



Assignment

At the request of the District Attorney for the 112 Judicial District of the State of Texas, I have reviewed all of the available fire-related documentary evidence, photographs and testimony in the capital murder case styled State of Texas v. Ernest Willis, No. 1455. I have also inspected samples of red shag carpeting, carpet padding and tile from the subject house. The object of the study was to determine whether the original findings of the fire investigators in the 1986-1987 time frame would be capable of supporting the prosecution of the same case in 2004.

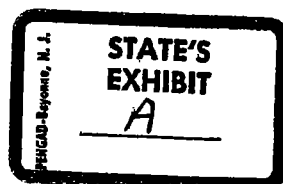
Alleged arson indicators

In reading this report, it should be kept in mind that the original arson determination was based almost exclusively on the observation of char patterns or "low burn" which the investigators believed could only be explained by the presence of a flammable liquid accelerant that had been poured over a large area of flooring and furniture. The judgment of all the prosecution experts was impaired by a lack of knowledge of the effects of radiation in structures which have rooms fully involved in post-flashover burning.

The alleged evidence of arson in this case was based solely on the visual interpretation of various burn marks and patterns and the subjective evaluation of the "excessive" level of destruction of certain items. Both the burn patterns and the level of damage were thought by the investigators to be explainable only by the presence of a flammable liquid accelerant.

The alleged elements of proof of use of an accelerant were:

1. A large, continuous, irregular floor pattern running from the front door through the living room and dining room to the kitchen door
2. A floor pattern running across the kitchen linoleum from the dining room door to the back door
3. A floor burn under the south end of a couch on the west wall of the living room
4. Annealed springs on the south end of the couch on the west wall of the living room
5. The nearly complete destruction of a couch in the living room
6. Low burns on the frame of a living room easy chair
7. A floor burn in front of the living room easy chair
8. Burning to the underside of the back door



9. Charring of the thresholds (door sills) of the front and back doors
10. "Puddle pattern" on the kitchen floor against the back door sill
11. Streaks of char or soot under the front door sill assembly
12. An area of burning on the under surface of the porch floor plywood section against the south wall of the house
13. The apparently complete destruction of a large, solid maple dining room table
14. The presence of a very large segment of burn pattern under the original location of the dining room table
15. The destruction of the dining room table in view of the "light" fuel load
16. The theory that liquid accelerants burn into wood at a different angle than other materials

The excessively long list of supposed accelerant indicators was obviously arrived at by assuming that every subjectively "unusual" pattern or effect of the fire was caused by some special properties possessed only by accelerants.

Most of the "unusual" burn patterns observed by the prosecution investigators in 1986 are now the commonplace subjects of treatises on normal post-flashover effects in elementary textbooks. Today, most journeyman fire investigators receive some training in fire dynamics and are thereby able to understand phenomena which 15 years earlier were often explainable only by the imagined magical properties of flammable liquid accelerants.

The initial rush to judgment by an unqualified county investigator

In any fire investigation it is imperative that the investigators gather all available data and subject the collected information to thoughtful and detailed analysis before reaching conclusions as to the origin and cause of a fire. Whenever an investigator reaches a premature conclusion of arson, there is a strong tendency for subsequent investigational activities to degenerate into case-making rather than fact-finding.

In the Willis case, Deputy Sheriff Larry D. Jackson conducted a cursory examination of the fire scene on the morning of the fire, some hours before the Deputy State Fire Marshals Le Roy Brown and Ed Cheevers and insurance investigator John Dailey arrived to conduct the formal investigations. Jackson wrote a long fire investigation report concluding that the fire was incendiary and that a flammable liquid had been used to accelerate the fire. He compiled a list of some eight meritless reasons for his conclusions. His reasoning was based on assumptions that the fire was "too hot" and

"too fast" not to be accelerated by a flammable liquid and that low burns were necessarily an indicator of the use of accelerant.

Deputy Jackson was obviously unaware that flashover had occurred in the fire and that post-flashover burning invariably produces low burn patterns. The deputy was clearly also unaware that modern furnishings, such as an easy chair or sofa can bring a room to flashover in less than three minutes from ignition. Also, the concept of "too hot" belongs to a long list of fire investigation myths because modern plastics, synthetics and ordinary wood all burn at essentially the same temperature as gasoline or higher.

Deputy Jackson was allowed to testify concerning fire cause and origin despite his admission that he was not an expert in the field (SOF Vol. 19, page 70, line 23 – page 71, line 12:

Q. (By Mr. Johnson :) Now, Officer Jackson, you are not intending to testify in this courtroom today as an expert, are you –

A. No, sir.

Q. Okay. A hundred and forty hours doesn't make you an arson investigator, does it?

A. Not in my opinion.

Q. Or an expert to come in this courtroom and tell the ladies and gentlemen of the jury what the origins of a fire were?

A. No, sir.

Q. Whether it was accidental or purposeful?

A. No, sir

Having explicitly admitted that he was not a fire investigator, Deputy Jackson was given carte blanche to testify to all aspects of fire cause and origin and to express opinions that would not be permitted in a Daubert court today. The court merely held that his lack of qualifications would "go to the credibility."

Initial errors by the Deputy State Fire Marshals

Two Deputy State Fire Marshals arrived at the fire scene in the early afternoon of the day of the fire. Mr. Le Roy Brown, the senior, level 2 Fire Investigator in charge of the case was accompanied by a level 1 Fire Investigator, Mr. Ed Cheever, who was, in effect, an apprentice being trained by Mr. Brown. At the time of the fire, Mr. Cheever had only seven months of experience and was clearly unqualified to handle the responsibility of an alleged murder case on his own.

Mr. Cheever took no notes at the scene and did not write a report. Neither Mr. Cheever nor Mr. Brown took any photographs.

Both Mr. Cheever and Mr. Brown left the fire scene before any rooms other than the dining room and living room had been cleared and inspected.

The senior investigator, Mr. Brown, wrote the official standard report of investigation. In that report, he erred in every important detail of the construction materials of the house. The following table compares the actual materials of construction with those listed by Mr. Brown:

	<u>Actual Composition</u>	<u>Alleged Composition</u>
Interior walls	Wood paneling	Sheet Rock
Exterior walls	Wood paneling	Slate
Ceilings	Cellulose fiberboard	Sheetrock
Roof	Steel	Composition
Sub-floor	Plywood	Hardwood

If Marshal Brown had been called as an expert by the prosecution, he would undoubtedly have suffered a credibility crisis under voir dire because it was largely the same elements of construction he got wrong which determined the rate of spread of the fire.

The problem was solved for the prosecution when they called the apprentice Marshal Cheever and succeeded in suppressing the Brown report as hearsay. Thus the defendant was subjected to those portions of Brown's findings which were inculpatory without being able to use Brown's errors as a challenge to credibility.

**The insurance Co. investigation:
Prejudice, misinformation, speculation, revision**

Prejudice

Before the fire investigator for the insurance company, John Dailey, arrived at the fire scene, the local authorities informed him that the state and county investigators had determined the fire to be arson.

It is rarely, if ever, a wise career move for an insurance investigator to contradict the findings of the state fire marshals unless there is clear and powerful evidence to back a subrogation claim against a solvent party. Thus, the insurance investigator was, without fault on his part, subjected to pressure to reach a concurring opinion of arson.

The correct policy for the authorities is always to preserve the confidentiality of an ongoing investigation. They have the legal right and obligation to obtain any independently gathered evidence from insurance companies, but should avoid sharing

their own findings, especially with parties who may have their own interest in the outcome of a case.

Misinformation

The resident of the fire scene, house, Mr. Robinson, informed Deputy Sheriff Larry Jackson that he had stored four or five one-quart bottles of the pesticide Malathion on the plywood floor of the front porch. This information was passed on to the insurance investigator, John Dailey. Somewhere in the transmission of the information, the name of the pesticide was misspelled, leading Mr. Dailey to believe that there had been four or five bottles of flammable methanol (wood alcohol) on the porch.

Speculation

Insurance investigator Dailey failed to question why anybody would keep bottles of methyl alcohol on the porch or any other part of a house. Armed with the incorrect information, Mr. Dailey apparently believed he had solved the case of fire causation and wrote in his report:

For these reasons, and in the absence of anything to indicate an accidental fire from any other cause, it is believed that this fire was an act of arson by the use of a flammable liquid, now believed to be the methanol which had been stored on the front porch of the risk and was convenient for the arsonist to use. The four quart glass jars in which the methanol was contained were not found because they were no doubt broken by fall down from the house and the porch and broken during the fire fighting activities.

Revision

Investigator Dailey agreed with Deputy State Fire Marshals Cheever and Brown that there was a major flammable liquid pour patterns running from the front door through the living room and dining room to the kitchen door. The two marshals had already left by the time Dailey arrived, so he enlisted the aid of Deputy Sheriff Larry Jackson and a number of local workers to excavate and clean the floors in the rest of the house. Under the debris he identified a continuing pattern running from the dining room door across the kitchen to the back door and a non-contiguous "pour patten" on the north side of the bed in the south bedroom off the kitchen. In his report of June 24, 1986, he concluded as follows that the origin of the fire was in that bedroom:

Based on investigation to date it is believed that the origin of the fire probably started in bedroom #3, where the 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 #3 directly into the kitchen where a large amount of flammable liquid had been poured by the arsonist. The origin then was the pouring of the liquid from front to back of the house and apparently the lighting of the fire at the front door by the arsonist so it

is believed we can speak only of an area of origin inasmuch as it apparently all went up at approximately the same time based on the trail of the flammable liquid burn patterns.

The mechanism of ignition of a separate pour in the bedroom as described by Mr. Dailey would be problematic for an arsonist using any flammable liquid, because such liquids emit substantial quantities of dense vapors which act as flammable gaseous bridges between disconnected puddles. It is at least conceivable that with a great deal of luck the sequence described by Mr. Dailey could succeed if conducted quickly with methanol as opposed to other flammable liquids. Methanol is much less volatile than gasoline and its vapors are much less dense and much more easily dispersed and diluted below their flammable range.

Gasoline, on the other hand, emits copious quantities of dense vapors which rapidly and invisibly spread in all directions over flat surfaces. Multiple separate puddles of gasoline on the floor of a structure can be ignited almost simultaneously by a single match. The flames simply propagate from puddle to puddle on the invisible, dense vapors which initially hug the floor.

Sometime before he testified at trial, Mr. Dailey would have learned that his methanol theory was invalid because there was no methanol at the fire scene – only Malathion, which is not a flammable liquid. His theory of multiple origins was based on the flawed concept that physically separated pours of flammable liquid puddles require multiple ignitions. In his report, Mr. Dailey had shown that the door to the bedroom was open during the fire. If a highly flammable liquid such as gasoline was poured in both the living room/dining room area and in the bedroom, ignition of either puddle would nearly instantly spread to the other.

The prosecution was attempting to establish by indirect evidence (a hose segment from a muck pile in the yard, which allegedly contained traces of gasoline) that the defendant had used gasoline poured through the length of the house to create an instantaneous fire which would prevent the escape of the two victims. Clearly, in a capital murder case, it would have been necessary to establish malice and premeditation. This could be accomplished by testimony from the prosecution experts showing the exits had been deliberately blocked by poured gasoline.

Dailey's discredited methanol theory presented the prosecution with a dilemma. If the witness stuck with his bedroom origin theory but used gasoline in place of methanol, there could be no reasonable probability that the arsonist would have survived the ignition. Furthermore, Fireman Robbie Dominguez would testify that there was no fire in the back bedroom when he entered the window in a failed rescue attempt. If there was no fire in the bedroom, then there was also no possibility of an earlier pour of highly volatile gasoline in that bedroom.

The prosecution planned to use the testimony of Dominguez that there was no fire in the bedroom to contradict the defendant's panicky memory of seeing fire everywhere. The prosecution's plan was outlined in their strategy notes as Follows:

"ROBBIE ALLEN DOMINGUEZ MEMBER FIRE DEPARTMENT, IRAAN

IMPORTANCE:

- 1. COULD HAVE IMPACT ON JURY AS HE DESCRIBES HIS ATTEMPTS TO REACH THE GIRL IN THE BACK BEDROOM....BECOMING STUCK IN WINDOW...BEING BLOWN OUT OF WINDOW....HAD HE NOT GOTTEN STUCK COULD HAVE HAD A 3RD VICTIM IN THIS FIRE.**
- 2. CAN TESTIFY THAT THERE WAS NO FIRE IN THE BACK BEDROOM. CONTRARY TO STATEMENT OF ERNEST WILLIS."**

Thus, in order to maintain credibility, it became desirable for Mr. Dailey to revoke his contradictory theory that the floor pattern in the back bedroom was the result of a flammable accelerant pour, and that that pattern represented a fire origin.

At trial, the debunked methanol theory was not raised as credibility issue. Mr. Dailey told the jury that he had been led to change his opinion that the carpet burn in the bedroom was a pour pattern by studying enlargements of photographs of the pattern. In this way, Mr. Dailey was able to preserve the prosecution's key illusion that pour patterns could be identified by merely looking at them (SOF Vol. 22, page 115, lines 13 - 24):

Q. Another point in your report I received, you indicated, as a conclusion, that the point of origin was in the bedroom. Have you changed your mind on that?

A. Yeah. I told you I have - I said one point of origin, but I have eliminated that after further consideration.

Q. What was the basis of your first point of origin being in bedroom number 3?

A. Because, at first, I thought that was a pour pattern. And subsequently, after due consideration, and examining my blowups and everything, I decided that I had been wrong on that particular point.

Every fire origin and cause analyst is intensely aware that photographs of fire patterns are a poor but sometimes necessary substitute for direct observation. Mr. Dailey personally inspected the fire pattern in question; therefore his explanation for changing his opinion lacks credibility.

Careful study of the exact wording of the Dailey report excerpt quoted above and portions of his testimony indicates that the actual reason for Dailey's complicated theory of multiple origins arose at least partly from his lack of knowledge prior to trial that flammable liquid puddles do not need to be contiguous to propagate flame.

In his direct testimony, Mr. Dailey also used the explanation for the revised opinion that the burn pattern did not penetrate the carpet and therefore was not caused by an accelerant. This is also an invalid reason based on the false assumption that liquid accelerants necessarily burn downward through carpets and/or that liquid accelerants are somehow superior to fall down in their ability to burn through floor coverings.

The subject of downward burning through floor coverings is discussed in greater detail later in this report.

It is obvious from the above considerations that Mr. Dailey's change of opinion was made necessary by unimpeachable eye-witness evidence and a newfound respect for the ability of gasoline flames to leap between puddles. Other explanations were given for the change of opinion, apparently in order preserve the jury's faith that liquid accelerant pour patterns could be reliably determined by visual means.

Absence of fire investigation standards and guidelines in 1987

At the time of the investigation in the Willis Case, there were effectively no learned treatises in the field of fire investigation. Unlike the forensic sciences, fire investigation was treated as an "art" based on experience rather than science. Typically, investigators had little or no training in science, but were ex-firemen or police officers.

The only significant textbook on fire investigation in 1986-7 was Kirk's Fire Investigation, Second Edition, 1983. Unfortunately for the Willis defense, this work contained only sparse and inaccurate treatments of the key phenomena of flashover, radiation and the resultant floor burn patterns which are easily mistaken for liquid accelerant pour patterns. Later editions of the same textbook, beginning in 1991 with the third edition, would include at least some photos and somewhat limited text warnings that apparent liquid accelerant pour patterns could be caused by other, accidental phenomena. Over the years the strength of the warnings grew more adamant.

The principle accrediting agency for fire investigators was and is the International Association of Arson Investigators (IAAI), which issues the CFI certificate. This organization set the standards for both civilian and state fire investigators. Reflecting the average background of their membership, the IAAI steadfastly defended fire investigation as an art as opposed to a science. This philosophy put the organization on an inevitable collision course with what would later (1993) come to be known as the Daubert rule.

As the courts moved toward the concept of the judge as a gatekeeper whose job was to assure a valid scientific connection to the pertinent inquiry as a precondition to admissibility, the IAAI attempted to escape the Daubert rule by maintaining that fire investigation was an art, rather than a science and thus not subject to the rule.

The controversy was ultimately settled after the IAAI filed an unsuccessful amicus brief in *Kumho Tire Company, Ltd. v. Patrick Carmichael, etc., et al*, 119 S.Ct. 1167 (March 23, 1999). In *Kumho*, the U.S. Supreme Court decided that the gatekeeping function of the courts under Daubert applies to all types of evidence, not merely traditional science.

Returning to the 1987 period, however, investigators generally viewed fire investigation as an art based on experience rather than as a rigorous discipline based on proven scientific principles. The problem with this philosophy was that it lacked the key principle in science that hypotheses must always be tested. Thus, an investigator who had been to 100 post-flashover fires could correctly claim extensive experience with such fires even if he erroneously concluded each time that the radiation burns on the floors were caused by an imaginary accelerant.

In 1987, an investigator studying the most widely-accepted fire investigation text, Kirk's *Fire Investigation* would have found no explicit warning that pool-shaped burn patterns could be caused by post-flashover burning. On the contrary, he would have learned the misleading fact that radiation burns (e.g. from flashover) tend to be uniform. It was not until the 5th edition of Kirk's in 2002, that the specific warning was given that the combination of radiation (as in flashover) and carpet can produce non-uniform or irregular char patterns – in other words patterns that look like liquid accelerant pours.

The typical investigator in 1987 was not equipped with the information required to evaluate post-flashover fires. He had been taught that the radiation from post-flashover fires produced uniform charring at floor level. Thus, when he encountered floor burn patterns with relatively sharp edges, he believed that this was irrefutable evidence of the presence of an accelerant. Even after the scientific awareness of the unreliability of such "pour pattern" evidence was well known, there was a tendency for the new information to be soft-pedaled in textbooks. For example, in the second edition of Kirk's, there is a picture (Fig. 7-2b) of a fire scene showing a very clear "pour pattern" on the floor. A fire investigator from that period would assume that an accelerant had been poured in that location. The caption of the picture available in 1987 says only:

"Same room after clean-up and reconstruction of furniture placement. More extensive destruction of chair at right indicates fire originated in this area."

A fire investigator reading the same chapter in any edition of Kirk's published after 1991 would have seen exactly the same picture with the following information added to the picture caption:

"Burn patterns on floor are not from a flammable liquid and are most probably from the combustion of the carpet pad."

Thus, an investigator who learned his craft prior to the mid 1990's would likely be unaware that the combination of flashover and carpeting could readily produce apparent "pour patterns." Furthermore, an investigator studying Kirk's in 1991 would find no explicit warning about this phenomenon but would have to rely on inference from a single sentence in the caption of a photograph. Only an investigator studying Kirk's after 2002 would receive an explicit if somewhat anemic warning about the potential for misinterpretation of floor patterns:

"The ignition of floor coverings by radiant heating can also result in char damage to the floor that is not as uniform as direct radiant heat char."

If the above warning appears somewhat obtuse, it should be remembered that Kirk's Fire Investigation has been the dominant text in the industry since 1969. Any changes reflecting shortcomings in the teachings of earlier editions are unlikely to be made the center of attention in later editions of the same publications.

NFPA 921, the introduction of standards and guidelines in 1992

Prior to 1992, there was no publication which could be legitimately classified as a learned treatise on fire investigation. The long-time favorite textbook, Kirk's Fire Investigation, had been the dominant learning tool in fire investigation, but it represented one man's opinion and was developed primarily as an aid for police and insurance investigators with little attention to warnings and caveats related to potential errors in interpreting evidence.

The pressing need for a reliable standard reference in fire investigation led to the formation of the NFPA 921 Committee under the auspices of the National Fire Protection Association, the largest fire service group in the World. The 28 original members of the 921 committee, including both private and government experts, published the first edition of NFPA 921 Guide to Fire and Explosion Investigation in early 1992.

Unlike textbooks such as Kirk's Fire Investigation, 921 was a consensus document which had been subjected to public scrutiny and comment prior to publication. The process of developing the content of the document was completely transparent and the final document represented the collective opinion of fire investigators, scientists, engineers, law enforcement personnel, academics and fire service personnel. After 1992, 921 was updated and modified every three years following a comprehensive public debate concerning each modification to the text.

NFPA 921 was created in accordance with the established protocol for ASTM standards and is recognized as such by the ASTM. It is dedicated to the systemization of fire investigation strictly in accordance with the scientific method. The document's primary value rests in its debunking of junk science and myths long associated with the field of fire investigation.

It is remarkable that NFPA 921 appeared in the fire investigation field at approximately the same time that the Daubert rule entered the world of the federal courts. 921 is easily the most frequently cited reference in Daubert hearings related to fire cases and the document has been widely accepted as authoritative by state and federal courts across the nation and, indeed, around the world.

Flashover and post-flashover burning

When a fire burns in a room or compartment, it generates hot smoke which forms a layer against the ceiling. If the fire has access to air and an adequate fuel source, such as a couch or wooden wall panels, the smoke layer will increase in both thickness and temperature over a period of minutes. If there is inadequate access to air or fuel for further dynamic fire growth the room will remain for some time in a state with an upper hot layer of black smoke and a lower layer of relatively cool, clear air. Extinguishment of the fire at this stage will reveal walls and items of furniture which appear to be burned from the top down.

Prior to and during the brief flashover transition period, the radiation damage to the room is relatively light but not necessarily uniform. This relatively moderate radiation can cause pyrolysis (thermal decomposition) of floor surfaces, leaving patterns, especially on floor covering areas in which the surface material is poorly bonded to the floor.

If the temperature of the smoke layer climbs to about 550-600 C, the radiation from the black smoke particles of the upper layer becomes so intense that the floor and every other unprotected combustible surface in the room springs into flame. From this point forward the subject room undergoes post-flashover burning, also known as "full room involvement." After flashover, the two layer structure is destroyed, leaving a single, homogeneous, extremely hot body of incandescent smoke from ceiling to floor. If the fire continues to burn in this stage, it will destroy all combustibles in a structure and burn through floors.

Once post-flashover burning occurs, the damage becomes severe and often highly irregular as a result of complex ventilation, heat conduction and shadowing effects. It is during this post-flashover period that strong burn patterns, often resembling liquid pour patterns, form on the floor. Continued post-flashover combustion can even burn irregular holes through wooden flooring.

If a post-flashover fire is extinguished before it burns the floors out, it will leave irregular burn patterns on the floors which are similar in appearance to the patterns left by ignitable liquids. The patterns are irregular because of ventilation, convection, conduction and protection (shielding) effects. The rate of combustion of items in a post-flashover fire is dominated by the availability of oxygen, which is limited by the size of openings such as doors and windows. Items and areas of flooring which have better access to the inflowing air will tend to burn faster and hotter. However, ventilation effects are extremely complex and not easily predictable, even with sophisticated programs on high-speed computers.

During post-flashover burning, charring and ignition of low areas on walls and furniture will also occur because the extremely hot gases in the room act like a well-stirred mixture, bringing the gases into contact with some areas which may be shielded from direct radiation

No one can yet claim to fully understand the mathematics and mechanism of formation of irregular burn patterns in post-flashover fires. The knowledge that such patterns are formed and that they are easily confused with liquid pour patterns is based on the indisputable results of full-scale experiments which have been conducted in recent years under various government agencies, including the work of the United States Fire Administration cited later.

Irregular floor patterns (so-called pour patterns)

NFPA 921 contains severe warnings that the patterns produced by full room involvement may be misinterpreted as ignitable liquid pour patterns. For example, the 2004 edition addresses the problem as follows:

6.17.8.2 Irregular Patterns. Irregular, curved or "pool-shaped" patterns on floors and floor coverings should not be identified as resulting from ignitable liquids on the basis of observation of shape alone. In cases of full room involvement, patterns similar in appearance to ignitable liquid burn patterns can be produced when no ignitable liquid is present.

6.17.8.2.1 The lines of demarcation between the damaged and undamaged areas of irregular patterns range from sharp edges to smooth gradations depending on the properties of the material and the intensity of heat exposure. Denser materials like oak flooring will generally show sharper lines of demarcation than thermoplastic (e.g. nylon) carpet. The absence of a carpet pad often leads to sharper lines.

6.17.8.2.5 The term pour pattern implies that a liquid has been poured or otherwise distributed, and therefore, is demonstrative of an intentional act. Because fire patterns resulting from burning ignitable liquids are not visually unique, the use of the term pour pattern and reference to the nature of the pattern should be avoided. The correct term for this fire pattern is an irregularly shaped fire pattern. The presence of an ignitable liquid should be confirmed by laboratory analysis. The determination of the nature of an irregular pattern should not be made by visual interpretation alone. See Figure 6.17.8.2.5(a) and Figure 6.17.8.2.5(b) for examples of patterns on floors.

Recent editions of Kirk's Fire Investigation suggest that the illusionary pour patterns may be caused by melting carpet materials. This explanation is probably inadequate given that the patterns also often occur on bare wooden floors, but it suffices for our purposes

that the existence of the phenomenon has been repeatedly demonstrated in controlled experiments.

Burning under furniture and doors.

The understanding of flashover phenomena has evolved continuously over the last 30 years. Prior to the publication of the 1995 edition of NFPA 921, it was widely accepted that post-flashover burning or “full room involvement” would not cause burning on floor areas under furniture. This erroneous belief may have persisted after 1992 because the flashover sequence sketches in the 1992 edition only depicted events up to the flashover period per se. However in the 1995 and subsequent editions, an additional sketch of post-flashover burning was included to show graphically that areas under furniture do ignite and burn. Thus the investigators in the Willis case erred in assuming that burning under furniture was indicative of the presence of an accelerant.

The 2004 edition of NFPA 921 describes the fire pattern effects of full room involvement as follows (emphasis mine):

***6.2.5 Patterns generated by full room involvement.** If a fire progresses to full room involvement (see 5.5.4.2 through 5.5.4.2.11), damage found at low levels in the room down to and including the floor can be more extensive due to the effects of high radiative flux and the convected heat from the descending gas layer. Damage can include charring to the undersides of furniture, burning of carpet under furniture, uniform burning around table legs, burning of baseboards and the undersides of doors, and burning of floor coverings in corners. Holes can be burned through carpet and floors. The effects of protected areas and floor clutter should be considered (see 6.17.7.2 and 6.18.2). Although the degree of damage will increase with time, the extreme conditions of the full room involvement can produce major damage in a few minutes, depending on ventilation and fuels present.*

Burning under doors and on door sills can also be caused by ember fall down which lands at the base of the door. This mechanism occurs in numerous fires because doorways are usually framed in wood. Even in the absence of full room involvement, the upper portions of door frames are easily ignited by the hot smoke layer, yielding embers which naturally fall against the base of the door. This Phenomenon is described in all recent editions of NFPA 921, including the 2004 edition, which states:

6.2.3.2 When a door is closed on a fire, hot gases (being lighter) can escape through the space at the top of the closed door, resulting in charring. Cool air may enter the compartment at the bottom of the door, as in Figure 6.3.2.3(a). In a fully developed room fire where hot gases extend to the floor, the hot gases may escape under the door and cause charring under the door and possibly through the threshold, as in Figure 6.2.3.2(b). Charring can also occur if glowing debris falls against the door either on the inside or the outside, as in Figure 6.2.3.2(c).

Burning under doors and door sills is not caused by accelerants:

As was shown in the previous section, burning under doors or in analogous cracks between a doorsill and the underlying wood may be caused by either fall down or post-flashover combustion. Insurance investigator Dailey and District Attorney Investigator Kenley both erroneously testified that burning under the door and door sill could only have been caused by a liquid accelerant. This false idea was most clearly expressed by Mr. Kenley (SOF, Vol. 27, page 17, lines 14 – 25):

Q. And I have here in evidence what has been labeled as States Exhibit Number 62, which is the back door, Mr. Kenley. Did you find any evidence of what you suspected to be a flammable liquid or accelerant in the back door of the house?

A. Yes. Under the bottom edge of the door. And there is just nothing in that – there is just nothing that I know of that will cause a fire to run under – to run under this door like this when it's sitting down on that door jamb [sic] except for flammable liquids. When you put this together with everything else in the house, it just spells one thing, as far as I'm concerned, in my opinion.

Similarly, Mr. Dailey also testified about burns to the underside of the back door being an indicator of the presence of an accelerant (SOF Vol. 22, page 47, line 22 – page 48, line 5):

A. You see we have low burning along the bottom and we even have low burning underneath the door, which was closed at the time, and this means, as the other photograph shows, there was a puddle right in front of the doorjamb (sic). So we had what appears to be a flammable liquid burn pattern on the bottom of the door, which means they were on the floor and ran under the edge of the door. Ordinarily, in a normal fire, you would just have the upper part of the door burned and it will exit through the door.

In both sets of testimony, the two investigators assume that flammable liquids are able to burn in narrow, horizontal gaps between boards. This is another case of investigators imputing special properties to accelerants in order to make a case. Flammable liquids, such as gasoline will not, in fact, propagate flame in narrow layers. Thus, burning of the underside of a door may be caused by post-flashover combustion or by embers dropping to the base of a door, but not by burning gasoline which has been trailed across threshold.

District Attorney Investigator Kenley also pointed to burning under a metal strip on the floor at a doorway as being caused by a liquid accelerant running under it. Of course, a liquid accelerant cannot burn under a metal strip. Burns under metal strips, such as threshold plates are caused by the high thermal conduction of the metal. The metal acts like a branding iron.

Liquid accelerants have a property known as the "quenching distance." This is the minimum dimension at which a stable flame can exist. Below this dimension, no liquid

fuel can generate a flame. The quenching distance is always much larger than the crack under a floor strip.

**The experts in the Willis trial did not
understand post-flashover effects**

Mr. Kenley's testimony about flashover:

During the Prosecution's rebuttal, District Attorney Investigator Kenley was asked if he had heard prosecution experts Cheevers and Dailey testify about flashover. Kenley replied in the affirmative and then proceeded to describe his interpretation of the phenomenon as it related to the Willis case.

In fact, neither Cheevers nor Dailey actually testified about flashover although they used the term incorrectly a couple of times to refer to other phenomena such as "rollover" or intermittent flashing of vapor.

Mr. Kenley, described flashover as a phenomenon capable of igniting the tops of furniture and supporting the continued burning of carpet which had previously been ignited by an accelerant. He either did not know or at least failed to tell the jury that the hallmark of flashover and post-flashover radiation is its ability to ignite carpeting and other flooring. Mr. Kenley argued that whereas gasoline would merely melt carpet without damaging the underlying wood, the continued burning of the accelerant-ignited area under post-flashover radiation would produce patterns proving the earlier presence of the accelerant. Thus, he was aware of the existence of post-flashover radiation, but vastly underestimated its effect on floors.

Kenley's reasoning sounds seductively scientific, but this is his personal theory based on incorrect assumptions. Since the time of the trial, several full-scale experiments have been conducted by various researchers and it has been shown that post-flashover burning acts to obliterate rather than to enhance evidence of ignition by an accelerant. For example, in Kirk's Fire Investigation, 5th Edition, 2002, page 194, the author describes a set of full-scale burns as follows (emphasis mine):

Figure 7.17 shows two identically furnished rooms, one accelerated with gasoline, the other ignited by open flame, that were extinguished just as flashover occurred (with ceiling and floor temperatures of 815C (1,500F). Note that the synthetic carpets have melted in both rooms in an irregular fashion, probably due to their non-uniform contact with the floor. The pour pattern of the gasoline is still visible but would be obscured once the carpet and floor were ignited by post-flashover radiant heat.

The results reported in Kirk's are confirmed by extensive research funded by the United States Fire Administration. Following a substantial series of full-scale test burns, the organization published a 200-page report: USFA FIRE BURN PATTERN TESTS, July

16, 1997 by Alletto, Corry, Herndon, Kennedy and Ward. The research team reached the following conclusion (page 65) relevant to the issues in the Willis case:

3. The presence of floor patterns in a room which has had flashover conditions is not a reliable indicator of the presence of an ignitable liquid introduced for incendiary purposes. It was observed that floor patterns were consistently produced on different floor surfaces by the pyrolysis and combustion of the floor surface caused by flashover, with and without the use of an accelerant.

State Deputy Fire Marshal Cheever:

Because of the limited training materials available in the 1987 period, Deputy Fire Marshal Cheever was unaware that post-flashover radiation commonly ignites floors and leave irregular patterns on them. The state of his knowledge in 1987 can be judged from the following cross-examination testimony (SOF Vol. 21, page 103, lines 17 – 25):

Q. All right. So that in some houses, you would agree with me, wouldn't you, sir, where – in some situations where you might absolutely know there was no flammable liquid poured, you can get some marks on the floor that are not due to fall down of material, but are due to what we call radiation. I might call it reradiation, but radiation from the bottom down; is that correct, sir?

A. That would possibly be a possibility, but I have never experienced that.

It is highly unlikely that Marshal Cheever had never encountered floor burn patterns resulting from post-flashover radiation. Most fires in which flames are seen coming out of windows or doors are at the full-involvement stage and will produce low burn patterns.

It is obvious from the exchange on cross that neither the defense attorney nor Marshal Cheever was aware that the floor-burning radiation usually does not emanate from the solid ceiling surface, but from the black layer of smoke which descends from the ceiling, to near the floor prior to flashover. Being unaware that he must have seen radiation-burned floor patterns in his then 7-month career, Mr. Cheever assumed that the hypothetical radiation would, if it burned the floor at all, do so uniformly, and that areas under furniture would not be burned. This conclusion is easily deduced from his redirect testimony in which it becomes obvious that neither the Prosecutor nor the Marshal is aware of the smoke origin of flashover radiation, the propensity to produce irregular patterns or the ability to burn under furniture such as a dining room table. (SOF, Vol. 21, page 126, lines 1-22)

Q. How would the surface below have been affected if, assuming that theory – under that theory that that occurred, that the entire ceiling had burnt and radiated the heat down to the bottom, how would you have expected to find that floor?

A. The floor itself?

Q Yes, sir.

A. If it had reached its ignition temperature, I would have expected to find the floor burned.

Q. Do you have an opinion as to how much of that floor you would have expected to find burned?

A. The entire floor I would have expected to have found burned, except for the areas that were protected by furniture.

Q. Did you find that in this diagram?

A. No, sir.

Q. Or in this investigation?

A. No, sir.

Q. Assuming that under that theory for a moment that that had occurred. Would you have found any burning beneath that dining that dining room table?

A. I wouldn't have expected to, no, sir.

From the above testimony, it is obvious that Marshal Cheever was unaware that the radiation from full involvement could produce irregular low burn patterns on floor, walls, furnishings and on floors under furniture. Thus, he would have erroneously assumed that any such low burns must be caused by a liquid accelerant.

Insurance investigator John Dailey:

Investigator Dailey was completely unaware of the nature of post-flashover radiation and its ability to produce low burn patterns which are easily confused with liquid accelerant patterns as described in the publications cited in section entitled "Flashover and post-flashover burning." The following testimony shows that Mr. Dailey would necessarily have attributed low radiation patterns from an accidental fire to an imagined accelerant (SOF Vol. 22, page 141, line 9 - page 142, line 24):

Q. Would you also agree or not, Mr. Dailey, that assuming we had a severe fire in the room that caused severe heat in the ceiling area, could you have a radiation pattern created on the carpet similar to the ones we have been talking about?

A. I don't believe so, no, sir.

Q. Under - not even under the right circumstances?

A. Not to form the -

Q. I'm not saying we had it in this case.

A. Sir?

Q. I'm not saying we have got it in this case. I'm just asking from a professional standpoint, do you think that that could be done under the proper circumstances?

A. I don't believe it would have this configuration, but you could have the floor burn from radiation, right, or fall down – and/or fall down.

Q. Have you heard other experts in the area that might disagree with that opinion?

A. I don't believe so, sir.

Q. And to make sure I understand, you are telling us that under no conditions, regardless of the amount of severe heat that you would have in the ceiling, radiation would not cause a burn on a carpet that would be similar to or first appear as a pour pattern?

A. Yes, sir.

Q. "Yes, sir" that it could happen or it could not happen?

A. Could not happen.

The above testimony is directly contrary to the principles that are now accepted in modern fire investigation. The earlier quotes from recent editions of Kirk's Fire Investigation, NFPA 921 and the National Fire Administration research project are explicit in stating that radiation patterns cannot be differentiated from liquid accelerant patterns by visual means. In the absence of a confirming laboratory analysis, no burn pattern can be identified as a pour pattern in a structure in which there has undergone flashover or structural collapse (fall down).

The destruction of the dining table is not an indicator of a liquid accelerant

A great deal of attention was drawn by the prosecution experts to the "complete" destruction of a large maple dining room table and also to a relatively "heavy duty" couch-length coffee table in the living room. The experts maintained that no normal fire effect could have caused such thorough destruction. Once again they invoked the imagined super powers of liquid accelerants to burn the unburnable.

The belief that accelerants somehow burn much hotter than ordinary fuels very often leads fire investigators up a false path. Flammable liquids burn rapidly but relatively briefly. They produce tall, short-lived flames that are no hotter than the flames from ordinary household construction materials.

Ordinary experience with barbecues, campfires and fireplaces teaches that the application of charcoal lighter fluid, gasoline or kerosene can help ignite hefty chunks of wood, but such accelerants never destroy much of their target fuel. Instead, these ignitable liquids send the vast majority of their heat up into the air where it is dissipated. If the ignition is successful, there will be only spots of flame or glowing embers left in their wake. Later,

the flames from the individual pieces of wood reinforce each other with their mutual radiation and the fire grows as the wood is destroyed.

It is radiation that allows wood to burn. If a blow torch is applied to a table top or wooden floor, it will severely char the area of flame contact, but when the torch flame is removed, the fire will snuff itself out. However, in a room which has a layer of hot smoke, the radiation from that smoke can cause the table top or floor to continue burning once it is ignited. If the radiation from the smoke increases, the rate of burning of the wood will also increase.

When flashover occurs in a room, as it did in the dining room and living room of the subject house, the radiation level will jump to the order of 75-200 kilowatts per square meter and the temperature in the room will rise to a level much higher than the temperature of a gasoline flame. In effect the tables in such a room will find themselves immersed in an extra hot room-sized flame.

During post-flashover burning, the entire room is hot from ceiling to floor. Thus the radiation strikes both the top and bottom of table tops and ignites the carpets beneath them.

When a carpet burns beneath a table, the table top causes a dynamic layer of hot smoke to gather beneath it. The radiation from this local smoke also strikes the carpet, where it can cause a substantial increase in the rate of burning of the carpet, even in the absence of flashover. Of course, when the carpet burning rate increases, it, in turn, increases the rate of burning of the underside of the table. The experimental work supporting this mechanism is discussed in "*An Introduction to Fire Dynamics*" by Dougal Drysdale, John Wiley and Sons, 1985 pp 281-2.

Under conditions (crib fire) equivalent to post-flashover radiation, wood can burn at a rate of approximately 11 grams per square meter per second (See: "*Principles of Fire Behavior*" by James G. Quintiere, Delmar Publishers, 1998, pp 109 and 112). For the two sides of a four-by-seven foot table top alone, such as was present in the dining room, this would amount to the combustion or reduction to char of about 7.5 lbs of wood per minute. This approximate rate is far more than sufficient to account for the apparently complete destruction of the table.

Another way of looking at the rate of combustion of a slab of wood under flashover conditions is given by Drysdale on page 182:

In a compartment fire, localized temperatures as high as 1100 °C may be achieved: the corresponding black body radiation is 200 kW/m², which could result in 'rates of burning of wood' as high as 4.4 mm/min.

At the cited rate of 4.4 mm/min, a one-inch thick table top burning from both faces would be completely destroyed in less than three minutes.

It is quite clear that the prosecution experts were grossly misguided in assuming that the presence of an accelerant was necessary to explain the destruction of the dining room table or the long coffee table in the living room.

Flammable liquids vs. dining table fall down: Origin of “pour patterns.”

The primary basis on which the prosecution built its case for arson was the belief that the severe floor patterns in the dining room and living room could only have been caused by a flammable liquid accelerant. Deputy Fire Marshal Cheever, Insurance Investigator Dailey and Deputy Sheriff Jackson probably all believed in the “self-evident” ability of flammable liquids to burn their way through carpets and underlying tile and then to char the wooden plywood beneath the tile. The defense expert, Smith, knew from his experiments that flammable liquids only melt carpet and generally leave the substrate undamaged. Unfortunately for the defense, the District Attorney had his own captive fire investigator, Mr. Kenley, available to apply the necessary technical spin make it appear that even if the defense expert was right, he was wrong.

Kenley knew that a flammable liquid pour could not have caused the deep patterns running through the dining room and living room but would only melt the carpet. Any investigator who had ever actually tested flammable liquids on typical carpets would have known this fact. Kenley testified (SOF Vol. 27, page 30, lines 16 – 21 – emphasis mine):

“...So, in order for me to take and start a house on fire with gasoline, I have got to make sure that I have got it up against some combustible objects so my fire will spread; otherwise, people come back or someone calls the fire department, and they will just find an area of melted carpeting running through the house.”

At this juncture, the prosecution had to know that its other three experts were wrong in their belief that a poured accelerant could account for the pattern of char running through the house, and doubly wrong in the assertion that accelerants burn deeper than other, non-incendiary phenomena.

In order to support the prosecution’s liquid accelerant theory, Mr. Kennedy created his own special theory that flashover in the subject rooms acted as a sort of thermal hypo to develop the latent images left earlier by an accelerant which itself could not produce such patterns. Kennedy explained that an accelerant pour would increase the relative burning time of the floor areas where accelerant had been poured. He argued that longer burning time would produce greater damage where the accelerant had been.

Kennedy’s theory was what scientists call a hypothesis. A hypothesis is nothing more than a guess until it has been verified experimentally. Any scientist knows that once a hypothesis has been formed, the next step is to try to falsify (disprove) that hypothesis. Mr. Kenley’s did not try to falsify his hypothesis, but other researchers have subsequently done so, as is described in the earlier section entitled “*Mr. Kenley’s testimony about flashover:*”

It was also previously shown that post-flashover burning can in and of itself cause apparent "pour patterns" on floors. Fall down can also cause such patterns. However, the prosecution experts minimized the effects of fall down in the subject fire until Mr. Dailey was required to change his testimony and declare the pattern north of the bed as an artifact of fall down rather than a consequence of a flammable liquid pour.

In order to bolster the incorrect theory that an accelerant and only an accelerant could have caused the severe patterns, the prosecution experts had to make two additional assumptions:

1. That the patterns were not caused by fall down because the fall down would have landed on the tables.
2. That the patterns were not caused by radiation ("from the ceiling") because the tables would have shielded (shadowed) the floor

Both of these assumptions are clearly false. The simple fact that the tables and the dining room chairs were missing after the fire, is proof enough that glowing wood embers must have formed and dropped. Both the tables and the chairs were made of wood which burned. Whenever wood burns, it drops glowing embers just as it does in a fireplace or wood stove or at the base of a wooden door frame. Glowing wood embers create a high localized temperature in their vicinity and can continue to burn without flame at oxygen levels far below those needed to sustain flaming combustion. Ventilation effects can raise the temperature of embers to a level higher than that of a flame.

It has already been shown that the tables cannot shield the floor from post-flashover radiation because that radiation is generated in all directions by the hot smoke which extends from ceiling to floor during full room involvement.

The ability of wood embers to melt metals, char floors, thresholds and door bottoms and even to burn holes completely through floors is addressed in the following sections of the 2004 edition of NFPA 921: 6.2.3, 6.2.3.1, 6.2.3.2.

The table in the dining room was seven feet long. The room itself was only 11 feet long. A chair at each end of the table would have extended the wood of construction to approximately the length of the room. Given that the table was originally located in the middle of the widest area of the dining room floor burn pattern, it is impossible to eliminate embers from the wooden dining room set as a principal contributing source of the dining room burn pattern.

The coffee table in the living room sat atop an extremely heavy Persian carpet which could easily have acted to protect areas of the floor from damage while the table was being destroyed. The portion of the pattern leading to the front door is typical of ventilation patterns found in rooms that are open to the outside air and have undergone flashover. Such rooms frequently even have threshold plates of aluminum which are

melted (660 C) by heat generated in the turbulent reaction of hot combustible pyrolyzate gases with fresh air.

The allegedly light fuel load vs. the destruction of the dining table

Insurance investigator Dailey testified that the "light" fuel load in the house could not account for the destruction of the heavy maple table in the dining room (SOF Vol. 22, page 77, lines 11-22):

A. Well, to me, the inescapable fact is there was nothing in this house, not a fuel load on the floor, to create these burn patterns. In other words, we had -- in these two rooms we had a very intense fire that burned down to the carpeting, the padding, and into the subfloor. And Mr. Robinson told me that we had a dining room set here that was totally consumed, apparently. Firemen said they could not find any of it. And we have the pour pattern from the front door to back door, which is abnormal, but the fact remains is, there was no fuel load in these two rooms to create such a fire as to penetrate the ceiling and to destroy the furniture that was destroyed.

The above testimony shows an unexpected level of misunderstanding regarding the concept of "fuel load." The fuel load is simply the amount of combustible material available in a structure. It is best expressed in terms of the total amount of heat that can be generated by a fire burning the contents of a structure. More often the general concept simply refers to the concentrations of furnishings in a house plus the amount of combustible wall and ceiling materials present.

By any reasonable measure, the subject house had not only a very large fuel load, but an ample assortment of individual items having potential heat release rates capable of bringing a room to flashover in a matter of minutes. Any of the following items could have brought on flashover conditions in a matter of minutes by generating a heat output in excess of 1.5 megawatts:

1. The couch on the south wall of the living room
2. The couch on the west wall of the living room
3. The easy chair in the living room

As was explained earlier in this section, once flashover conditions were reached, the dining room furniture, the walls, ceilings and floor coverings would become a major source of heat release and substantial contributors to the total active fuel load.

Given that Mr. Dailey believed a few gallons of flammable liquid could destroy the dining room table, he apparently confused the concepts of high heat release rate with that of high fuel load. A few gallons of gasoline would amount to a trivial fuel load compared with the furnishings, carpeting, walls and ceilings of the house.

It is the high heat release rate items, such as those listed above, which bring a room quickly to flashover, and the large fuel load that sustains the post-flashover burning.

Heat release rate data for various types of furniture are readily available from the publications of the Building Fire Research Laboratory operating under FEMA.

The uncertain dimensions of the living room and dining room floor patterns

The prosecution experts apparently failed to recognize that the tiles beneath the carpet in the dining room and living room were the long-discontinued fire-proof variety, probably manufactured prior to 1972. These tiles do not combust to any significant extent under the influence of flame or heat; they simply undergo calcination to leave a solid, white mineral residue which acts to protect the wood beneath them. When heat is applied to the floor, it may cause weakening of the thin mastic used to bond the tile to the floor. Thus the exact shape and size of suspected burn patterns becomes largely a matter of how much force is used in shoveling and cleaning the floor to expose the underlying wood, which has been baked but not burned in the sense of generating a flame. The calcined tiles could be removed whole or as irregular broken pieces, depending on how well bonded the original tile was. Thus the exact shape of any alleged section of burn pattern depended to some degree on how the workman applied his tools.

The kitchen

Flashover is a process which occurs over a finite length of time – it is not instantaneous, but represents a transition phase. Investigators are currently taught that flashover occurs when the radiation at floor level reaches 20 kilowatts per square meter. This level of radiation is cited as being enough to cause pyrolysis of wood and synthetics and to ignite the vapors which are formed by thermal decomposition. This description is an oversimplification of a much more complicated scenario.

Pyrolysis of various materials may begin at much lower levels of radiation. Local ignition of the generated vapors may also occur without leading to flashover. For instance, wooden surfaces may undergo local ignition at 10 kilowatts per square meter and produce localized burn patterns without the general conflagration of flashover.

The kitchen of the subject structure presents an extremely problematic situation for the analysis of burn patterns. The kitchen was located adjacent to the dining room, which underwent full post-flashover burning. This fact assures that the radiation through the doorway of the kitchen must have set the kitchen floor covering on fire – at least in the proximity of the doorway.

The hot, smoky gases from the dining room entered the kitchen and banked down toward the kitchen floor. These gases were at a lower temperature than in the dining room because of heat losses to the walls and ceiling. However, the gases were still hot enough to leave evidence of radiation effects down to floor level. Those effects were greatly

influenced by various throw rugs and carpets on the floor of the kitchen, which protected some areas and may have contributed to the burning of other areas.

The situation was further complicated by the fact that the kitchen ceiling was made of two different combustible materials: Cellulose fiberboard and a wood-framed wooden panel which gave access to the attic.

The linoleum floor of the kitchen would not normally support combustion. However, in the presence of the radiation from the hot smoke, it would have continued to burn horizontally if ignited by even a small flaming ember from the ceiling. The geometry of the pattern left by such flaming would depend on ventilation eddy currents and augmentation or hindrance by local floor coverings, depending on their mass and composition.

The two Deputy State Fire Marshals, Brown and Cheever did not inspect the kitchen, but left the scene after satisfying themselves that the fire origin was in the dining room/living room area.

The kitchen and north bedroom were later excavated by Deputy Sheriff Larry Jackson and insurance investigator John Dailey, who identified patterns in both rooms as "pour patterns." Mr. Dailey later retracted his identification of the bedroom patterns to suit the perceived needs of the prosecution.

Investigators today are taught that it is not proper to identify a floor pattern by visual means alone. It is generally accepted that radiation and fall down can produce patterns which are easily confused with patterns cause by liquid accelerants.

Deputy Sheriff Jackson was convinced that he possessed the ability to distinguish between pour patterns and all other accidental causes. He claimed this remarkable ability while readily admitting that he was not an expert in fire investigation and not qualified to determine arson (SOF Vol. 19, page 179 line 4 - page 180, line 6):

Q. Are you observant enough or sufficiently trained to be able to tell what would be a pour pattern on the floor caused from an accelerant versus what might be burns on the floor caused from ceiling droppings?

A. In my opinion, I am, yes, sir.

Mr. DeHart: Your Honor, I am going to object. He has already testified he is not a qualified expert. He is not testifying as an expert, and the DA is asking if he can identify a pour pattern on the floor.

Mr. Johnson: No, sir. I'm asking him if he can distinguish a pour pattern on a floor from a pattern caused from a ceiling dropping with his own observation.

The Court: All right, what is your objection?

Mr. DeHart: My objection is he is not qualified to express an opinion, Your Honor.

The Court: Goes to the weight. I'm going to overrule the objection.

Mr. Johnson: Thank You.

Q. (By Mr. Johnson) Did you understand my question?

A. Yes, sir. In my opinion, I can tell the difference

Q. Can you as a lay person relate to the rest of us as a lay persons as to what the difference is

A. When you have fall down – fall down on the floor like it burns, it doesn't – a fire burns upwards. It doesn't burn down deep into the area like this here was, which some of the areas was burned deep into the plywood.

The above testimony is nonsense but it mirrors exactly the excuse Mr. Dailey used to justify changing his testimony regarding the patterns in the north bedroom. Both of these men were now claiming that fall down can only produce shallow burns whereas accelerants produce deep burns.

Both Mr. Dailey and Deputy Jackson were dead wrong in their beliefs about the characteristics of fall down burns as opposed to accelerant burns. Fallen embers have the ability to burn over a range from light charring to complete penetration through wooden floors. Flammable liquid accelerants such as gasoline can only lightly char the top surface of a wooden floor burning from the top down (See Kirk's Fire Investigation, 5th Edition Fig. 7.18a.)

The 2004 edition of NFPA 921 warns:

6.17.8.2.4 Pooled ignitable liquids that soak into floor covering materials as well as melted plastics can produce irregular patterns. These patterns can also be produced by localized heating or fallen fire debris.

6.2.3.1 Airflow over coals or embers can raise temperatures high enough to burn holes through floors...

It is obvious that neither Mr. Dailey nor Deputy Jackson understood the relative burning characteristics of liquid accelerants versus the effects of radiation and fall down. They overestimated the power of flammable liquids and vastly underestimated the potential of both radiation and fall down. The information they passed on to the jury was highly misleading junk science. None of the key testimony of the prosecution experts

concerning low burn patterns would survive a Daubert hearing in a competent court today.

The front porch

Insurance investigator Dailey correctly determined that the widespread charring of the front porch deck was caused by radiation. Mr. Dailey accepted radiation effects on the porch while rejecting related effects inside the structure partly because of his incorrect assumption that radiation always produces uniform charring. Mr. Dailey was also undoubtedly aware that floor-to-ceiling porch fires, driven by flames exiting through a door, are well documented (See Kirk's Fire Investigation, 2nd Edition, 1983, pp 25-6). Thus, when he found an area of somewhat deeper burn on the otherwise uniformly burned porch, he opined that a local accelerant might have been present. The investigators also noted that a small section of plywood porch deck adjacent to the front wall of the house showed some charring underneath. They attempted to make the case that "only a liquid accelerant" could have produced such a burn.

If it were indeed true that only a liquid accelerant could produce the local burns on the porch, it would be impossible to eliminate as a cause the bottles of Malathion that were frequently kept on the porch by the current resident of the house, Mr. Robinson. Malathion is a pesticide formulation using a kerosene or mineral spirits vehicle. It will not propagate a flame rapidly like gasoline, but it is just as effective as the latter in producing burn patterns. The DA's investigator, Mr. Kenley, admitted that the Malathion could be responsible for the local porch burns. This subject was not a real issue, but it is doubtful that the jury understood this fact.

It is worth noting that the full involvement of the front porch was enabled by the fact that the wooden overhang, deck and wall paneling formed a configuration known as a "slot fire." The three broad surfaces of the slot acted to reinforce the combustion of each surface by mutual radiation. This principle formed the basis of the so-called "physicists fire" grate which was patented and sold for years as the "Texas Fire Frame."

This type of effect was responsible for the deadly Bradford City Soccer Stadium fire in 1985 in which flashover occurred quickly under a stadium overhang claiming 53 lives.

Annealing of couch springs -- a mythological accelerant indicator

The insurance investigator, Mr. Dailey testified that the annealing and collapse of the springs of the west wall couch in the living room was attributable to the action of an accelerant (SOF Vol. 22, page 34, line 19 - page 35, line 4):

A. Okay. This is the same couch, and this is the south end of the - the end nearest the front door. And when I see a couch like that in a fire - you can see how flat the springs are. They have been 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 will not burn like that. Furniture will burn

the upper portion 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.

Dailey also testified that the burning of the floor under the section of "annealed" springs was caused by an accelerant (SOF Vol. 22, page 35, line 19 – page 36, line 2):

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 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.

Whether the springs of the couch were actually more annealed on the south end than on the north cannot be derived from their collapsed position. The springs on both the north and south ends were undoubtedly softened by the fire, given that annealing takes place at normal fire temperatures. It must be remembered that liquid accelerant flames are no hotter than the flames from wood or synthetic materials fires. The local collapse of the springs could have simply been the result of crushing of the no longer springy springs when the firemen tossed the couch remnants out of the house.

There is, however, little doubt the south end of the couch got hotter than the north end during the fire. This temperature difference had nothing to do with the presence or absence of a liquid accelerant but was caused by the superior ventilation of the fire near the open door. The 2004 edition of NFPA 921 addresses the subject of such ventilation as follows:

6.2.3.4.2 The effect of ventilation on the intensity of the fire, as well as the location, shape and damage magnitude of patterns being used to determine the origin of a fire should be considered. Where fresh air ventilation is available to a fire, it is not uncommon to find locally heavy damage on combustible items close to the ventilation openings, patterns which may have no relevance to the point of origin.

The concept of annealed springs as an indicator of the use of an accelerant is a well-known myth in fire investigation. There are published lists of so-called "old wives tales" which are familiar to all contemporary fire analysts. These lists invariably include the annealed-springs myth. Kirk's Fire Investigation, 5th Edition contains a typical list entitled "Myths and Misconceptions," which addresses, inter alia, the annealed spring myth as follows (page 235):

Annealing of Steel Springs and Structural Materials

Fact: Steel loses its temper and tensile strength at temperatures above 1000 F (500 C). Such temperatures can be produced by smoldering or flaming combustion of ordinary upholstery materials.

The fact that burning under furniture can occur as a result of post-flashover combustion has already been discussed in the sub-section entitled "**Burning under furniture and doors,**" in which NFPA 6.2.5 was cited as relevant.

**The destruction of a living room couch
Low burns on and near an easy chair**

The prosecution experts constantly expressed surprise at either the presence of various forms of low burn patterns or the extent of destruction of various items. Their surprise consistently arises from a lack of understanding of post-flashover burning, which readily produces low patterns, ignites low lying areas of carpet or furniture and thus simulates the effects of a liquid accelerant. In the following testimony, Mr. Dailey, the insurance investigator, again tries to make a case for the presence of an accelerant out of what he considers an "unusual" level of destruction of a couch (SOF Vol. 22, page 32, lines 17 – 23):

"... And then, in this corner, we have the remainder of a couch that had coiled springs in it. And, on that couch, it's unusual that a piece of furniture will be totally consumed. Usually, the fire – a normal fire will burn the off the top of the furniture and go down some, but you will have quite a bit left of the bottom frame."

What Mr. Dailey did not know was that the "normal" fire he was describing was simply any fire which did not go to flashover. Before a fire reaches flashover, the room of the fire is clearly divided between an upper, hot layer and a lower, cool layer. Under these conditions items of furniture do indeed burn from the top down, just as they did in the bedrooms of the subject house. However, when flashover occurs and thereafter the two layers meld into one very, very hot layer from floor to ceiling. Under the latter conditions ignition occurs down to floor level and combustible materials burn at a greatly accelerated rate.

The couch in this fire was destroyed by the same mechanism that was described in detail in relation to the destruction of the dining room table above.

Following the same poor paradigm for fire behavior, Mr. Dailey cited low burns on and around the living room easy chair as evidence for the presence of an accelerant (SOF Vol. 22, page 37, lines 19 – 24):

A. Yeah, 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 this chair were burned at floor level. Of course, here, part of that liquid burn pattern is in front of the chair, which not doubt caused the damage to the lower portion.

As has been repeatedly shown, the low burning to both the floor and the chair are not unexpected in a post-flashover fire. No accelerant is needed to produce the low burns. Additionally, it should be noted that apparent liquid burns are common near upholstered furniture. The synthetic fabrics, foams and padding are frequently made of thermoplastics which liquefy and burn just like liquid accelerants during the course of a fire.

The voodoo theory that liquid accelerants burn into floors at a unique angle

The prosecution created the illusion of the existence of a magical property possessed by liquid accelerants which causes them to burn into wood at an angle which is different from the burn angle produced by other sources – such as fall down. The illusion was created in the following testimony by Deputy Fire Marshal Cheever (SOF Vol. 21, page 94, line 8 – page 96, line 11):

Q. Speaking of that [SE living room corner] burn into the floor, have you, in the course of your training or experience, come across any materials which talk about the angle of burn or a difference between the angle of burn of a natural fire and a flammable liquid angle burn?

A. Yes. Are you talking about the angle of the burn itself?

Q. Yes, sir.

A. Yes, sir.

Q. Do you agree that much of the or some of the literature in your field holds that a flammable liquid poured on a surface will cause a burn generally at right angles going down into the floor; do you recall reading material to that effect?

A. Very close to a right angle, yes, sir.

Q. Whereas something that's a naturally occurring fire, or a fire from something other than a flammable liquid, will occur at around a 60 degree angle?

A. It will be much more sloped, yes, sir.

Q. Could you demonstrate that on the blackboard for the jury, the two different types?

A. If you have a floor such as this, and in this area you have got a burn, if it's – a flammable liquid applied, you would expect to see a very deep penetration without much angulation to it.

Q. Okay.

A. The same type of pattern where you might have a curtain fall down from a window, or something of that nature, where it's not a flammable liquid that penetrates the surface of the wood, you would expect to find more of a sloped type of burn.

Q. Okay. Would you label that top one, "Flammable liquid," and the bottom one, "Other Material"? "FL" is good and, "OM" is good. All right, sir. Thank you. By the way, Marshal Cheever, I believe you have testified – I'm sorry. Can we move that diagram back out? I believe you testified that there is some burn through in the floor in the Southeast corner of the living room, that would be down in the lower left, and also a similar type of thing occurring in the dining room, southeast corner of the dining room, being down in the lower left; is that correct, sir.

A. Yes, sir.

Q. Now, on either of those, did you – I started to ask you if you had made any notes about it, but do you recall or not that burn through resembles a 90 degree angle or more of a sloped burn?

A. As I recall, it was more in keeping with what I would consider a flammable liquid type burn pattern.

This testimony is worse than merely absurd; it is unconscionable. There is not and never has been any accepted theory of the sort proposed by the prosecutor. If all it took to discern an accelerant pour was a measurement of the angle of burn, Mr. Cheever and the other investigators would have been at the fire scene with cross section saws and protractors. Since no such measurements were ever made, it is obvious that the bogus theory first reared its head at trial.

Cheever's testimony is obviously specious when he "remembers" the angles of the burns in the room corners being "more in keeping with what I would consider a flammable liquid type burn pattern." No liquid accelerant could have burned into the wooden floor because it was protected by flame retardant asbestos tiles. Cheever could only have seen the underlying wood that was exposed after the layer of tile was removed. An accelerant could only have baked the underlying wood through the residual tile minerals. Also, Mr. Cheever could not possibly have determined any angle of burn without conducting extensive experimental work. Cheever and Brown did not even stay at the fire scene for the excavation and inspection of the majority of the rooms. They certainly did not make any measurements of cross sections of floor cut outs.

Conclusions

1. The prosecutions case for arson was based almost exclusively on the incorrect interpretation of various low burn patterns.

2. The investigators did not understand the nature and properties of post-flashover burning.
3. The investigators did not understand that radiation and fall down can produce low burn patterns which cannot be differentiated from liquid accelerant pour patterns by visual means alone.
4. The prosecution mistakenly believed that they could differentiate between patterns which were caused by liquid accelerants and those that were caused by fall down by the angle of burning into flooring.
5. The investigators ascribed properties to liquid accelerants which they do not possess. These properties included the ability to burn in narrow horizontal slits, to burn through substantial carpeting, and to destroy massive items of furniture.
6. The investigators grossly underestimated the ability of post-flashover radiation to produce low burn patterns which emulate accelerant pours, to burn under doors, to burn through carpets and other floor coverings and to destroy massive items of furniture.
7. The investigators mistakenly believed that liquid accelerants can burn more deeply into flooring than can fall down embers.
8. The prosecution erred in believing and telling the jury that annealed and collapsed springs are an indicator of the presence of a liquid accelerant.
9. At the time of the original trial in this case, there were no effective standards in fire investigation and few restrictions on the subject matter to which an expert could testify.
10. There are now standards and guidelines in fire investigation and there are new rules of law governing the limits of opinion testimony by experts (Daubert). Under the recently mandated procedures, none of the key testimony by experts in the 1987 trial would be allowed in a competent court today.
11. There is not a single item of physical evidence in this case which supports a finding of arson. Advances in the science of fire analysis over the last 15 years have created a knowledge base which would compel any competent contemporary fire investigator to declare the origin and cause of the subject fire to be undetermined. Given the absence of evidence to support the corpus of arson, there would be no technical basis for retrying this case.

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