A: No, sir.

He had previously testified that the reason he focused on the living room and dining room was that those rooms were more heavily damaged. It is a serious lapse of basic fire investigation methodology that a room that is arguably as heavily damaged as the living room and dining room was not documented and was simply ignored by the Fire Marshal.

Mr. Cheever's firm but inaccurate belief in the unidirectional flow of heat in a fire was brought out again on cross-examination at page 93 in the following exchange:

> Q: Okay. If there were testimony that there was a magazine rack in that area and if that magazine rack caught on fire, lots of papers and magazines, or whatever, would that contribute to that burning into the floor over there?
>
> A: As far as making the type of pattern that we saw?
>
> Q: Yes, sir.
>
> A: In my opinion, no.
>
> Q: Okay. Because fire burns up, not down?
> A: That's correct."

At page 101, Mr. Cheever reveals his flawed view of radiant heat in the following exchange:

> Q: Radiant heat. And I wonder if you can briefly explain that to me again, sir, that principle.
>
> A: Okay. The principle is, basically, that if you have one burning object close to another one, that the energy of heat will be transmitted by waves of energy, and that the other object nearby will increase in temperature.

The transmission of thermal radiant energy from a hot gas layer to the floor, as well as post-flashover conditions are precisely what cause the irregular patterns and low burning observed by the Fire Marshal, but he fails to make that connection. Defense Counsel apparently had some education in that regard as evidenced by the following exchange at page 103:

> "Q: Alright. That in some house, you would agree with me, wouldn't you, sir, where - - in some situations where you might absolutely know there was not flammable liquid poured, you can get some marks on the floor that are not due to fall down of material but, but are due to what we call radiation. I might call it re-radiation but radiation from the bottom down; is that correct, sir?
>
> A: That would be a possibility, but I have never experienced that."

What the Fire Marshal has admitted to here is a lack of knowledge and experience with the most common cause of low burning in fires. The exchange continues:

> Q: Not within the realm of your experience, but because you recognize the principle, you recognize that it's possible?
>
> A: Yes, sir.
>
> Q: Okay. Alright. Talking about liquid pours, pouring of liquid, material, flammable liquids on carpets and floors, would you agree with the statement, sir, that occasionally extensive and irregular damage to a floor can be an indication of flammable liquid use?
>
> A: Yes; that's possible.
>
> Q: Okay. Can you agree, also, with the statement that occasionally caution should be used because the carpet fabrication or other circumstances can also create the same appearance?
>
> A: I'm not sure that I would use the same terminology in saying the same appearance, but a similar appearance.
>
> Q: Or a similar appearance?
>
> A: Yes, sir.

This could have been a pivotal admission had the jury recognized it. What the Fire Marshal was saying in this exchange was "I know it when I see it." The fact is that the only way to make a valid distinction between an irregular fire pattern caused by an ignitable liquid and an irregular fire pattern caused by radiation is to collect samples and find the residue of the ignitable liquid. In the absence of such a positive finding, the pattern must be attributed to radiation rather than an ignitable liquid, but in far too many cases, fire investigators insist on their ability to recognize arson, even where it does not exist.

In the last question in his cross-examination, Mr. Cheever admits to an ignorance of the statistics that have been collected for decades on fatal fires. The following exchange occurred:

> Q: Okay. We will move on, then. One last question Marshal Cheever. Would you agree with me that smoking materials are the leading cause of fatal fires in home in this nation?
>
> A: I'm not familiar with those statistics, no, sir.

Historically, smoking materials have been the leading cause of fire deaths in the United States.[43] Roughly one in four fire deaths is caused by smoking materials. A fire investigator who is unaware of the leading causes of civilian fire deaths is unlikely to be able to investigate them accurately.

At page 128, in recross-examination, the following exchange took place:

> Q: Okay. Now, in your experience, training, and your reading publications to keep up-to-date, have you or have you not heard of the phenomenon that radiation can cause irregular patterns?
>
> A: I have never run across that, no, sir.

Mr. Cheever again states that he is not familiar with radiation causing irregular patterns, which has a direct bearing on the validity of his opinion concerning the presence of ignitable liquids and the validity of his determination that this fire was the result of arson. As demonstrated in the outcome of the trial in this case, such ignorance conveyed to the jury provides sufficient momentum for miscarriages of justice.

[43] Source NFPA.org.

Trial Testimony of John Dailey

John Dailey was a retired FBI agent, who, at the time of the trial, was working as a fraudulent claims investigator for J.C. Penney Insurance Company. At the time of the fire, he was employed by Cimarron Insurance Company, which insured the residence. He took a 90-hour arson investigation course in May of 1983 and was certified in the State of New Jersey as an arson investigator. Mr. Dailey stated that he spent 2½ days at the fire scene. He stated that he took ten samples from the scene and submitted them to a laboratory, and all of them tested negative for the presence of ignitable liquids. He stated that it was not unusual to receive a negative finding on laboratory samples. His investigation took place after the living room and dining room had been cleaned off and washed down. He hired six individuals to clean the debris out of the rest of the house in order to examine the floors.

Mr. Dailey harbored most if not all of the same misconceptions harbored by Mr. Cheever and by the investigators in the Willingham case. In describing the way fire spreads through a doorway he states:

> A: Okay. This shows that you had a lot of fire coming out of the front door, and you have low burning on the doorjamb all the way down to the bottom. And, usually, when fire comes out of a door, it will come out in the upper areas and you will get a 'V' pattern where it will come out. This shows me we had low burning right in here because the whole thing it burnt from top to bottom.
>
> Q: Mr. Dailey, why would fire necessarily want to come out of the top of the door? Why wouldn't it come out the bottom?
>
> A: Well, it's based on the theory that fire goes up and seeks the nearest exit. So if it's near a door, it will go up and out the upper portions of the window or door.
>
> Q: Is there instances where fire goes down?
>
> A: There could be, but, generally, the pretty basic rule is it goes up.
>
> Q: If it goes down, is it defying the force of gravity.
>
> A: Well, I don't know about gravity, but fire—there could be an instance where fire could bank down in a room if the room were closed, and you had enough fuel, and it would go lower, but it would be unusual.

Actually there is nothing at all unusual about fires occurring in closed rooms as described by Mr. Dailey, nor is it unusual to find burning all the way to the floor level of a doorjamb where ignitable liquids were not introduced. The important point is that Mr. Dailey lacks the fundamental knowledge of compartment fire dynamics. More specifically, he is apparently unfamiliar with the characteristics of post-flashover compartment fires that would explain the "low burns" without the introduction of ignitable liquids.

In yet another mirror of the testimony in the Willingham case, Mr. Dailey describes burning underneath the doorjamb from inside the living room. He states at page 29:

> A: You can see where flammable liquid ran down and really burned underneath the doorjamb here.
>
> Q: Why wouldn't the fire just have got in under there?
>
> A: Well, sir, fire just does not travel up under, does not make those patterns.
>
> Q: Fire doesn't have the ability to go underneath that doorjamb and burn on the inside?
>
> A: No sir, not and leave patterns like this."

The damage to the wood below the doorjamb does not have to be the result of a fire burning underneath. Wood will char and create patterns when heated to temperatures below those required for flaming ignition to occur. The rise in temperature of the wood below the doorjamb is the result of heat transfer from exposure to the fire conditions above the sub-floor. It is the lack of oxygen to sustain combustion that precludes both fire and flammable liquids from "going underneath" a doorjamb and causing damage to the wood subsurface, which is a concept that Mr. Dailey unquestionably failed to take into account in the course of his investigation.

On pages 32 and 33, when describing the condition of the couch, Mr. Dailey states:

> A:…and, on the couch, it unusual that a piece of furniture will be that totally consumed. Usually the fire—a normal fire will burn off the top of the furniture and go down some, but you will have quite a bit left of the bottom frame. … The significance of this is that on the south end of the couch toward the door, the springs were annealed. And when I say, "annealed," I mean that all of the tension was gone out of them. They were real flat. And that is generally only—that only occurs when you have intense heat on the springs of a couch….
>
> And when I see a couch like that in a fire—you can see how flat the springs are. They have annealed, or lost their temper. That is generally an indication that an accelerant had been placed on there that caused this intense fire. Like I say, furniture generally will not burn like that. Furniture will burn the upper portions of it. And whenever an investigator sees a piece of furniture like this where the springs have been annealed, or distempered, then there is a very strong indication that an accelerant had been put on the couch.

It is not unusual for upholstered furniture to be totally consumed in a compartment fire. Upholstered furniture, like other fuel packages, can be totally consumed if post-flashover conditions continue for a time sufficient to burn all of the materials. Thus, the fuel loading in the room, the ventilation conditions, as well as the timing of fire suppression activities play a

significant role in the duration of post-flashover conditions and thus, how much of the fuel item is consumed.

The testimony concerning the annealing of the springs was given in 1987, two years before Tobin and Monson, two scientists at the FBI laboratory debunked most of the mythology about annealed springs providing fire investigators any information about the intensity of a fire. If one end of a sofa is exposed to more heat than the other, certainly, the form of the springs may change, but one cannot make a valid conclusion about whether the fire was "fast" or "slow" based on the condition of the springs.[44] Ironically in the 1980's the same spring conditions were sometimes interpreted to indicate a "smoking" fire, although that fact was apparently unknown by Mr. Dailey at the time.

Further misinformation about the meaning of the condition of the couch was conveyed to the jury in the following exchange:

> Q: What if someone was to go to sleep on a couch and drop a cigarette? Would it cause that type of damage to that item of furniture?
>
> A: No, sir.
>
> Q: Would you also be able to determine a point of origin in that couch as to where the fire started?
>
> A: No. All I can say is, there was more fire on the south end than on the north end.
>
> Q: Okay. And you don't believe it was caused by a cigarette?
>
> A: No, sir. I have been in schools where we have tried to ignite furniture with cigarettes, and it's very, very difficult. And if you get them ignited, you get a little smoldering fire."

This is simply false[45], but unfortunately, the jury had no way of knowing that this expert was wrong. If all that happened when cigarettes ignited furniture was a "little smoldering fire," logic dictates that smoking materials would not be the number one cause of fire deaths. As a result of such statistics, extensive research, in the last three decades[46, 47, 48], has been performed with

[44] Tobin, W. A. and Monson, K.L., Collapsed Spring Observations in Arson Investigations: A Critical Metallurgical Evaluation, *Fire Technology*, 25(4), 1989, 317.

[45] The Bureau of Fire Research (BFRL) at the National Institute of Standards and Technology (NIST) reports in a study on fire safe cigarettes: "The most recent statistics (1997) from the U.S. Consumer Product Safety Commission indicate that about 25 percent of all U.S. fire fatalities occur when a smoker falls asleep in bed or a lighted cigarette is dropped on a couch or chair." The full report is available at the BFRL website: http://www.bfrl.nist.gov/info/fire_safe_cig/questions_and_answers.htm

[46] Damant, G. H., "Cigarette Induced Smoldering in Flexible Polyurethane Foams," *Consumer Product Flammability* Vol. 2, 140 -153, June, 1975.

[47] Babrauskas, V., and Krasny, J. F., "Fire Behavior of Upholstered Furniture," NBS Monograph 173, National Bureau of Standards, Gaithersburg, MD, November 1985.

respect to the propensity of ignition of upholstered furniture. Cigarettes in the crevices of upholstered furniture can and do cause fires. The cigarette first produces a smoldering fire, as testified by Mr. Dailey. The significant knowledge that Mr. Dailey failed to mention to the jury is that smoldering fires in upholstered furniture can transition to a flaming fire that behaves no differently than if the upholstered furniture had been ignited by a flaming ignition source.

Prior to actually showing the photograph of the couch to the jury, the following exchange took place:

> Q: Okay. Is there any significance to the fact that that pour pattern seems to run underneath the couch there?
>
> A: Yes, sir. There is a significance. Actually, two possibilities: one, that the flammable liquid pour pattern shows that a flammable liquid was poured under the couch. The other possibility, not as strong, is that enough was poured on the couch to where it might have dripped through and caused that damage to the floor. There are two possibilities."

In a completely involved room, there is a third dominant possibility, which explains the condition of the couch: its condition is nothing more than a part of the natural progression of a compartment fire, as previously discussed. That possibility was not put before the jury. Essentially, the State gave the jury two incendiary scenarios from which to choose, not even suggesting the possibility of a naturally occurring fire.

As if constant repetition would make the assertion true, Mr. Dailey goes on at page 37 to state:

> A: As I said, fire ordinarily will not burn down but, in this instance, I was struck by the fact that the wooden portion, including the two legs of the chair, were burned at floor level. Of course, here, part of that liquid burn pattern is in front of the chair, which, no doubt, caused the damage to the lower portion.
>
> Q: Is it unusual for you to go into a structure where there has been a fire and find so many items or articles of furniture burned at floor level?
>
> A: It's not very usual.
>
> Q: Does that cause you suspicions?
>
> A: That's one of the things we look for is low burning; yes sir."

Mr. Dailey's misinterpretations of the fire patterns on the floor also allowed him to infer a motive of the person pouring the alleged ignitable liquid.

[48] Ohlemiller, T. J., Villa, K. M., Braun, E., Eberhardt, K. R., Harris, R. H., Lawson, J. R., and Gann, R. G., "Test Methods for Quantifying the Propensity of Cigarettes to Ignite Soft Furnishings," NIST SP 851, National Institute of Standards and Technology, Gaithersburg, MD, August, 1993.

> Q: Do you have an opinion on whether or not the effective escape routes from that back area were closed off, Mr. Dailey?
>
> A: Yes, sir. I would say so. You definitely couldn't go out the front door or the back door.

Mr. Dailey's testimony continues for many pages repeating assertions not validated by laboratory analysis that there was flammable liquid on the floor.

Showing a surprising lack of knowledge about compartment fire dynamics, Mr. Dailey described the fire's behavior at the ceiling as resulting from the relative quantity of flammable liquids on the floor.

> A: Well, the worst burning was in the living room and dining room. And when I first went into the house—we always—of course, one of the things—you check the ceiling. And I noticed that in the living room and dining room it had penetrated the ceiling, which indicates that you had an intense fire on the floor. And in the kitchen the ceiling was not penetrated, and it was - - obviously, less flammable liquid had been placed in there, and the fire damage was as I showed you on the kitchen cabinets, they were not severely burned. So the main damage was in the living room and dining room where it penetrated the ceiling.

Ceilings, whether constructed of gypsum wallboard, plaster lath, or combustible ceiling tiles can and do fail in compartment fires that have achieved post-flashover conditions without the introduction of ignitable liquids. It is the burning of a significant fuel load that causes a compartment to achieve flashover. While the burning duration of the flammable liquids on the floor is insufficient to achieve flashover conditions in the absence of other significant fuel packages, their presence allows more fuel to become involved in a shorter time frame (i.e. accelerated) and thus, the onset of flashover conditions is achieved sooner than without ignitable liquids. An example of a compartment fire that was initiated with flammable liquids within a compartment and where the ceiling was not penetrated is included in Test 6 of the USFA Fire Pattern Tests[49].

Mr. Dailey, at page 77, evidences a lack of understanding of the concept of fuel load, when he states:

> but the fact remains, there was no fuel load in these two rooms to create such a fire as to penetrate the ceiling and to destroy the furniture.

In this case, the furniture itself was the fuel load, and Mr. Dailey's statements that another fuel load would be required to destroy the furniture evidences either a lack of understanding of compartment fires or else an extreme bias in favor of finding arson. Many pieces of upholstered furniture incorporate polyurethane foam, which is capable of releasing tremendous amounts of energy. A typical sofa can release two to three megawatts of heat energy. It is not uncommon for

[49] Shanley, J. H., "Report of the United States Fire Administration Program for the Study of Fire Patterns," FA 178, Federal Emergency Management Administration, United States Fire Administration, July 16, 1997.

a single burning sofa to bring a traditionally sized residential room to flashover in less than five minutes.

Later in his testimony, when asked about the dining room table, Mr. Dailey stated:

> I didn't consider it a fuel load. My experience on these house fires that your heavier pieces of furniture like that, you can have a really good fire going, a normal progressive fire, but a solid oak or heavy wood table will sustain charring, but it will not be consumed. You just do not get that kind of heat generated, particularly at floor level.
>
> Q: Would there be something left of a piece of furniture that's that heavy or that well made?
>
> A: Ordinarily, there would be, yes, sir.
>
> Q: Well, what does the complete consumption of that dining room set indicate to you Mr. Dailey?
>
> A: It indicates to me that we had an accelerant present around it, which caused total consumption of it."

As is typical in this type of case, Mr. Dailey then compares the defendant's story to his own flawed interpretation based on the fire patterns. Mr. Willis stated he had been asleep on the couch and woke to find fire. Mr. Dailey was asked:

> Q: Okay. Do you think it's possible to run through flames like that and live?
>
> A: Well, I think you would be burned. I don't know about if it would be fatal or not.
>
> Q: The degree of intensity of that fire, Mr. Dailey, would it be possible for someone to have done the feat that this defendant did without having - - … without suffering some indication of burns on their body? …
>
> A: All I can fall back on is common sense and just say that if you run through a very flammable area, flames coming up, I would think you would get burned.

Thermal burns to bare skin are a function of the intensity of the exposure and the duration of the exposure.[50] In order to determine the ability of an occupant to escape from a fire without injury requires knowledge of the fire conditions (i.e. the location and size of the fire or the exposure). The assumption that Mr. Dailey makes is that at the time Mr. Willis awoke, the fire was of a size and location that would require him to run through flames. There is no evidence to support such an assumption. Since, in general, fires grow in size with time and start with a "no fire" condition.

[50] SFPE, "Engineering Guide: Predicting 1st & 2nd Degree Skin Burns from Thermal Radiation," Society of Fire Protection Engineers, Bethesda, MD, March, 2000.

Thus, the time he awoke relative to the size and location of the fire are required elements in order for Mr. Cheever to accurately assess the conditions to which Mr. Willis would have been exposed. Mr. Dailey's testimony did not include such an analysis. Any assumption on Mr. Dailey's part as to the size and location of the fire at the time of discovery would have been based on misinterpretations of the evidence and, thus unreliable.

Report of the Texas State Fire Marshal

LeRoy Brown, who was the senior investigator on the scene with Edward Cheever, authored this report. Mr. Brown did not testify at the trial; however, because the prosecutor did not want him to be subject to cross-examination on the contents of this report.

The report provided conclusions, but no bases for those conclusions. To the extent that the report described the scene, important details of the description were reported inaccurately. Mr. Brown wrote "The exterior walls were slate. The interior walls and ceiling were sheetrock." Actually, the exterior walls were asbestos shingles that had recently been re-covered with combustible pressed-wood paneling, and the interior walls were covered with thin, highly combustible paneling.

Mr. Brown's failure to accurately assess the interior finish severely impaired his ability to assess how a fire would normally be expected to behave in such a structure. Had he testified, his credibility would have been destroyed because of his lack of care on the fire scene. He stated in his report "Upon arrival, this investigator and investigator Edward Cheever conducted a thorough and systematic fire scene investigation." Presumably, Mr. Cheever also failed to make the necessary observations about the interior finish, but because he did not sign his name to this report, he was able to avoid cross-examination on this serious error.

Nowhere in the report are the fire patterns described. Nowhere in the report is any mention of the fuel packages that burned, the condition of the doors and windows, and nowhere in the report is there a discussion of samples collected, sent to the laboratory, and analyzed and found to contain no ignitable residue. In short, the report provides the reader with very little information other than the opinion of the investigator, which is based on a seriously flawed investigation.

Report of John Dailey

Mr. Dailey's investigative report covered 18 pages, and was certainly more descriptive than the Fire Marshal report prepared by Mr. Brown.

Interestingly, Mr. Dailey stated that he believed that there was a separate origin of the fire with the use of flammable liquids in bedroom number 3, a finding which he found it necessary to take back during his direct testimony. Further, he opined in his report that he believed that methanol was the ignitable liquid used, thus explaining the lack of positive laboratory results. Nowhere in his trial testimony was this opinion elicited.

The report begins with a description of the risk followed by a section entitled *Fire Officials*. It was noted that in this section that both of the Willis cousins, Billy and Ernest, were barefooted

when the Fire Department arrived. Mr. Dailey apparently found it significant that neither Billy nor Ernest showed any emotion, as he mentioned it three times in the space of one page of text.

A description of a suspect's failure to display what an investigator considers an appropriate amount of emotional distress is an unfortunate common theme in wrongful prosecutions and convictions. Generally, people in this situation are in shock, and the emotional display is not predictable, nor should it form the basis of any conclusions. Furthermore, the assessment by the State's witness of the "proper" amount of distress to be shown by a fire victim lacks any scientific validity.

Mr. Dailey's description of the fire scene inspection runs from page 4 to page 10 of his report. He noted that all the circuit breaker switches were in the off position but failed to comment on that observation other than to state that "The circuit connectors did not show any signs of overheating or shorting."

Typically, but with a few exceptions, circuit breakers have three positions: on, off and tripped. Finding all breakers in the off position suggests that they had been moved since the fire. Mr. Dailey's characterization of the condition of the circuit breakers, and the lack of specific "overheating" or "shorting" evidence, demonstrates his lack of knowledge to properly assess and eliminate electricity as a potential fire cause. The lack of either condition does not in any way preclude the electrical system from causing the fire. Looking at the circuit panel does not eliminate anything electrical in the structure. One needs to look at the entire system including the loads and the distribution system.

By the second page of his description of the fire scene inspection, Mr. Dailey is describing severe flammable liquid burn patterns that had gone through the carpeting, the foam rubber padding, the asphalt tile covering and into the plywood sub flooring. From this point on, he constantly refers to flammable liquids. On page 6, he refers to his interpretation of the burning damage in bedroom number 3, "Along the north edge of the bed was a burn pattern in the rug which appeared to be consistent with a flammable liquid having been poured along the bed in a trail towards the door leading into the kitchen."

All this suggests is that Mr. Dailey, like every other fire investigator, is incapable, by visual observation, of distinguishing ignitable liquid patterns from patterns produced by thermal radiant heat transfer in fully-developed compartment fires.

Mr. Dailey, on page 7, indicates that he believes that flammable liquids cause more intense burning than other types of fuel packages, another appealing notion that is simply untrue. The popular reason a fire setter utilizes a flammable liquid is to spread the fire quickly, thinking that it burns more intensely. In fact, in most set fires, the flammable liquid is largely consumed within the first few minutes. He stated, at page 7, while describing the dining room set, "No trace of this dining room set could be found in the debris and it was presumed that the fire was so intense on the floor at this point that the entire dining room set was completely consumed. There was also a small china closet, which the tenants stated had been completely consumed by the fire as he could not find any remnants of it.

On page 8, he again returns to bedroom number 3 and describes a flammable liquid pattern running along the north edge of the bed. He states “Photographs 53 through 97 were made after the complete cleanup of the house and clearly show the burn patterns in the carpeting in bedroom number 3. In the linoleum in the kitchen as well as those already described in the dining room and living room.” He later on page 8 refers again to the flammable liquid burn patterns in bedroom number 3.

Mr. Dailey’s improper methodology for eliminating accidental fires becomes clear in the fourth paragraph on page 9 where he states, “Any accidental fires are considered to have been eliminated as the fire obviously started on the floor.” Later he states, “It is felt that one contributing factor to the spread of the fire was the type of wall paneling used throughout the house which is the highly flammable type.” He apparently (and selectively) did not consider this highly flammable paneling to have played a significant role in the spread of the fire, instead choosing to blame the spread on the presence of methanol or some other flammable liquid.

He continues on at page 9 to state, “Other factors which substantiate an unnatural and set fire are the complete consumption of the sofa in the corner of the living room against the south wall, the severe burning of the easy chair which was in the northeast corner of the living room, and the severe burning and uneven burning of the couch which was found on the west wall of the living room.” All of these artifacts, in fact, occur in accidental fires. He then goes on to describe the annealing or collapse of springs on the couch, which “Showed that a flammable liquid may have been poured on that end of the couch.”

At page 17, Mr. Dailey provides his conclusion in a section entitle *Determination of Origin and Cause* where he states, “Based on investigation to date it is believed that the origin of the fire probably started in bedroom number 3 where a small amount of flammable liquid had apparently been poured along the bed. This is so because there was no complete connecting trail of a flammable liquid pattern from bedroom number 3 directly into the kitchen where a large amount of flammable liquid had been poured by the arsonist.”

It is not clear what caused Mr. Dailey to change his mind about the origin in bedroom number 3, although the testimony of fire fighter Robbie Dominguez, who attempted to enter the room and saw no fire on the floor, may have persuaded him that his original interpretation of the floor patterns was wrong.

The State of the Art in Fire Investigation Prior to 1992

Prior to 1992 the state of the art in fire investigation was, in a word, dismal. Fire investigators, by and large, were, and continue to be, individuals without any serious training in scientific methodology. More experienced fire investigators would mentor less experienced fire investigators, and pass on what became a collection of myths. Many investigators, who obtained their "basic training" before 1995,[51] were trained with misinformation and misconceptions. Some of those investigators have taken very little additional training since then, and of those, many refuse to recognize how flawed their early training was.

No one would contend that there was any malice involved—most investigators, including most of the undersigned, were simply misinformed. Fire investigators were generally law enforcement officers or fire marshals whose job was to "catch arsonists." They learned to "recognize arson" from their experienced mentors, and by attending weekend seminars involving "test" fires, typically set using a flammable liquid, that were not allowed to burn beyond flashover. Most fire investigators begin their careers with little, if any, formal education in the science of fire. Through the process of training, investigators have been provided analysis tools in the form of "rules of thumb" (i.e. if this, then this) that are simple to apply and are easily understood by those with little scientific background. Unfortunately, these rules of thumb are the result of the extrapolation of previous experience and, therefore, may not be applicable to the next fire scene, because extrapolation that is not based on science can often lead to erroneous conclusions. Fire protection engineers, who were gaining fundamental knowledge of physics, chemistry, thermodynamics, fluid flow and heat transfer, and learning about post-fire artifacts, did not interact with fire investigators, and thus many opportunities for remedial learning were lost.

The Law Enforcement Assistance Administration collected some of the myths about fire investigation in a 1977 study entitled "Arson and Arson Investigation: Survey and Assessment."[52]

The arson investigators surveyed cited interpretation of "burn indicators" as the most common method of establishing arson. Some of the burn indicators used are alligatoring, crazing of glass, depth of char, lines of demarcation, sagged furniture springs and spalled concrete. The LEAA report, after listing the indicators, provided the following caution:

> Although burn indicators are widely used to establish the causes of fire, they have received little or no scientific testing. There appears to be no published material in the scientific literature to substantiate their validity.
>
> It is recommended that a program of carefully planned scientific experiments be conducted to establish the reliability of currently used burn indicators. Of

[51] Although NFPA 921 was first published in 1992, it encountered stiff resistance, and training in fire investigation did not really begin to improve significantly until the mid-1990s. Proponents of the scientific method for fire investigations, or those who believed in alternate interpretations of "low burning" were often treated as heretics.

[52] Boudreau, J.F., Kwan, Q.Y., Faragher, W.E., and Denault, G.C., *Arson and Arson Investigation: Survey and Assessment*, National Institute of Law Enforcement and Criminal Justice, Law Enforcement Assistance Administration, U.S. Department of Justice, October 1977.

> particular importance is the discovery of any circumstances, which cause them to give false indications (of, say, a fire accelerant). A primary objective of this testing would be to avert the formidable repercussions of court ruling on the inadmissibility of burn indicators on the grounds that their scientific validity had not been established. In addition, the research might well uncover new methods of value to fire and arson investigators. A handbook based on the results of the testing program should be prepared for field use by arson investigators."

This well reasoned recommendation was only partially followed. Without any of the recommended scientific testing, the National Bureau of Standards in 1980 released NBS Handbook 134, *Fire Investigation Handbook.*[53]

Based on contributions of material from officials at the National Fire Academy (which was responsible for teaching most of the public sector fire investigators in the U.S.), this *Handbook* gave the imprimatur of the National Bureau of Standards to the indicators that the previous study had stated had "received little or no scientific testing." The NBS *Handbook* further entrenched the errant mythology of arson investigation in the fire investigation community. It has taken decades to undo the damage.

In both the Willingham and Willis cases, one of the myths from the NBS *Handbook* was repeatedly cited, to wit,

> Floors seldom receive damage similar to that of ceilings, even in the case of total burnout, as the heat of the fire will be concentrated at the ceiling. In addition, as ceiling materials are damaged and fall, these materials protect the floor below. If, on the other hand, a large area of floor is extensively damaged, the use of accelerants may be indicated.

The NBS *Handbook* communicated myths regarding crazing of glass, "alligatoring," lines of demarcation, and the angle of 'V' patterns. The myths printed in the NBS *Handbook* were cited and repeated in many other textbooks for fire investigators.

In 1985, the National Fire Protection Association Standards Council recognized the lack of reliability of fire investigations, and formed the Technical Committee on Fire Investigations to prepare a standard document. Unfortunately, the first edition of NFPA 921, *Guide for Fire and Explosion Investigations*, was not published until shortly after the Willingham fire. Even if it had been published, there is little chance that it would have been accepted. The fire investigation community resisted this document and the principles it espoused for most of the 1990s.

Fire investigators who were trained at the National Fire Academy prior to 1995 are likely to harbor a whole host of misconceptions about the proper interpretation of post-fire artifacts. Many of these individuals still practice fire investigation, and many of them resent the fact that the fire investigation profession is moving toward a more scientific approach and that a "benchmark" has

[53] Brannigan, F.L., Bright, R.G., and Jason, N.H., Editors, *Fire Investigation Handbook*, U.S. Department of Commerce, National Bureau of Standards, August 1980.

been established to measure their performance. Such individuals are likely to be highly critical of this report.

The State of the Art in Fire Investigation Since 1992

With the introduction of NFPA 921, the fire investigation profession began a movement toward the implementation of scientific principles in fire investigation. This change has been met with sometimes-fierce resistance, and it is only since 2000 that the scientific method can be said to have been "generally accepted" by the relevant community. The first serious challenge to the "old school" of fire investigators came in 1996 in a case titled *Benfield v. Michigan Millers Mutual*.[54] In that case, a fire investigator who failed to properly document his observations was excluded from testifying, and in the appeal from that exclusion, the International Association of Arson Investigators (IAAI) filed an *amicus curiae* brief, in which they contended that fire investigators should not be held to a reliability inquiry because fire investigation was "less scientific" than the kind of scientific testing discussed in the *Daubert* decision of 1993. For a time, fire investigators were advised by certain attorneys to avoid using the term "science" in their testimony. Eventually, there were enough court rulings, including the Supreme Court decision in *Kumho v. Carmichael*, to convince the majority of fire investigators that it was necessary to accept the scientific method as the basis for fire investigation. Thus, in the year 2000, the IAAI formally endorsed the adoption of the 2001 edition of NFPA 921. Currently, most fire investigators will acknowledge that NFPA 921 is an authoritative guide, and most fire investigators purport to follow the scientific method, if only out of fear that they will be excluded from testifying.

A modern investigator, who keeps up with developments in the field, gains the fundamental knowledge required to understand compartment fire dynamics, and who follows the guidance of NFPA 921 is more likely to reach a technically valid determination of the origin and cause of a fire than in the past.

Recommendations

In order to avoid miscarriages such as occurred in the Willis and Willingham cases, first and foremost, individuals conducting investigations of fire incidents must be provided with fundamental scientific knowledge of the physics and chemistry of fire as a prerequisite for the practical application of fire dynamics within the context of the Scientific Method.

The significant lack of understanding of the behavior of fire, as evidenced by the expert opinions in the Willingham and Willis cases, can and does result in significant misinterpretations of fire evidence, unreliable determinations, and serious miscarriages of justice with respect to the crime of arson. Continuous (and in some cases, remedial) education and professional development of fire investigators is required. There is a wealth of published fire research that routinely goes unused in the analysis of fires. One of the benefits of fundamental scientific knowledge is that it allows investigators to continue gaining knowledge throughout their careers through the understanding and the practical application of the available scientific literature on fire behavior. A scientific background will improve the quality of fire investigations, allow a greater number

[54] Michigan Millers Mutual Insurance Company v. Janelle R. Benfield, 140 F.3d 915 (11th Circuit 1998).

of individuals in the fire investigation community to contribute to the available scientific literature, provide better quality educational programs that will advance the profession, and help investigators self-police through quality control. Furthermore, there should be an initial and on-going technical review of the methods and curriculum being used as instructional materials for fire investigators, on a local and state level as well as nationally to insure that scientifically based information is being widely disseminated.

Some changes in the interaction between fire investigators and the criminal justice system are in order. As stated earlier in this report, if a fire is miscalled as incendiary, there is frequently only one viable suspect. Criminal defense attorneys, who are accustomed to focusing on the identity of the perpetrator, are generally unaccustomed to discussing whether or not a crime has, in fact, been committed, and are generally not trained to distinguish between a correct arson determination and an incorrect one. Frequently, counsel simply accepts the assertion that a fire was incendiary, when the evidence might not support that assertion. Education of defense counsel is, therefore, critical. Even more critical, however, is the education of prosecuting attorneys. It is they who decide whether to bring an arson case forward in the first place. They need to exercise appropriate skepticism when presented with an arson determination that was not arrived at using accepted scientific methodology as set forth in NFPA 921. When a fire investigator opines, as all of the State's experts did in Willis and Willingham, that irregular patterns on a floor were caused by the application of an ignitable liquid, there should be laboratory confirmation of that opinion. Laboratory testing today is much more sensitive than it was in the 1970s and 1980s, when "false negatives" were common. Using sensitive methodology developed by the Bureau of Alcohol, Tobacco and Firearms in the 1980s, fire debris analysis laboratories can routinely detect less than one microliter of ignitable liquid residue in a kilogram of fire debris. In fact, most laboratories can easily detect 1/10 of a microliter, or 1/500 of a drop. The possibility that a building was doused with sufficient ignitable liquid to cause large "pour patterns" and then all of that ignitable liquid was consumed to a level below the detection limit of today's laboratories is indeed a remote one.

Even with a positive laboratory report, however, there must be a logical connection between the burning and the alleged ignitable liquid. Because of the extreme sensitivity of today's laboratories, background petroleum products, such as those from insecticides or furniture polish applications, credit card slips, adhesives in shoes, and petroleum products in building materials, may be detected and misinterpreted as foreign ignitable liquid residues, when, in fact, those residues are naturally occurring.

Because of the increasingly "scientific" approach to fire investigations, and because scientific evidence is held in such high regard by juries, defendants in arson cases should be afforded the opportunity to retain an independent fire investigation expert to evaluate the State's expert's fire analysis. Without expert assistance, defense counsel is unlikely to be in a position to render effective assistance to his client.

Alternatively, the court could appoint a fire expert as a special master to advise the court on the validity of the State's fire cause determination. This alternative is rarely used. Although other scientific endeavors have encouraged the judiciary to equip itself with a source of knowledge, the trier of fact in arson cases apparently is content with allowing almost any self-professed fire

expert to testify and the fire investigation community apparently sees no reason to change this practice. The lack of recognition of inept fire experts by the courts and the lack of self policing by the fire investigation community may be the most formidable obstacle to improvement in the prosecution of arson cases.

There is no crime other than homicide by arson for which a person can be sent to death row based on the unsupported opinion of someone who received all of his training "on the job." All that is necessary for a conviction is that the jury accepts that opinion. If an incompetent witness renders a false opinion in a confident manner, how is a jury to know? The false convictions in the Willis and Willingham cases illustrate the danger of the current situation. These two individuals were convicted on nearly identical evidence. It is likely that the only reason Mr. Willis is still breathing is that he had better access to the effective assistance of counsel. The State should seriously consider reviewing similar cases, i.e., where people have been sent to prison for intentionally lighting fires based solely on the opinion of a State Fire Marshal or other investigator, with no supporting laboratory analysis. There are likely other individuals in prison in Texas and elsewhere falsely accused and convicted using invalid indicators.

Finally, the justice system should recognize that just because a person has been incarcerated based on bad science, that is no reason to keep them incarcerated. New knowledge, or the belated acceptance of old knowledge, should be acknowledged for what is: "newly discovered evidence." If an investigator is willing to admit that a citizen was convicted based on bad science, then the only civilized course of action is to reopen the investigation. It was resistance to this concept that allowed the state to execute Mr. Willingham, even though it was known that the evidence used to convict him was invalid. When interviewed by the Chicago Tribune about the Willingham case, Mr. Cheever (who was involved in the case but did not testify) acknowledged the validity of published criticism of the conviction. He stated, "At the time of the Corsicana fire, we were still testifying to things that aren't accurate today, They were true then, but they aren't now. **Hurst,** [55], **was pretty much right on**. ... We know now not to make those same assumptions."[56]

Actually, the behavior of fire is no different in 2006 than it was in 1986, so Mr. Cheever's statement that "They were true then, but they aren't now" is very far wide of the mark. The laws of physics did not change between 1986 and 2006. What is false today was false in 1986 and 1992. The fact that some poorly trained fire marshal believed it does not make it any more true, although it may make the fire marshal feel better about his errors.

The justice system has no right to take such a "feel good" approach to miscarriages of justice. Inevitably, when a convict like Ernest Ray Willis is exonerated, someone remarks, "See? The system worked!" Even by that low standard, the system failed to work for Cameron Todd Willingham.

To the extent that there are still investigators in Texas and elsewhere, who interpret low burning, irregular fire patterns and collapsed furniture springs as indicators of incendiary fires, there will

[55] A reference to Dr. Gerald Hurst, who reviewed both the Willis case at the request of the State of Texas, and who also reviewed the Willingham case at the request of Mr. Willingham's appellate counsel.

[56] Mills, S., and Possley, M., "Texas Man Executed on Disproved Forensics," *Chicago Tribune*, December 9, 2004.

continue to be serious miscarriages of justice. The authors sincerely hope that this report will help to undo similar miscarriages, and help prevent future ones from occurring.

The Authors

John J. Lentini is a certified fire investigator and chemist with 32 years experience in forensic science and fire investigation. Since 1978, he has managed the fire investigation division of Applied Technical Services, Inc., an independent consulting firm in Marietta, Georgia.

Mr. Lentini has personally investigated more than 2,000 fire scenes, and has been accepted as an expert witness on more than 200 occasions. He is the immediate past chairman of ASTM Committee E30 on Forensic Sciences. Since 1996, he has been a member of the National Fire Protection Association (NFPA) Technical Committee on Fire Investigations, where he represents ASTM Committee E30. His textbook, *Scientific Protocols for Fire Investigation*, was published by CRC Press in January 2006. Mr. Lentini's resume can be downloaded at www.atslab.com.

Daniel L. Churchward has been investigating fires since 1972 as a sheriff's deputy, fire fighter, insurance company Special Investigations Unit member, and privately employed forensic engineer. He is a graduate of Purdue University with a B.S. in Electrical Engineering Technology.

Since 1995, he has been the owner and president of Kodiak Enterprises, Inc. He is a charter member and the current Chairman of the NFPA Technical Committee on Fire Investigations responsible for NFPA 921, *Guide for Fire and Explosion Investigations.* Mr. Churchward has qualified as an expert in fire investigation in both state and federal courts and has served as an expert for the court as well. He has investigated approximately 2500 fires in his 34 years as a fire investigator. Mr. Churchward's resume can be downloaded at www.kodiakconsulting.com.

David M. Smith is a certified fire investigator with over 35 years of experience. He began his career in law enforcement in 1968 and served as a bomb technician and arson/homicide detective. Since 1981 he has owned and managed Associated Fire Consultants, Inc., a private firm specializing in fire and explosion investigations in Tucson, Arizona.

Mr. Smith has been accepted as an expert witness numerous times throughout the United States and Canada and actively lectures regarding fire investigation matters in Australia, New Zealand, the United Kingdom and the United States. He is a past-president of the International Association of Arson Investigators (IAAI) and has represented the International Fire Service Training Association as a Principal member of the NFPA Technical Committee on Fire Investigations since 1992. Mr. Smith's resume can be downloaded at www.assocfire.com.

Douglas J. Carpenter has been investigating fires since 1996 as a fire protection engineer. He holds an A.S. in Mechanical Engineering from Vermont Technical College, a B.S. in Mechanical Engineering from the University of Vermont with and an M.S. in Fire Protection Engineering. from Worcester Polytechnic Institute. He is a registered Professional Engineer (P.E.) in the State of Maryland and a Certified Fire and Explosion Investigator.

Since 1998, he has been vice president and principal engineer with Combustion Science & Engineering, Inc., an independent consulting firm in Columbia, MD. He is an alternate member of the NFPA Technical Committee on Fire Investigations responsible for NFPA 921, *Guide for Fire and Explosion Investigations.* Mr. Carpenter has qualified as an expert in the areas of fire origin and cause investigation, fire dynamics, fire reconstruction, and computer fire modeling, in both state and federal courts. He has numerous publications in the areas of fire protection engineering and fire investigations, and has developed and frequently teaches courses for the Society of Fire Protection Engineering and other professional organizations. Mr. Carpenter's resume can be downloaded at www.csefire.com.

Michael A. McKenzie is a trial attorney licensed to practice law in the State of Georgia. He received his J.D. from the Mercer University Walter F. George School of Law in 1977. He has coordinated the investigation of fires for clients since 1979 and has tried to verdict approximately 35 alleged arson cases. He provided the fire litigation expertise for the defense in the case of *Georgia v. Weldon Wayne Carr.*

Mr. McKenzie practices with the firm of Cozen O'Connor in Atlanta, Georgia. He has lectured frequently on topics involving arson and fraud throughout his 29 years of law practice. Mr. McKenzie's resume can be downloaded at www.cozen.com.

STATE OF MARYLAND

COUNTY OF HOWARD

I swear under the penalties of perjury that the statements in the foregoing Report on the Peer Review of the Expert Testimony in the Cases of State of Texas v. Cameron Todd Willingham and State of Texas v. Ernest Ray Willis are true and correct to the best of my knowledge and ability.

Douglas J. Carpenter

4/3/06
Date

SWORN AND SUBSCRIBED before me
On this 3rd day of April 2006

Melissa dewitt
Signature

Melissa dewitt
Printed Name

MELISSA DEWITT
NOTARY PUBLIC
BALTIMORE COUNTY, MD
MY COMMISSION EXPIRES SEPT 1, 2007

STATE OF INDIANA

COUNTY OF

I swear under the penalties of perjury that the statements in the foregoing Report on the Peer Review of Expert Testimony in the Cases of State of Texas v. Cameron Todd Willingham and State of Texas v. Ernest Ray Willis are true and correct to the best of my knowledge and ability.

Daniel L. Churchward

5 APRIL 06
Date

SWORN AND SUBSCRIBED before me
On this 5 day of April 2006

Christine L. Yoakum
Signature

CHRISTINE L. YOAKUM
Printed name

CHRISTINE L. YOAKUM
Notary Public, State of Indiana
County of Allen
My Commission Expires Jun. 1, 2012

STATE OF GEORGIA

COUNTY OF COBB

I swear under the penalties of perjury that the statements in the foregoing Report on the Peer Review of Expert Testimony in the Cases of State of Texas v. Cameron Todd Willingham and State of Texas v. Ernest Ray Willis are true and correct to the best of my knowledge and ability.

John J. Lentini

4/3/06
Date

SWORN AND SUBSCRIBED before me
On this 3rd day of April 2006

Signature

DANIELLE M. DUQUETTE
Printed name

Notary Public
Paulding County, Georgia
My Commission Expires Feb 6, 2010

STATE OF GEORGIA

COUNTY OF

I swear under the penalties of perjury that the statements in the foregoing Report on the Peer Review of Expert Testimony in the Cases of State of Texas v. Cameron Todd Willingham and State of Texas v. Ernest Ray Willis are true and correct to the best of my knowledge and ability.

Michael A. McKenzie

4-11-06.
Date

SWORN AND SUBSCRIBED before me
On this 11th day of April 2006

Mary Joann Leone
Signature

MARY JOANN LEONE
Printed name

Notary Public, Jasper County, Georgia
My Commission Expires March 27, 2009

STATE OF ARIZONA

COUNTY OF PIMA

I swear under the penalties of perjury that the statements in the foregoing Peer Review Report, State of Texas v. Cameron Todd Willingham and State of Texas v. Ernest Ray Willis are true and correct to the best of my knowledge and ability.

David M. Smith

3-28-2006
Date

SWORN AND SUBSCRIBED before me
On this 28 day of March 2006

Signature

TONI N SHOOTS
Printed name

OFFICIAL SEAL
TONI N. SHOOTS
NOTARY PUBLIC – ARIZONA
PIMA COUNTY
My Comm. Expires Sept. 14, 2007