

THE MYTHOLOGY OF ARSON INVESTIGATION^a

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ABSTRACT

Unlike in many other fields of scientific inquiry, progress in fire investigation is held back by the burden of an entrenched mythology. Despite the fact that it has been fourteen years since NFPA 921 was first published, some fire investigators still rely on “misconceptions” about the meaning of various fire effects and fire patterns.

This presentation will explore the development and promulgation of the mythology of arson investigation. Certainly, there is no reason to believe that anyone ever set out to promulgate something that was not true. It is likely that many myths came about as a result of unwarranted generalizations. For example, an investigator might observe a pattern of spalling around the remains of a gasoline container and make an association of gasoline with spalling. The next time that spalling is observed, gasoline is inferred.

Some myths arose because of intuitively “obvious deductions.” The notion that gasoline burns hotter than wood is an appealing one, as is the notion that a narrow V-pattern indicates a “rapid fire.” The problem is that the term “rapid” is never defined, thus making it impossible, in many cases, to actually design an experiment to test a particular hypothesis about the significance of a particular indicator. Even when an indicator can be shown by direct evidence to be of no value, resistance to change and a culture of “circular citations” allows the myth to live on.

Many of the myths were gathered by the Law Enforcement Assistance Administration (LEAA) in *Arson and Arson Investigation Survey and Assessment* (1977), and although they were reported with appropriate cautionary language, the cautions were not heeded. And when the “indicators” were listed by what should have been the ultimate authority, the cautions were lost. No less an authority than the National Bureau of Standards (NBS then—now NIST) published a *Fire Investigation Handbook* (1980), which stated that crazed glass meant rapid heating, shiny alligator blisters meant that a fire burned “faster than normal,” and narrow V’s indicate “fast-developing, hot fires.”

In the 1980s, one American text after another referred to the NBS publication or to another publication that cited the myths published in the LEAA report. These circular citations continue in books still in print. Interestingly, many of the myths never gained much credibility in the United Kingdom because the major “go to” textbook, Cooke and Ide’s *Principles of Fire Investigation* (1985), either did not repeat the myths, or provided an accurate interpretation of the significance of indicators such as crazing and spalling.

In 1985, when the National Fire Protection Association (NFPA) Standards Council became sufficiently concerned about the validity of fire investigations, it appointed a Technical Committee to address the issue. Seven years later, the Committee and NFPA produced the first edition of NFPA 921, *Guide for Fire and Explosion Investigations*. The howls of protest from fire investigation “professionals” were deafening. If what was printed in that document were actually true, it meant that hundreds or thousands of accidental fires had been wrongly determined to be incendiary fires. No investigator wanted to admit to the unspeakable possibility that they had caused an innocent person to be wrongly convicted, or a family to be wrongly denied their life savings. The profession was in denial.

In 1998, the Technical Committee on Fire Investigations, responding to public pressure, removed the word “misconception” from the titles of several paragraphs in the chapter on pattern development in the optimistic

^a This paper is essentially a distillation of Chapter 8 from the author’s textbook, *Scientific Protocols for Fire Investigation*, CRC Press, 2006.

but mistaken belief that previous editions of the document, which was still not accepted in many organizations, had relieved the profession of these misconceptions.

The myths are slowly dying out (or being “*Dauberted*” out), but there are still practitioners who use them today, with disastrous consequences. Examples of the continued promulgation and application of the mythology since 2000 will be presented, as will the debunking of the myths as set forward in NFPA 921.

THE DEVELOPMENT AND PROMULGATION OF MYTHS

The introduction and persistence of mythology in arson investigation is an unfortunate part of the history of the discipline, and is a subject that many fire investigators do not like to think about. Some would like to pretend that the myths have died, in the hope that people would gradually forget about them and they would not be a problem anymore. It is this failure to address a serious problem in the training and education of fire investigators that causes the myths to persist. The unfortunate consequence is that innocent lives are destroyed by well-meaning but ignorant investigators. The purpose of this paper is to expose those myths, and to the extent possible, attempt to understand why they came into being, and why some of them still persist. The hope is that new investigators, or those considering entering the discipline, may be spared the necessity of having to “unlearn” things that are simply not true.

Just as in the study of Greek or Roman mythology, no single reason exists why a myth develops. Certainly, no reason exists to believe that any investigator deliberately set out to promulgate something that was not true. It is likely that most myths came about as a result of unwarranted generalizations. For example, an investigator might observe that in a garage fire, a pattern of spalling surrounds the remains of a gasoline container, and makes an association of gasoline with spalling. The next time he sees spalled concrete, he infers that gasoline must have been involved.

Some myths arise because of intuitively obvious “deductions.” The notion that gasoline burns hotter than wood is appealing; as anyone who has ever started a wood fire knows, it is much easier to start it with liquid fuel. And certainly after a short time, a fire started with, for example, gasoline is throwing off much more heat than the fire burning wood only. Therefore, the flame temperature must be higher, right? Wrong! But even Paul Kirk, arguably one of the finest forensic scientists of his time, bought into this notion. In the first edition of *Kirk’s Fire Investigation* (1969) he described the utility of examining melted metals.

Whenever any residues of molten metal are present at the fire scene, they will reliably establish a minimum temperature for the point of their fusion in the fire. The investigator may use this fact to advantage in many instances, because of the differences in effective temperature between simple wood fires and those in which extraneous fuel, such as accelerant is present.¹

To this day, investigators sometimes infer the presence of accelerants when they observe a melted aluminum threshold.

The notion that crazed glass indicates that the glass was rapidly heated was appealing enough that Brannigan, Bright and Jason, three respected fire researchers at the National Bureau of Standards (now NIST), allowed it into the *Fire Investigation Handbook* (1980). Some authors have declared that crazed glass is sufficiently useful that the size of the crazing cracks can indicate proximity to the area of origin².

It is the **publication** and continued promulgation of myths that ensures their longevity. If an “arson school” decides to use a text in its training courses, hundreds of investigators can be exposed to this false “gospel.” Those who take few refresher courses, fail to keep up with the literature, and attend few meetings, may never be exposed to updated ideas and new research.

The question naturally arises as to why fire investigation espouses (or has espoused) such a wide variety of myths, whereas DNA analysis, a forensic discipline derived from molecular biology, has many fewer myths to expunge. To some extent, the answer lies in the nature of the practitioners. In forensic DNA, the leaders in the field are trained scientists. If someone told them that crazed glass resulted specifically from rapid heating, they might remember an experiment in undergraduate chemistry lab that they tried to save from overheating by adding some water, only to watch the glass beaker craze when the water touched it. Thus they might consider an alternate explanation for the observation of crazing. During their training, scientists are supposed to acquire what Carl Sagan referred to as a “baloney detector,” otherwise known as natural scientific skepticism. However, one need not possess a science degree to be appropriately skeptical. Sagan wrote:

The tenets of skepticism do not require an advanced degree to master as most successful used car buyers demonstrate. The whole idea of a democratic application of skepticism is that everyone should have the essential tools to effectively and constructively evaluate claims of knowledge. All science asks is to employ the same levels of skepticism we use in buying a used car³.

Presented with the notion that large shiny alligator blisters occur only on wood surfaces that have been rapidly heated, a scientist will say, “Show me the data!” while an apprentice fire investigator will absorb the “knowledge” from his experienced mentor. When someone with an advanced degree publishes the myth and maybe even an apparent explanation for why it is so (albeit with no real data), the apprentice internalizes the fallacy as fact, making retraining difficult. And once the investigator uses the myth to send someone to prison, he is extremely reluctant to question the myth’s authority, lest he be forced to admit to an unspeakable error.^b

Much of the mythology about fire investigation was collected by the Aerospace Corporation, under a contract to the Law Enforcement Assistance Administration (LEAA) in a 1977 booklet entitled *Arson and Arson Investigation: Survey and Assessment*. To their credit, the authors of this survey pointed out, “Although burn indicators are widely used to establish the causes of fires, **they have received little or no scientific testing.**” They recommended, “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).” In a remarkably prescient statement, they added, “A primary objective of this testing would be to avert the formidable repercussions of a court ruling on the inadmissibility of burn indicators on the grounds that their scientific validity had not been established.” Despite this prediction, serious challenges to the myths did not become common until NFPA 921 was published. Part of the reason for the acceptance of the mythology may be that no less an authority than the National Bureau of Standards gave its blessing to many of the myths. In section 1.1 of the *Fire Investigation Handbook*, which two National Fire Academy staffers are credited with contributing, most of the myths from the LEAA report were reprinted without a single caution of the type found in the original study. Having the imprimatur of such an august body as NBS, fire investigators and

^b Though rare, such admissions happen. A Texas fire marshal, commenting on the execution of Cameron Todd Willingham, stated the following in the Chicago Tribune: “At the time of the Corsicana fire, we were still testifying to things that aren't accurate today, **They were true then, but they aren't now.**”

textbook authors believed (incorrectly as it turns out, but who knew?) that the myths had been scientifically tested.

The LEAA study provides as good a jumping off place as any for the study of the myths of fire investigation. Here is the list from the survey.

Alligatoring effect: checking of charred wood, giving it the appearance of alligator skin. Large rolling blisters indicate rapid intense heat, while small flat alligatoring indicates long, low heat. (This myth was repeated in the *NBS Handbook*.)

Crazing of glass: formation of irregular cracks in glass due to rapid intense heat—possible fire accelerant. (This myth was repeated in the *NBS Handbook*.)

Depth of char: depth of burning of wood—used to determine length of burn and thereby locate the point of origin of the fire.

Line of demarcation: boundary between charred and uncharred material. On floors or rugs, a puddle-shaped line of demarcation is believed to indicate a liquid fire accelerant. In the cross section of wood, a sharp distinct line of demarcation indicates a rapid, intense fire. (This myth was repeated in the *NBS Handbook*.)

Sagged furniture springs: because of the heat required for furniture springs to collapse from their own weight (1150° F) and because of the insulating effect of the upholstery, sagged springs are believed to be possible only in either a fire originating inside the cushions, (as from a cigarette rolling between the cushions) or an external fire intensified by a fire accelerant.

Spalling: breaking off of pieces of the surface of concrete, cement or brick due to intense heat. Brown stains around the spall indicate the use of a fire accelerant.⁴

In addition to the misconceptions listed in the LEAA report, the following myths have also been widely promulgated:

Fire load: Knowing the energy content (as opposed to the energy release rate) of the fuels in a structure was believed to allow an investigator to calculate the damage that a “normal” fire should produce in a given time frame.

Low burning and holes in the floor: Because heat rises, it was widely believed that burning on the floor, particularly under furniture, indicated an origin on the floor.

V-pattern angle: The angle of a V-pattern was supposed to indicate the speed of the fire. (This myth was printed in the *NBS Handbook*.)

Time and Temperature: By estimating the speed of a fire, or establishing the temperature achieved by a fire, it was believed that an investigator could determine whether it was accelerated.

Many of the myths about fire investigation were addressed in the first two editions (1992, 1995) of NFPA 921. In the chapter on fire patterns, there were several paragraphs entitled “Misconceptions about _____ (char, spalling, v-patterns, inverted cone patterns).” While the Technical Committee felt it important to shine a spotlight on these myths, many in the fire investigation community railed against the notion that any of them had ever harbored any misconceptions about anything. They insisted, and the committee acquiesced to a change in the 1998 edition, that changed the section titles to “Interpretation of _____,” as if removing the **word** “misconception” would remove the misconception.

ALLIGATORING

The *Fire Investigation Handbook* is a mostly useful book, except for the instructions on how to determine the origin and cause. The *Handbook* states:

In determining whether the fire was a slowly developing one or a rapidly developing one, the following indicators may be used: a) Alligatoring of wood--slow fires produce relatively flat alligatoring. Fast fires produce hump-backed shiny alligatoring.⁵

The 1982 IFSTA (International Fire Service Training Association) manual unequivocally states:

If alligatoring is large, deep, and shiny, the fire spread extremely rapidly. Large alligatoring should be considered an indication of the nearby presence of a flammable or combustible liquid.⁶

Nowhere is it stated what the difference is between a “fast” fire and a “normal” fire. The lack of a definition of these subjective words not only renders the “indicators” of a fire’s progress meaningless, it also makes it nearly impossible to design an experiment that tests the indicator’s usefulness. The Army’s Field Manual 19-20, *Law Enforcement Investigations*^c provides a slightly different interpretation of alligatoring when it states:

When wood burns, it chars a pattern of cracks which looks like the scales on an alligator’s back. The scales will be the smallest and the cracks the deepest where the fire has been burning the longest or the hottest. Most wood in structures char at the rate of 1 inch in depth per 40 to 45 minutes of burning at 1400° to 1600° Fahrenheit — the temperature of most house fires. (*Thus combining three misconceptions in a single paragraph!*)⁷

O’Connor’s *Practical Fire and Arson Investigation* (1986) stated:

Deep alligatoring (large rolling blisters) on an exposed wooden surface ordinarily indicates an intense, rapidly moving body of flame. This condition may be associated with the use of an accelerant.⁸

The second edition of the book is far more cautious, the authors having been brought up to speed on this subject. The newer text states:

It has been suggested that the presence of large shiny blisters (alligator char) and the surface appearance of char, such as dullness, shininess or colors have some relation to the presence of liquid accelerant as the cause, but no scientific evidence substantiates this. The investigator is advised to be very cautious in using wood char appearance as an indicator of incendiarism.”

They have not completely given up on the myth, however. The 1997 text shows a photo of “a heavy rolling char...caused by the rapid intense movement (extension) of heat and flame.”

^c The Manual was originally published in 1985, and reprinted in 1995. The Army has updated the manual, and made the update available on a “need to know” basis only, so it is not clear whether the errors have been corrected. The 1995 document is still available to the public through several internet vendors.

Noon, in his 1995 *Engineering Analysis of Fires and Explosions*, wrote:

In the same way that a hunting guide interprets signs and markers to follow a trail of game, a fire investigator looks for signs and markers which may lead to a point of origin. For example, a fast, very hot burn will produce shiny type wood charring with large alligatoring. A cooler, slower fire will produce alligatoring with smaller spacing and a duller appearing char.

Noon then goes on to explain “scientifically” why this is should be so.

As heat impinges on the piece of wood, the water in the surface material will evaporate and escape from the wood. The rapid loss of the water at the surface is also accompanied by a rapid loss of volume, the volume which the water formerly occupied. The wood surface then is in tension as the loss of water causes the wood to shrink. This is the reason why wood checks or cracks when exposed to high heat or simply dries out over time. Of course, if the heat is very intense, more of the water “cooks” out, and the cracking or alligatoring is more severe.⁹

The scientific-sounding explanation (though it is rubbish) lulls the reader into believing that the author actually knows what he is talking about. This kind of exposition in many books that repeat the myths has enhanced their credibility and thus their longevity.

The final word on this and most other myths is NFPA 921. Here is what it says about alligatoring:

6.5.5 Interpretation of Char. The appearance of the char and cracks has been given meaning by the fire investigation community beyond what has been substantiated by controlled experimentation. It has been widely stated that the presence of large shiny blisters (alligator char) is proof that a liquid accelerant was present during the fire. 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. Figure 6.5.5, showing boards exposed to the same fire, illustrates the variability of char blister.

6.5.5.1 It is sometimes claimed that the surface appearance of the char, such as dullness, shininess, or colors, has some relation to the use of a hydrocarbon accelerant or the rate of fire growth. There is no scientific evidence of such a correlation, and the investigator is advised not to claim indications of accelerant or fire growth rate on the basis of the appearance of the char alone.

The referenced figure is a photograph taken by Monty McGill, which was first shown in *Kirk's Fire Investigation*, Second Edition. It is the definitive evidence that debunks the myth of the shiny alligator. For our friends in the UK, we note the fact that Dougal Drysdale prefers the term “crocodiling.”

CRAZED GLASS

It is unclear why anyone ever thought that crazing of glass indicated rapid heating. Perhaps a piece of crazed glass was observed near the known origin of a fire, and one influential investigator reached the wrong conclusion and repeated it to a large group of seminar attendees. However the notion began, it achieved widespread acceptance. Unlike most myths, this one has proved especially amenable to testing, but until 1992, nobody bothered to make the effort.

The NBS *Handbook* stated, “Window glass fragments in large pieces with heavy smoke deposits usually indicates slowly developing fires. crazed or irregular pieces with light smoke deposits indicate a rapid buildup of heat.”¹⁰ Both statements are false, but crazing is our focus for now. The Army’s Field Manual, *Law Enforcement Investigations*, states, “As a general rule, glass that contains many cracks indicates a rapid heat buildup. Glass that is heavily stained indicates a slow, smoky fire.”¹¹

IFSTA’s Fire Cause Determination stated:

A window with small crazing (minute cracking), and perhaps with light smoke accumulation, is probably near the point of origin, its condition suggesting intense and rapid heat buildup. Large crazing and a heavy smoke accumulation suggest slow heat buildup and remoteness from the point of origin.¹²

The IFSTA manual may have been the source used in *Practical Fire and Arson Investigation*, (O’Connor, 1986 and O’Connor and Redsicker, 1997), which repeats the notion that crazing implies a “rapid and intense” heat buildup, and that if the crazing is “small,” it is close to the area of origin. A larger crazing pattern, on the other hand, “implies that it may have been located in an area some distance away from the point of origin.” The misconception about crazing follows an extensive discussion of the types of glass that an investigator may encounter, complete with softening points, chemical compositions and applications. The reader thus is led to believe that the writers know all about glass.

DeHaan, who today warns against reading anything into a finding of crazed glass and lists it under “Myths and Misconceptions,”¹³ still believed the myth in 1991. He stated, “Crazed glass, where the fractures or cracks resemble a complex road map in the glass, is certainly indicative of a very rapid buildup of heat sometime during the fire.” Getting closer to an understanding of the true cause of the phenomenon, he went on to state, “Small cratering or spalling of the glass is more likely due to a spray of water hitting a hot pane of glass during suppression.” By the time the fourth edition of *Kirk’s* was published, in 1997, DeHaan acknowledged the work by this author that proved that crazing is **only** the result of rapid cooling.¹⁴

In the study conducted by the author following the urban wildland fire in Oakland, CA in 1991, crazed glass was one of three “indicators” examined. We observed that all of the crazing occurred at those parts of the fire where there had been active suppression efforts, suggesting that water was associated with crazing. Later, in a series of laboratory experiments conducted by the author, we demonstrated that crazing is never caused by rapid heating, and can only be caused by rapid cooling.¹⁵

It is interesting to note that crazing of glass as an indicator of rapid heating is a myth that never caught on in the United Kingdom. This is almost certainly because in the UK, the most widely read fire investigation text, *Principles of Fire Investigation*, correctly identified “the appearance of many small conchoidal fractures on one surface of the glass,” as being the result of rapid cooling from extinguishment water.¹⁶ The authors of that text did not use the term “crazing.” The absence of the crazing myth in the UK lends credence to the proposition that it is **publication** in apparently respectable texts that is responsible for the perpetuation of the mythology of arson investigation.

DEPTH AND LOCATION OF CHAR

In 1979, Aetna Life & Casualty published a brochure-style handbook, authored by John Barracato, which espoused as many myths as any publication ever printed on the subject. On the subject of depth of char, the booklet entitled *fire...is it arson?* states:

The speed at which a fire burns is an important indicator of its cause. A fire not involving accelerant (such as gasoline or other flammable liquid) burns at the rate of 3/4 inch per hour into pine wood. The investigator should ask the fire department how long and intensely the fire burned, then carefully inspect any charred wood to see if there is a reasonable correspondence between the length of time the fire burned and the degree of damage it caused.¹⁷

Exactly this type of analysis was put forward in the case of Commonwealth v. Han Tak Lee. (1989). The investigator in that case made the following observations:

- (a) the fire burned for a total of 28 minutes,
- (b) fire burns one inch in 45 minutes (note: this is a more commonly cited charring rate than Barracato's 3/4 inch per hour), and
- (c) 2 by 10s, were completely consumed.

Therefore, the fire **must** have been accelerated because it would take 4.5 hours to burn through a 2 by 10. This of course, assumed that the fire would only burn in one dimension, as opposed to attacking the wood from both sides. He estimated the time required to burn a 2 by 4 at 1 hour 43 minutes at 1780° F.¹⁸ The investigator was misled by two myths, one, that the depth of char could be used to determine reliably the time of burning, and two, a uniquely-held belief that only one dimension of the wood would be attacked by the fire. If we assume, for the sake of argument, that fire burns one inch in 45 minutes, then it should take only 34 minutes to burn through a 1 1/2 inch piece of wood, assuming it is attacked from both sides. This investigator had both his premise and his implementation of that premise wrong. NFPA 921 states unequivocally that depth of char measurements should not be relied on to determine the duration of the burning.

LINES OF DEMARCATION

This is one of the more complex myths in fire investigation because, in some instances, lines of demarcation can be used to tell exactly what happened, whereas in other instances, lines of demarcation are just lines. The threshold question is whether the compartment where the lines occur experienced full room involvement. Let us be clear. There are times when a fire pattern is so obviously caused by an ignitable liquid that further analysis truly is "the icing on the cake," to coin a phrase. Once a fire progresses to full room involvement, however, it is no longer valid to make a determination using visual cues alone, and there are some who maintain this should never be done. Sharp, continuous, irregular lines of demarcation between burned and unburned areas are frequently cited as evidence of the use of ignitable liquids. It is true that ignitable liquids can produce such patterns, and many arson seminars include staged fires that are extinguished early, so that investigators can learn to recognize "pour patterns." What is not evident from these incipient test fires is what happens after the room becomes fully involved.

Lines of demarcation can occur for no apparent reason. The intensity of radiation falls off as the square of the distance from the source to the target, so at some point, perhaps a sharply defined point, insufficient energy exists to maintain combustion. This property, as well as the random nature of some burning, can result in sharp lines of demarcation

Protection patterns can be produced by irregularly shaped pieces of gypsum drywall, which fall from the ceiling and provide protection to whatever floor they land upon. Clothing on the floor has also been known to produce alternating areas of exposure and protection.

In a ground-breaking study of burn patterns caused by burning pools of gasoline and kerosene, Putorti demonstrated that even on wood and vinyl floors, the edges of the patterns produced are not necessarily all that sharp.¹⁹ The only definitive pattern he found that could reliably be associated with the use of ignitable liquids was the “doughnut” pattern on carpeting, caused by protection at the center of the pattern by the presence of liquid fuel that had not yet evaporated.

Lines of demarcation in the cross section of charred wood have been cited since 1980 as an indicator of the speed of a fire. The *Fire Investigation Handbook* stated, “A distinct line between charred and uncharred portions indicates a rapidly developing fire. Lack of a distinct line usually indicates a slow, cooking process, thus, a slowly developing fire.”²⁰ O’Connor (1986) and O’Connor and Redsicker (1997) both provide a diagram of a cross section of a piece of lumber showing a sharp line of demarcation indicating a rapid spread, and a gradual line of demarcation indicating a slow-burning fire. DeHaan (2002) states, “One indicator that is more reliable [than the surface appearance of char] is the appearance of the charred wood in cross section. When a charred beam is cut crosswise, the gradation between the charred layer and the underlying undamaged wood is more gradual with a slowly developing fire.” He then goes on to provide a perfectly reasoned analysis of why this should be so, but, like O’Connor, provides neither data (though he does provide a drawing), nor a definition of what is meant by “sharp,” “gradual,” “fast,” or “slow.” It seems to be a case of “I know it when I see it.” To his credit, DeHaan cautions that a fast-developing fire may or may not be accelerated. Nonetheless, this is the type of “data” that an investigator may use to incorrectly “eliminate” a smoking fire, since smoking fires are not “fast-developing.”

Some of the more frequently debated sections of NFPA 921 deal with determinations made by observing lines of demarcation. While it is silent on the observation of cross sections, the document contains a whole section devoted to caution in the interpretation of burn patterns on the floor. **NFPA 921 contains more cautions on this subject than on any other.** The reason for the abundance of cautions on the subject of interpreting lines of demarcation is simple—the errors caused by this particular misinterpretation have been legion.

SAGGED FURNITURE SPRINGS

The Aetna booklet *fire...is it arson?* (1979) advised fire investigators to photograph furniture springs, “because their appearance can help the investigator document the area of origin. Severely sagging springs can indicate that a flammable liquid was involved and created heat intense enough to cause the springs to sag.”²¹ Carter, on the other hand, writing in *Arson Investigation* (1978) stated that collapsing all or part of a coil spring was an indication of a cigarette starting the fire.²²

In the Han Tak Lee case, smoking in bed was ruled out because the bedsprings had lost their temper. Clearly, this is an area of much confusion. In 1989, Tobin and Monson, two FBI laboratory scientists, subjected furniture springs, both loaded and unloaded (with and without weights on them), to different fire conditions, and basically concluded that the condition of the springs is of little probative value in fire investigation.²³ DeHaan correctly states that varying degrees of spring damage can provide some insight about the progress of a fire but cautions that the collapse of springs cannot be reliably used to determine whether a fire was incendiary.²⁴ NFPA 921 states that the value of analyzing the furniture springs is in comparing (comparative analysis) the differences in the springs to other areas of the mattress, cushion, frame, and so forth. Comparative analysis of the springs can assist the investigator in developing hypotheses concerning the relative exposure to a particular heat source.

SPALLING

There exists no more misunderstood and misused indicator than concrete spalling. It has been the pivotal “indicator” in many major fire cases, and has been the subject of numerous contentious articles in the *Fire and Arson Investigator*. To this day, arson cases are made on the basis of spalled concrete. Kennedy’s “Blue Book,”(1977) had the following comments on spalling:

Spalling caused by flammable liquids burning is usually found at low levels because the flammable liquid vapors are heavier than air and tend to go down.

... Regardless of the composition of the concrete or brick, the indicator is the spalled area or areas indicating the burning of accelerants....

...The spalling temperatures are usually much higher than the temperatures found in the normal dwelling or commercial building fire. Therefore, we know that accelerants were used.²⁵

IFSTA’s *Fire Cause Determination* provided the following statement on spalling in 1982:

Concrete floors and assemblies that have spalling should be examined closely. The spalling may be an indicator of the use of accelerants. If the accelerants had adequate time to soak in before ignition, the spalling will follow the flow pattern of the liquid. Spot spalling is not a clear indicator of the use of accelerants. Further, it is not unusual for spot spalling to result from severe fire exposure.²⁶

This semi-cautious language is typical of what has been written about spalling. Skeptics have always questioned the relationship between ignitable liquids and spalling. Harvey French in 1979, Fred Smith and Jack Mitchell in 1981, Ettling in 1984, Charles Midkiff in 1990 and Bernard Beland in 1993. Some fire investigators simply ignored all these skeptics, and ploughed on with their case making.

One of the largest insurance bad faith awards in Alabama history was the result of a fire investigator, who, relied on a “trail of spalling” in addition to other “indicators” to conclude that the cause of a fire was arson. It did not help that the fire chief stood on the “trail” before the fire reached the basement. Nor was the court impressed with the shape of the “trail” when it learned that its shape resulted from the investigator shoveling a trail.^d When the slab was completely cleared, it was found that the entire slab had spalled, and no “trail” of any kind had ever existed.²⁷

Fire investigators have argued endlessly about the characteristics of an accelerant-induced spall versus a naturally occurring one. A brownish, or pinkish halo around the hole was thought to indicate the presence of burning hydrocarbons^e. Numerous slides and photos were exchanged, but in the end, the consensus was that the skeptics were right.

^d The court’s characterization of the testimony of the investigator is instructive. “The court concludes that not only is [the investigator’s] testimony as a whole completely void of credibility, but the presentation of his testimony borders on the perpetration of a fraud upon this court. For [the investigator] and [the insurance company] to present to this court a case so heavily dependent upon “spalling” as this case, when it is indisputable that [the investigator] selectively cleared only those areas of the floor which supported this incredulous theory is reprehensible.”

^e Cook and Ide (1985) reported that the color change was probably a result of the dehydration of yellow colored hydrated iron oxides, which turned pink or reddish brown at about 300 °C.

The evolution of DeHaan's thinking is instructive. In 1991 he wrote, "As a fire indicator, spalling can indicate the presence of such suspicious sources of localized heating as a chemical incendiary or a volatile petroleum liquid." In the next edition (1997), the language was moderated to the following: "As a fire indicator, spalling can indicate the presence of a significant fuel load of ordinary combustibles, as well as the presence of suspicious sources of localized heating as a chemical incendiary or a volatile petroleum liquid." By the fifth edition (2002) of *Kirk's*, spalling had been relegated to DeHaan's list of "Myths and Misconceptions."

Most of what is written about spalling today wishfully refers to misconceptions formerly held. NFPA 921 has, since its inception, warned about misinterpreting spalling. Overall, 921 states that the importance of spalling to the fire investigator lies in the documentation and analysis of a heat source.

The easiest way to tell whether an investigator is keeping up is to look at the way he spells spalling. Some people spell it "spalding" and some spell it "spaulding." The origin of the misnomer is probably the past tense of the word spall. One sees spalled concrete. People who don't know any better add the "d" and call the process spalding or spaulding. Such people have apparently never read a text or even an article on the subject, and are quite beyond hope.

OTHER MYTHS

Space does not permit a full discussion of several other myths that are used, like the rest, as indicators of an incendiary cause. These include the following:

- One can calculate the "expected" behavior of a fire by knowing the energy content of the fuels (rather than their heat release rate)
- Heat rises, so fire always burns up, and if the floor is burned the fire must have had "help"
- A wide "V" pattern indicates a "slow" fire and a narrow "V" indicates a "fast" fire
- A fire that achieves temperatures above the ASTM "Standard Time Temperature Curve" must have been accelerated

CONCLUSION

Fire investigation involves the comparison of the investigator's "expectations" with his perception of the behavior of the fire. If those expectations are not properly "calibrated," the result will be numerous errors. In the 17th century, when the scientific community was first getting organized, it was understandable that misconceptions about fire, such as the phlogiston and caloric theories, should exist. What is surprising is that after three centuries of scientific examination of fire, myths have been added rather than dispelled. The sheer number of misconceptions, and their widespread publication in learned and not-so-learned treatises indicates that fire investigation, as a profession, still has very far to go.

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