

Arson Review Committee

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Report on the Peer Review of the Expert Testimony in the Case of State of Arizona

v.

Louis C. Taylor

Innocence Project
Arson Review Committee (ARC) Report

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Executive Summary

The fire that killed 28 guests at the Pioneer Hotel had only one point of origin. The conclusion that this fire was an intentional fire rested entirely upon the determination that the fire started in two places. There is no factual basis for this allegation.

The State's expert witness in this case relied on interpretations of fire "indicators" that they were taught constituted evidence of arson. While we have no doubt that these witnesses believed what they were saying, all of the indicators relied upon by the investigators at the time of this fire have since been proven to be scientifically invalid and unreliable.

Advancements in the fire science and investigative methodology of fire investigation have been made in the thirty-eight years since the Pioneer Hotel investigation, particularly in the area of fire patterns analysis research. 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, 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.

When the facts and opinions expressed by the investigators in 1970 are analyzed using current fire investigation science and technology, this fire would not be classified as incendiary.

In the cases of individuals already convicted using what is now known to be bad science (or no science), the Courts should consider the "new" science as "newly discovered evidence."

The fire at the Pioneer Hotel occurred in Tucson, Arizona, on December 20, 1970. In 1972, Louis C. Taylor was convicted of 28 counts of first-degree murder and arson for setting the fire at the Pioneer Hotel, and is currently serving a life sentence in prison.

The undersigned fire investigators have been requested by the Arizona Justice Project to examine the conviction of Louis C. Taylor. None of the authors has received any compensation for this *pro bono* review, nor will any compensation be accepted.

The primary goal of this review is to identify the factors relied upon by the fire investigators in 1970 that led to the conviction of Mr. Taylor for the crime of arson. Depending upon the outcome of that review, the second goal was to provide recommendations that, if followed, would lead to the remediation of Mr. Taylor's conviction. The third goal was to identify the errors in the determination in the crime of arson (and classifying the fire cause as incendiary) in order to prevent future errors.

Investigative Procedure

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*. Thus, a threshold question for the jury is not only whether the defendant committed the crime, but first and foremost, whether in fact a crime was committed at all. 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, by looking at photographs of the fire scene, a review of the fire investigator's report and reviewing trial testimony, others, including the authors of this report, are able to identify the methodological and analytical processes used in prior investigations. Ultimately, it is the testimony of the fire investigator, an expert witness, upon which the jury relies to reach its verdict. Jurors, however, are generally not equipped to evaluate whether the testimony is accurate, valid or meaningful. In the absence of any generally accepted standards, the judgment of courts and jurors is likely to be based more on subjective evaluations of a witness's sincerity and confidence, than on any relationship the testimony may have to reality.

It is the goal of this study to compare the information presented to the jury with what is now known about the behavior of fire. Much of the information in this field was not available at the time of the trial. 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 investigators¹ who testified that the fire had been intentionally set.

Review of Testimony and Report

State of Arizona v. Louis C. Taylor

Review of Trial Testimony and Report of Mr. Cyrillis W. Holmes

Mr. Cyrillis W. Holmes, Jr. was presented as the lead expert witness for the prosecution. At the time he was retained for this investigation, Mr. Holmes was a Fire Prevention Officer for the California Department of Forestry (CDF). Mr. Holmes had been retained by the City of Tucson to conduct an independent investigation of the fire at the Pioneer Hotel. At the time of his investigation, Mr. Holmes had served for 20 years in various positions within the CDF. He also had five years of employment with other fire service agencies and 18 months as a firefighter in the military.

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. This methodology requires an investigator to consider all of the data when forming hypotheses.

Mr. Holmes failed to interview early witnesses to the fire, and further, he failed to review interviews conducted by the Tucson Police Department. Thus he did not consider those witnesses observations in his analysis of the fire's origin. Failure to consider the information obtained during the interviews was a major flaw that the authors of this

¹ 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.

report noted in the analysis of Mr. Holmes' investigation. Witness information and observations, especially in a large fire such as this one, can provide important information in the analysis of a fire's origin, spread and cause. Even at the time of this investigation, applicable fire investigation texts (e.g. Kirk's and Kennedy) stressed the importance of witness information when analyzing the origin and cause of a fire.

“...the cause and origin of the fire is very often established, at least in part, by interviewing firemen and other witnesses.” [Kennedy]²

“Important questions that should be answered by all witnesses in order to assist the technical investigator with background information are as follows:

- Where was fire or smoke first noted?
- Where was the witness at the time of noting the fire or smoke?
- From what part of the building was the smoke (or flames) emerging? [Kirk]³

Investigation Chronology

Mr. Holmes performed his on-site investigation of the Pioneer Hotel fire on December 30, 1970 (10 days after the fire) and filed his report on January 11, 1971. The interviews of several important witnesses (Mrs. Dora Ojeda, Mr. Scoggins, Mr. David Marion Johnson, and Tucson F.D. firefighters) took place on or around September 15, 1971, eight months after Mr. Holmes had filed his initial (and only) report, but six months prior to his testimony on February 15, 1972. Mr. Holmes consciously or inadvertently chose to disregard this important eyewitness information of a single fire located near the north stairwell on the fourth floor. Had Mr. Holmes considered this important information, it should have substantially altered his findings and conclusions.

Mr. Holmes' Origin Determination

Mr. Holmes' conclusion of causation of this fire was based solely on his determination that there were two separate and distinct origins, unconnected and independent of each other.

“The cause of the subject fire is concluded to be an act of arson, constituting the willful and malicious act of exposing a flaming object or flaming material to the vertical wall covering, probably at or near the floor level in the hallway at two separate and distinct locations” (Holmes report, p.2).

“There were at least two separate and distinct points of origin unconnected and independent of each other, located in the north-south hallway on the fourth floor” (Holmes report, p.5)

² Kennedy, J., *Fire, Arson and Explosion Investigation*, Investigations Institute, Chicago, IL, 1962, p. 120.

³ Kirk, P., *Fire Investigation, including fire-related phenomena: Arson, Explosion & Asphyxiation*, John Wiley & Sons, New York, NY, 1969, p. 150.

Even by today's standards, a finding of *separate* and *distinct* origins which are *unconnected* and *independent* of each other "may provide physical evidence of an incendiary fire cause".⁴ The sole basis for Mr. Holmes' conclusion regarding the incendiary fire cause was his determination that there were two separate and distinct fire origins.

"In order to conclude that there are multiple fires, the investigator should determine that any *separate* fire was not the natural outgrowth of the initial fire. Separate fires that are not caused by multiple deliberate ignitions can result from fire spread by conduction, convection, or radiation".⁵ Fires within a contiguous fire area do not and cannot be considered separate fires. "Fire in different rooms, floors on different stories with no connecting fires, or separate fires inside and outside the building are examples of multiple fires."⁶

In establishing that these hypothetical origins were *unconnected* and *independent*, Mr. Holmes did not provide a definition or discussion of *unconnected* or *independent*. Therefore, standard dictionary definitions would have been relied upon. Unconnected is defined as, "not connected; not joined together or attached; lacking coherence".⁷ Independent is defined as, "separate from; exclusive; irrespective; irrespective of; regardless of".⁸

By definition then, for Mr. Holmes' two areas of origin to be *unconnected* and *independent*, the fires could not have been "connected" or within the same or a contiguous fire area. It is evident that all of the burned area in the north-south hallway and elevator lobby on the fourth floor constituted a single, or contiguous fire area, as shown in the photographs, videotape of the fire scene, notes, and as described by Mr. Holmes and other investigators. Simply, Mr. Holmes' allegation that the two fire origins were unconnected and independent is not supported by the evidence.

In describing the damage, Mr. Holmes stated that the degree of damage was such that his two hypothetical areas of origin encompass the majority of the north-south hallway. Mr. Holmes testified at Volume 15, page 132, line 19 that his first area of origin at the south end of the north-south hallway was approximately 12-15 feet in length and encompassed the width of the hallway.

Q. ...What size area was encompassed? Start with the area down at the south end of the north-south stairway.

A. The area of origin between Room 411 and 412, the maximum is fifteen feet with twelve feet being the most logical.

Mr. Holmes testified at Volume 15, p. 133, line 4 that his second area of origin at the north end of the north-south hallway was approximately 8-12 feet in length and encompassed the width of the hallway.

⁴ NFPA 921, *Guide for Fire and Explosion Investigations*, National Fire Protection Association, Quincy, MA, 2008, §22.2.1 Multiple Fires

⁵ NFPA 921-08, §22.2.1.2

⁶ NFPA 921-08, §22.2.1.1

⁷ Webster's New World Dictionary, 2nd edition, New York, NY, 2002

⁸ Webster's New World Dictionary, 2nd edition, New York, NY, 2002

A. In the north hallway origin - - area of origin the distance is eight feet for the minimum. For the maximum of twelve.

Furthermore, in his report he described the extent of damage was such that:

“the burning characteristics of the hallway coverings complicated the exact point of origin determination” (Holmes report, p.4).

The simple fact that Mr. Holmes described two areas of origin that practically encompass the entire hallway demonstrates that the degree of damage was extensive. Analysis of the north-south hallway between his two hypothetical origins also demonstrates an extensive amount of damage. On page 105, Volume 16 he further described the extent of damage in the fourth floor hallway between his origins in the following exchange:

Q. Let me develop facts. On the fourth floor, does your examination reveal whether there was total destruction of all the wall coverings in the area between 403 and 409?

A. It is my recollection that the wall coverings, the exposed wall coverings, were **totally destroyed**, although I don't have specific recollection of every little piece. It was my general recollection it was.

Then again, on page 14, Volume 16, line 14 – page 16, line 1.

A. ... and Room 416 the door burned through and the fire traveled into the room doing light damage...In Room 414 the fire entered the room through the burning through the door...In 412 the fire burned through the door...In 410 the fire burned through the panel door...411 the fire burned in through the room through the door...And 409 the fire burned through the door...405, 3 and 7, the large room, fire burned through the door...406 the fire extended into the room.

Q. The door burned out on that room (406) as you recall?

A. Yes, the panels burned away and the fire entered...Room 404, fire burned the panels away...Room 402, the fire burned through the door panels...401, the fire burned through the door panels.

This total destruction of materials between his two hypothetical origins is also demonstrated in Mr. Holmes' notes and diagram. In the diagram, he notes that all the carpet between these areas has been completely consumed, greater depths of char are recorded in the area between his areas of origin, and that every door to individual rooms located between his hypothetical origins has burned away.

The extent of damage was so great that Mr. Holmes chose to utilize depth of char measurements as the method in evaluating the progression of the fire on the fourth floor in the north-south hallway. It is evident that Mr. Holmes utilized this tool because the damage was so severe that he could not distinguish two points of origin by visual observation. This alone is a major reason why the alleged second fire cannot be considered *separate* and *distinct* nor *unconnected* and *independent*.

Mr. Holmes' also testified that there is a possible third point of origin, but stated, "There's a remote possibility that some falling debris may have dropped down the stairwell and caused that." (Volume 14, p. 129, line 20) Later in his testimony, he stated that the upper layer development provided the same patterns from a single fire source, by radiant heat. (Volume 18, page 22, line 7)

"The carpet had been preheated, most likely by the fire itself at the upper level radiating down on the stairwell preheating this carpet up to or above its auto ignition temperature, or to a point where the fire when one portion ignited, it ignited across evenly. There are no indications that the fire ignited in one spot, and V'd out as it would normally, and the only explanation for this would be that the entire area had been preheated."

Mr. Holmes obviously recognized the importance of alternative causes for multiple fires (i.e. radiant heat transfer from an upper layer and drop down ignition) when he applied this principle to the stairway origin hypothesis, so why was it not considered a factor in the development that occurred in the hallway itself? Mr. Holmes appears to have inconsistently applied his own set of standards for interpreting fire scene evidence.

Areas of origin that encompass nearly the entire fourth floor north-south hallway, extensive damage between these areas, the use of depth of char, and recognition of alternative causes for what he believes to be multiple fires neither substantiates nor supports his opinion of unconnected and independent fires. By Mr. Holmes' own documentation, the degree of damage was so great that it supports the natural outgrowth of a single fire, therefore, negating his conclusion that there are fires *separate* and *distinct* or *unconnected* and *independent* of each other.

Depth of Char Analysis

Mr. Holmes stated that he used depth of char in his analysis and described the reason for his depth of char measurements in his report by stating:

"It is the visual or mechanical measuring of the depth of char on adjacent combustible materials of like type and size that enable the experienced fire examiner to back-track the travel of the fire and determine the origin of a fire" (Holmes report, p.6).

When wood is exposed to elevated temperatures, a chemical decomposition process, known as pyrolysis, begins to drive off gases, water vapor, and other products as smoke. The remaining black material (char) mainly consists of carbon that shrinks during this process and will develop cracks and blisters. The depth of charring is a function of the amount of total heat exposure to the wood. Therefore, the locations of better combustion and/or longer duration will also be the location of greater heat transfer resulting in a deeper char.⁹ It is common practice, even today, for investigators to utilize a blunt-end depth gauge to analyze the depth of charring to evaluate fire spread. If done properly, "the investigator may deduce the direction of fire spread, with decreasing char depths being farther away

⁹ NFPA 921, Guide for Fire and Explosion Investigations, National Fire Protection Association, Quincy, MA, 2008.

from the heat source”.¹⁰ However, investigators are cautioned about the use of this analysis tool due to the many variables that may affect the depth of charring, including duration, exposure, and ventilation.^{11,12}

NFPA 921, further cautions that “wood can exhibit deeper charring when adjacent to a ventilation source or an opening where hot fire gases can escape”.¹³ The concept of ventilation-limited fires burning better at open doors and windows where an available source of oxygen is present is not a novel theory and has been present in many combustion and thermodynamics textbooks since the mid-1800’s.^{14,15,16} These cautions are not new to the fire investigation profession either and had been reported as early as 1969 in fire investigation texts.¹⁷ This text cautioned the investigator in the use of depth of char by stating:

“It is evident that other factors being constant, there should be a direct relation between char depth and time of burning. However, to place more than casual emphasis on this point may well lead to failure to diagnose the situation fully.

Not only the time of burning, but the flame intensity, which varies locally to a great degree, will often be involved.”¹⁸

These cautions on the use of fire patterns, including depth of char, are easily explained and understood through the study of the dynamics of compartment fire behavior. When a fire occurs inside a compartment (i.e. a compartment fire¹⁹), the fire behaves differently than if it is burning in the open.²⁰ Following ignition, while the fire in a compartment is still relatively small, it will be burning freely.^{21, 22} 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.²³ 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 layer*. Mass and energy are transported from the fire source to the

¹⁰ NFPA 921, Guide for Fire and Explosion Investigations, National Fire Protection Association, Quincy, MA, 2008, §6.2.4.5

¹¹ The term “ventilation” is defined as circulation of air in any space by natural wind or convection or by fans blowing air into or exhausting air out of a space, including doors, windows, stairwells, and HVAC fans.

¹² NFPA 921, *Guide for Fire and Explosion Investigations*, National Fire Protection Association, Quincy, MA, 2008, §6.2.4.4

¹³ NFPA 921, *Guide for Fire and Explosion Investigations*, National Fire Protection Association, Quincy, MA, 2008, §17.4.3.

¹⁴ Faraday, M., *The Chemical History of a Candle*, Chautauqua Press, New York, NY, 1860

¹⁵ Turns, S., *An Introduction to Combustion: Concepts and Applications*, 2nd edition, McGraw Hill, Boston, MA, 2000

¹⁶ Cengel, Y, Boles, M., *Thermodynamics-An Engineering Approach*, 5th edition, New York, NY,

¹⁷ Kirk, P., *Fire Investigation, including fire-related phenomena: Arson, Explosion & Asphyxiation*, John Wiley & Sons, New York, NY, 1969

¹⁸ Kirk, P., *Fire Investigation, including fire-related phenomena: Arson, Explosion & Asphyxiation*, John Wiley & Sons, New York, NY, 1969, p. 80.

¹⁹ The term “compartment fire” is defined as a fire that is confined within an enclosure such as in a room or building.

²⁰ Drysdale, D., *An Introduction to Fire Dynamics*, second edition, John Wiley & Sons, New York, 1999.

²¹ 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.

²² 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.

²³ Drysdale, D., *An Introduction to Fire Dynamics*, second edition, John Wiley & Sons, New York, 1999.

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.²⁴

When the temperature of the upper layer reaches approximately 1,100-1,200 °F, there is sufficient thermal radiation (i.e. 20 kW/m²) reaching the fuel packages within the compartment to ignite every exposed and “easily-ignitable” combustible surface in the room, including the carpet. 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*. More important to pattern development, flashover also marks a transition from a fuel-controlled fire to a ventilation-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 dependent on the rate of inflow of air into the compartment. The post-flashover compartment fire is characterized by an excess of available fuel but lacking adequate oxygen for combustion. Therefore, 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 ignite and consume materials lining the compartment, such as floors, ceilings, carpet, and walls. This process can create intensity patterns on surfaces of the type described by Mr. Holmes. The better the combustion, the greater the damage that will result on the material exposed to the heat. This process can create greater depths of char due to the increased combustion in this region.^{25,26}

Carpet lined the hallway floors, as well as the lower 18 inches of the hallway walls at the Pioneer Hotel. Above the carpet on the walls was a nine-inch-wide piece of five-ply board that ran lengthwise down both sides of the hall. A vinyl wall covering glued onto plasterboard extended to the ceiling above the wood. The fuel load within these hallways was quite significant and would have quickly allowed the fire to spread and produce thick, black smoke rapidly transitioning the compartment to a ventilation-controlled fire, evidenced by the fire department burn tests (available on video). In fact, the fire department tests, performed in an undamaged part of the hotel, had to be extinguished within 3 minutes and 30 seconds due to the large volume of black smoke that quickly filled the hallway and forced the observers out of the hallway.

Mr. Holmes acknowledges several times in both his report and testimony the importance of ventilation as it relates to both combustion and to depth of char measurements. Specifically, he discussed the effects of ventilation on depth of char measurements when he stated,

“...once a fire is extinguished, there is deeper charring of the combustible materials at the point of origin than found at the perimeter. This depth of char is progressive in dimension on horizontal surfaces such as ceilings and floors...**Available and continuing sources of oxygen to the fire are additional considerations**” (Holmes report, p.6).

²⁴ NFPA 921, *Guide for Fire and Explosion Investigations*, National Fire Protection Association, Quincy, MA, 2004.

²⁵ Carmen, S., *Improving the Understanding of Post-Flashover Fire Behavior*, International Symposium on Fire Investigation, Sarasota, FL, 2008.

²⁶ Lentini, J., *Scientific Protocols in Fire Investigation*, CRC Press, 2006.

Moreover, Mr. Holmes explains during his testimony that fires burn better at areas of ventilation paths, which create extensive damage, in the following exchange:

Volume 15, p. 33, line 11

A. On the eighth floor, for instance, we had Room 803, which is a large room normally consisting of three and 802, 804, and both of those cases the doors were open so that the fire had free access into the rooms in the early stages of the fire.

Q. Did the smoke stain indicate they had vented out?

A. Yes, sir, it did.

Q. What would this do to a fire that was burning? How would it react to this?

A. Well, the venting itself would supply oxygen to the fire through the lower portion of the window, allow the gases to escape and would provide free burning and would intensify the fire in that room. It would create alternately a low pressure area in the hallway which could draw fire into the room and create a draft in the hall

Q. Now, did you find some intense burning in the hallways at the upper floors?

A. Yes, sir.

Q. I'm not talking about rooms now.

A. Yes, sir.

Q. Would it – was it the same principle that created this intense burning in the hallways in the upper floors?

A. Yes, sir, the rooms again acted as a draft or a horizontal chimney so it were, and **it created heavier burning in the hallways opposite these rooms or close to the rooms.**

Mr. Holmes failed to recognize that the locations of greatest damage (his hypothetical areas of origin) were located at the ventilation paths created by the open stairwells (i.e. north-south stairwell and east-west stairwell). The stairways in this hotel did not have doors and were open to each floor all the way through the top floor. The heated gases and smoke are less dense than the surrounding air, creating buoyancy forces allowing these gases to rise from the burning fuel and follow the path of least resistance. If a fire is burning near an open stairway, the smoke and heated gases will rise through the stairway similar to a chimney. Based on the laws of conservation of mass and fluid dynamics, when the thermal plume of heated gases and smoke are moving upwards through the stairway, uncontaminated (well-oxygenated) air from the areas below (stairway and lower floors) will be pulled up into the base of this fluid movement. This circulation of clean air will provide a constant source of oxygen for better combustion in these ventilation paths. These ventilation paths fit the areas of greatest damage found by Mr. Holmes. Nevertheless, in direct contradiction to both his report and testimony regarding the effect of ventilation, Mr. Holmes relies solely on the depth of char as his directional patterns demonstrating his two alleged origins,

resulting in a determination of multiple fires. Mr. Holmes failed to recognize that his two hypothetical origins are located at the areas of best ventilation and thus better combustion, which would have resulted in greater damage and deeper char.

Further complicating his depth of char measurements, Mr. Holmes failed to use proper methodology. The proper methodology in conducting a depth of char analysis, according to NFPA 921 17.4.3.2 includes:

“Consistency in the method of measuring the depth of char is the key to generating reliable data. *Sharp pointed instruments*, such as pocket knives, *are not suitable* for accurate measurements because the sharp end of the knife has the tendency to cut into the non-charred wood. Thin, blunt-ended probes, such as calipers, tire depth gauges and dial calipers are best. The same measuring tool should be used for any set of comparable measurements. Consistent pressure for each measurement while inserting the measuring device is also necessary for accurate results.”²⁷

Mr. Holmes’ method of measuring depth of char was greatly lacking in both its methodology and objectivity. (Volume 16 pg 38 line 20)

Q. Was the knife that you demonstrated here the other day the very knife that you used on your inspection of the Pioneer?

A. Yes it was.

Q. Are there any calibrations or markings on that knife to indicate inches or fraction of inches?

A. No.

When performing a Depth of Char analysis, investigators must be aware that comparison of the depths measured from different types of wood (e.g., batting versus chair rails) does not provide reliable data. NFPA 921, cautions that the

“comparison of char measurements...should be done only for identical materials. It would not be valid to compare the depth of char from a wall stud to the depth of char of an adjacent wall panel”.²⁸

Therefore, the data compared by Mr. Holmes would not have constituted reliable data because he was comparing wood batting with other items, such as doorjamb. Because Mr. Holmes ignored the effects of ventilation and utilized a non-scaled and inaccurate measurement device on the char, the data gathered by his depth of char analysis is unreliable at best.

Other important factors that Mr. Holmes should have utilized in the analysis of his origin determination were the observations of witnesses. Mr. Holmes disregarded any information presented by many witnesses that was contrary to his origin hypothesis. As presented previously, witness information is important in the analysis of a fire. Witness information can be extremely important in assisting an investigator in the determination of an origin, so much that NFPA 921 details it as one of the four categories of information that can be utilized in determining an area of origin:

²⁷ NFPA 921, *Guide for Fire and Explosion Investigations*, National Fire Protection Association, Quincy, MA, 2008, §17.4.3.2.

²⁸ NFPA 921, *Guide for Fire and Explosion Investigations*, National Fire Protection Association, Quincy, MA, 2008, §17.4.3.

“Determination of the origin of the fire involves the coordination of information derived from one or more of the following: 1. *Witness Information*. The analysis of observations reported by persons who witnessed the fire or were aware of conditions present at the time of the fire.”²⁹

Had Mr. Holmes interviewed or reviewed any of the following witness statements, he would have inevitably determined that there was in fact only one origin.

- Captain Angel Carranzo – Tucson Fire Department, one of the first arriving fire apparatus sees flames on north stairway. (Volume 13, p. 54, line 22):

Q. Okay. And at that time you were able to see flames fully involved on the staircase, that north staircase?

A. When we got to the base of the stairs, I could see it, yes.

- Mr. Carter – Journalist standing outside of Pioneer Hotel at the early stages of fire development. (volume 37, p. 146)

“Sees fire only in the Northwest corner of 4th floor involved in fire.”

- David Marion Johnson – Custodian at Pioneer Hotel. Witnesses fire at head of north stairs only. (volume 19, p. 161)

Q. “Question: what – where did you see fire on the fourth floor?”

A. “Answer: well, the fourth floor right at the head of the stairs.”

- Mrs. Dora Ojeda – Pioneer Hotel guest staying in room 406 and 408 with her family. (Volume 19, p. 23 line 1)

Q. Where was the fire as you looked into the hall?

A. In the hall.

Q. Can you be more specific as to where in the hall as you looked out the door?

A. In front from left to right. The -- the flames went from left to right.

p. 36 line 6

Q. You said that the – you said that when you opened the door the fire seemed to be moving from your left to your right as you faced into the hall?

A. From the left to the right.

²⁹ NFPA 921, *Guide for Fire and Explosion Investigations*, National Fire Protection Association, Quincy, MA, 2008, §17.1.2..

- Mr. Scoggins – Pioneer Hotel guest. Tucson Police Department eyewitness interview.

Mr. Scoggins related that he came up from the banquet room to the 3rd floor via the annex stairwell, came to the north-south corridor and first observed Mr. Taylor approximately in front of room 309. He further stated that when he got to the **north stairwell**, he went up two or three steps and could observe that the fire **was not burning south of the point that can be seen**, looking from the stairwell to the 4th floor. The **fire was contained on the north section of the 4th floor**, as observed from the stairwell.

It is evident from this review that Mr. Holmes did not adequately demonstrate that two *separate* and *distinct* origins existed in the Pioneer Hotel fire. In fact, witness testimony, physical evidence, and the compartment fire dynamics all reliably indicate a single point of origin. According to Mr. Holmes, his cause determination rested solely on the two-origin theory. **“The key to eliminating the accidental cause in this particular case is the establishment of at least two separate and distinct points of origin”** (Holmes Report, p. 10). He even made assertions (based on his ignition tests) that had a fire originated from a single area that it could have easily been the result of an accident.

“On the horizontal surfaces they (single paper matches) did not cause ignition of the carpet; when carefully placed against the vertical carpet, they readily ignited the carpet which sustained ignition and spread. **Had only one point of origin been found, this would have been a possible source of accidental ignition.**” (Holmes Report, p.9)

Furthermore, to compound this inaccurate determination of a second origin, Mr. Holmes relied on interpretations of “indicators” that he was taught constituted evidence of arson. While Mr. Holmes may have believed what he was saying was true, all of the indicators he had relied upon have since that time have been proven to be scientifically invalid and unreliable. The sad fact is, Mr. Holmes’ “misinterpretations” of the char and char depth would have undoubtedly impressed the jury as Mr. Holmes relied heavily on his interpretation of rate of charring and the appearance of char to support his conclusion.

The appearance of the char and cracks in the past had been given emphasis as being indicative of a fast moving, high temperature fire, based on the shininess of the wood charring and the size of the blisters. Mr. Holmes used these indicators in testifying to the jury to infer that this fire was unusual.

Volume 16 pg. 60 line 13

Q. Mr. Holmes, can you tell the difference, as you look at a piece of wood, as to whether the alligatoring was caused by contacts with flame as opposed to just heat?

A. I cannot specifically do that in all cases, no.

Q. But in certain cases there is a difference between the shiny burn as based on whether flame or just heat caused the charring?

A. The difference is not so much contact by flame per se, but whether it is a rapid heat buildup of a hot fire, or a slow build up of a smoldering fire. That is where you get the difference rather than contact of flame.

The myth of large shiny alligator blisters being indicative of a "rapidly moving" fire was widely published, taught and believed well into the 1980s^{30,31}, but it was a myth nonetheless. NFPA 921 has refuted this myth by stating, "This is a misconception. These types of blisters can be found in many different types of fires. There is no justification that the appearance of large, curved blisters is an exclusive indicator of an accelerated fire."³²

Additionally, the duration of a fire cannot be determined by the depth of char as put forward by Mr. Holmes. Based on this faulty premise, Mr. Holmes testified that he could have provided the amount of time burning to support his determination that these fires were set "simultaneously". When asked to pin down his use of the word "simultaneous" to describe the time of ignition between his hypothetical origins, he testified that (volume 18, page 97, line 13):

"It would be difficult to pin down the outside limits, other than that the fire on the stairwell had to have been burning and have some significant burning before the fire in the hallway was progressed south and east. The fire at the south end of the hallway, the burning indicators there, the depth of char and all the other indicators indicate that there was no substantial burning over above the other of say fifteen minutes or possible even ten minutes, so that all the indicators coupled together indicate that the fire was substantially simultaneous, which would encompass a few minutes."

Utilization of depth of char to establish the length of time that a fire had burned has been proven to be unreliable.³³

³⁴ NFPA 921 6.2.4.4.3, warns that, "The investigator is cautioned that no specific time of burning can be determined based solely on depth of char".³⁵ Additionally, this warning is not new and was provided in fire investigation textbooks at the time of this investigation, which warned:

"In studying the pattern of a structural fire, variations in the depth of the char will inevitably be noted. Some investigators consider that this feature of the fire is of primary importance; they make measurements with the idea of determining the length of time the fire burned at this point. It is evident that other factors being constant, there should be a direct relation between char depth and

³⁰ 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, p87.

³¹ International Fire Service Training Association, (IFSTA), *Fire Cause Determination*, Fire Protection Publications, Oklahoma State University, 1982, p. 48.

³² NFPA 921, *Guide for Fire and Explosion Investigations*, National Fire Protection Association, Quincy, MA, 2008, §6.2.4.3.

³³ Babrauskas, V., *Wood Char Depth: Interpretation in Fire Investigations*, Proceedings of ISFI, International Symposium on Fire Investigation, Fire Service College, Morton in Marsh, England, 2004

³⁴ Babrauskas, V., *Charring Rate of Wood as a Tool for Fire Investigations*, Interflam, Interscience Communications, London, 2004

³⁵ NFPA 921, *Guide for Fire and Explosion Investigations*, National Fire Protection Association, Quincy, MA, 2008, § 6.2.4.4.3..

time of burning. However, to place more than casual emphasis on this point may well lead to failure to diagnose the situation fully.”³⁶

Review of Tucson Fire Department Report

R.B. Slagel, Chief of the Fire Prevention Division of the Tucson Fire Department conducted an on-scene investigation for the Fire Department. Chief Slagel determined the fire to have originated on the “fourth floor in the public hallway and there were at least two major fire origin areas separated by approximately 60 feet. No natural or accidental causes could be found. In my opinion, this was a deliberate, man-made fire, with malicious intent; therefore the fire cause is arson.” (Tucson F.D. Report, p. v) Chief Slagel does not provide any substantiation for his findings and conclusions. He seems only to be restating the findings of Mr. Holmes and did not provide any basis for his conclusions.

Review of Trial Testimony of Marshall Smyth

Carl Marshall Smyth was a consulting Mechanical Engineer hired by the General Adjustment Bureau to conduct an investigation of the Pioneer Hotel Fire. He worked for 25 years in the aeronautical field performing failure analysis and accident reconstruction for private and public corporations before becoming an independent contractor in 1968.

Mr. Smyth determined that the origin of this fire was a single origin, as explained in the following exchange:

Well, within the first day or two it appeared to me that the origin of the fire was on the lower floors, the fourth or possibly on the stairs between the third and the forth. (Volume 32, Page 22, line 23)

As a result of this, my conclusion in regard to origin is that an origin of the fire had to be in this north dead-end area in order to allow the complete disintegration and complete burning and combustion of all the materials that were in this dead-end area. (Volume 32, Page 61 line 1)

In my view there was no other information of the sufficient magnitude that would convince me that there was an origin any place else as far as the physical evidence was concerned. Now, when I say origin, I’m talking about the primary source of the fire. As fire progresses there are secondary fires that get going, and I’m not referring to those types of things. (Volume 34, p. 42, line 4)

When I talk about origin, I’m talking about my view of the initiation of the original fire, and **there was only one**. (Volume 34, Page 42 line 17)

Q: there was just one fire?

A: yes

³⁶ Kirk, P., *Fire Investigation, including fire-related phenomena: Arson, Explosion & Asphyxiation*, John Wiley & Sons, New York, NY, 1969, p. 80.

Q: How about as you go down the stairs from the fourth floor to the third floor? Are you excluding any origin on that staircase as well?

A: Well, **I didn't find any physical evidence that would substantiate an origin there.**

Volume 33, P 147 line 4

Q: in so far as this north-south hall or the fourth floor, what is your opinion?

A: in my opinion, it **moved from north to south the full length of the hallway**

Q: did you find any point throughout the entire north south hallway that indicated any change in direction of that fire?

A: I found no point that could substantiate in my mind of that was sufficient to substantiate a change in direction of airflow. No I could not.

Q: Direction of Air flow

A: Direction of the fire propagation, direction of the fire movement.

Other Evidentiary Factors

This Committee having made the determination that there was only one point of origin for this fire, thereby negating proof that a crime actually occurred, would seem to render a discussion of motives and other factors superfluous. That may indeed be the case, but there were discussions of these other factors during the investigation, which were presented to the jury. It is inappropriate to review means, motive or opportunity in the investigation of a fire prior to the finding that the fire is incendiary in nature. In fact, nearly all fires have "motive indicators" (e.g. financial stress) including fires eventually determined to be accidental.

Most criminal investigations of fires proceed along parallel tracks, with one group examining the physical evidence, and another group, working with the assumption that the fire was set, looking for suspects. The Tucson Police Department arrested a 16-year old minor, Louis Taylor, and began interrogating him without parental consent and before determining that the fire was incendiary. A total of 30 hours of interrogation took place.

Despite the fact that Mr. Holmes was retained by the city to conduct an investigation that was, in his own words, "limited in scope only to the determination of the origin and cause of this fire," he felt constrained to discuss

motive and opportunity. Mr. Holmes provided a discussion in his report regarding the various mindsets and motives of fire setters. In order for the reader of this report to more clearly appreciate the mindset that Mr. Holmes carried with him, that discussion will be reproduced here.

POSSIBLE MOTIVE

The perpetrator probably had no idea that this fire would develop beyond the nuisance stage. If patrons were known to have wealth, the fire may have been diversionary in nature to empty the hotel, causing confusion to allow burglars to work. This did not appear to be the case in this instance.

The most suspect motive would be for vanity reasons the vanity class of fire-setters are the "would-be hero" fire setter who generally are "low people" with big ideas but no ability to carry out their dreams. No activity is too bizarre if it brings them attention, for they are like little adolescents who dream of becoming courageous supermen. They are exhibitionists, pathological liars; they are impulsive and unmoral, capable of assault, rape and theft. They describe an irresistible impulse and are secondarily interested in firemen, though instead of wishing to extinguish the fire, they identify themselves with the spotters and the detectives. They are frequently among the first to report the fire, usually participate in rescues, enjoy the sight of women running from the fire or building in varying degrees of undress, and frequently are the firemen's most active helpers. The largest number set fires purely and simply to raise their own importance in the eyes of their friends, families and neighbors. They tend to embellish their activities with all the fantastic accomplishments of an adolescent girl striving for attention. They tend to deny all guilt or anxiety and are generally hard to convict, and many times someone will appear to plead in their behalf, offering many excuses for their activities.

It is this investigator's opinion that anyone sitting the general description above, who was present after the fire or during the fire helping in the rescues, assisting in the firefighting and generally professing great knowledge of events and details about the fire, would be most suspect in the setting of this fire.

Mr. Taylor does not fit the so-called "would-be hero" profile, as he only assisted with the rescue when requested by the fire department. Another possible motive put forth by Mr. Holmes is that the fire was set to cover up a crime. None of the activities noticed by the witnesses placed Mr. Taylor entering, removing, or possessing the property of others. Additionally, the Tucson Police Department did not find any possessions on Mr. Taylor that did not belong to him.

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The Tucson Police Department and Fire Department believed that Mr. Taylor was the perpetrator and as a result failed to follow up on other prominent investigation leads, including several recent “set” fires within the Pioneer hotel documented by the hotel staff in a hotel memorandum.

“We have had numerous reports of a potential arsonist in the hotel. In the last three weeks, there have been three small fires of no consequence; however, there is a potential threat of more permanent damage. As a result, in order to assist the Fire Department and cooperate with the Police Department, in the event any fire is reported to the front desk, the front desk will ask first if the fire is out. If not, the front desk will immediately call the Fire Department, whose number is 327-7431, and report the nature and location of the fire.

Shortly, a description of the suspected individual will be passed among all personnel. Should this individual be recognized, a call to the Police Department will be in order. Do Not attempt to apprehend the individual yourself.” (October 6, 1970 Memorandum from C.E. Goyette Resident Manager)

Several books of matches were found in Mr. Taylor's possession. The significance of this finding is questionable. Dr. Daniel Horn, Director for the National Clearinghouse for Smoking and Health reported that in 1970, 44.7 million people smoked cigarettes, which equates to approximately 42% of the United States adult population. One could easily surmise that if all persons were searched that night as they were exiting the Pioneer Hotel, 42% should have been equally plausible suspects as they would have been in possession of some item capable of producing an open flame (i.e. matches, lighter).

Mr. Taylor has never admitted to setting the fire or being involved in any way. Even now, when he could likely obtain release from prison by showing appropriate remorse, he continues to be adamant about having had nothing to do with the fire.

Conclusions

This fire was determined to be incendiary based on the determination that there were two separate origins. However, this committee has systematically shown that neither the physical evidence nor the witness statements support this conclusion. Even at the time of the fire, other investigators (Mr. Smyth) who investigated this fire also stated that the damage was consistent with the natural outgrowth of a single fire. A better understanding of compartment fire behavior and its relation to fire pattern development would have provided Mr. Holmes with the knowledge to better analyze this fire. Since the 1970s, significant studies have been conducted on the relationship of compartment fire behavior and fire pattern development. Possession of this knowledge would have altered the course of this investigation. In a recent interview, Mr. Smyth even admitted that, **“I’m very sure that neither Cy Holmes nor I should have or could have said that it was arson at the time that we did...if that fire were to occur again today, there’s no way, there’s no way anyone could prove it was arson”**.³⁷ In fact, in 1970 this fire was “proven” not to be arson. The Committee believes that the jury was bamboozled with fancy sounding “indicators” and pseudoscience.

By Mr. Holmes’ own admission, had he realized that this fire had only one origin, as shown in this review, then this fire could have been an accident. This fire was not proven to be incendiary; therefore, no crime was ever committed. This seems to be the sentiment of the lead Tucson Police Detective, turned private fire investigator David M. Smith. Mr. Smith was recently asked in an interview if the Arson Review Committee were to find that the fire was not incendiary, whether he would change his mind. His answer was “I’d have to, if you don’t have a crime, you don’t have an arrest.”³⁸

³⁷ Volante, E., *New Scientific Knowledge of How Fire Behaves is Raising Questions About Whether Tucson’s 1970 Pioneer International Hotel Fire Stemmed from Arson; New Probe is Sought for Hotel Fire that Killed 29*, The Arizona Daily Star, 2006

³⁸ Volante, E., *New Scientific Knowledge of How Fire Behaves is Raising Questions About Whether Tucson’s 1970 Pioneer International Hotel Fire Stemmed from Arson; New Probe is Sought for Hotel Fire that Killed 29*, The Arizona Daily Star, 2006

The Authors

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David Eliassen is the owner of Green Mountain Investigations, Inc., Sheffield, Vermont. He has served as a firefighter, police officer, and Deputy State Fire Marshal (Florida). He has been in the field doing public and later private fire investigation since 1979, and has attended the National Fire Academy, the BATF National Academy and numerous other training opportunities. He has been a certified fire investigator since 1986 and is a licensed private investigator in Florida, Vermont, New Hampshire and Maine. He has investigated nearly 3,000 fires and has testified at trial over 25 times in State and Federal courts in both criminal and civil cases. Mr. Eliassen is a long time member of the International Association of Arson Investigators (IAAI), and is co-chairman of the IAAI Vermont Chapter Certified Fire Investigator Committee.

Patrick M. Kennedy is the Principal Expert Fire and Explosion Analyst for John A. Kennedy and Associates, the world's oldest established fire investigation firm. He has investigated more than 2,500 fire and explosion incidents, worldwide, including some of the most significant fire incidents in recent times. He holds three Bachelor of Science degrees including a Summa Cum Laude degree in Fire and Safety Engineering Technology from the University of Cincinnati. He has been qualified to give expert trial testimony concerning the origins, causes, and responsibility for fires and explosions by both Federal and State courts on over 80 occasions in the United States and of Canada. He is the author of several well-regarded fire and explosion investigation textbooks. He serves as a principal member of the Technical Committee on Fire Investigations (921) and principal member the Technical Committee on Fire Investigator Professional Qualifications (1033). He has served six terms as the Chairman of the NFPA Fire Science and Technology Educators Section and is Chairman of the Board of the National Association of Fire Investigators (NAFI).

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Dennis W. Smith is a senior fire expert with Kodiak Enterprises, Inc. of Ft. Wayne, Indiana (1999 – present). He retired at the rank of Fire Captain after 25 years (1973-1999) with the Atlantic City, NJ Fire Department with more than eleven years experience in fire and arson investigation, and more than five years in plan review and inspections. He has a B.Sc. degree in Fire Science and a B.A. degree in Criminal Justice, and a A.Sc. degree in Fire Control Technology. He is a Certified Fire and Explosion Investigator (NAFI), a Certified Fire Investigation Instructor (NAFI), and a Accredited Fire Investigator (IFSAC) and formerly a New Jersey certified Arson Investigator. He has been a member of the NFPA Technical Committee for Fire Investigations since 1988 and a member of the NFPA Technical Committee for Fire Investigator Professional Qualifications, responsible for NFPA 1033, *Standard for Professional Qualifications for Fire Investigator* since 1991. He is also a member of the Fire Investigator Committee of the International Fire Service Training Association (IFSTA) responsible for the text *Fire Investigator*. He has lectured extensively throughout the United States and Canada and is currently an instructor for the NFPA Professional Development Training Program for seminars on NFPA 921, *Guide for Fire and Explosion Investigation* and a member of the national training staff for the National Association of Fire Investigators (NAFI).

Appendix A: The State of the Art in Fire Investigation

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 1995,³⁹ 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.”⁴⁰

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 particular importance is the discovery of any circumstances, which cause them to give false indications (of, say, a fire accelerant). A

³⁹ 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.

⁴⁰ 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.

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*.⁴¹

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.

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. The first edition of NFPA 921, *Guide for Fire and Explosion Investigations*, was published in 1992.

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 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*.⁴² 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

⁴¹ 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.

⁴² *Michigan Millers Mutual Insurance Company v. Janelle R. Benfield*, 140 F.3d 915 (11th Circuit 1998).

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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.

Appendix B: Recommendations

The following recommendations were provided by the Arson Review Committee for the Innocence Project based on their 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. These recommendations are germane to this case as well and have been added as an Appendix item for review. The authors have modified these recommendations based on the State of Arizona v. Louis C. Taylor case.

In order to avoid miscarriages such as occurred in the Taylor case, 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 Taylor case, 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 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.

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

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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 conviction in the Taylor case illustrates the danger of the current situation.

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.

To the extent that there are still investigators in Arizona 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. The authors sincerely hope that this report will help to undo similar miscarriages, and help prevent future ones from occurring.