Indicators of Trouble

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A recent unsigned article in the *National Fire & Arson Report* (Fall, 1998) entitled "Identifying Evidence of Ignitable Liquids," listed ten alleged indicators of ignitable liquids. Using these indicators without confirming their validity via laboratory testing is almost certain to get a fire investigator into trouble, and, more importantly, to cause irreparable harm to innocent people.

When I first learned about these indicators, some twenty years ago, they also included spalled concrete and crazed glass. The absence of these disproved indicators from the list implies some progress, but, despite the "cautions" that accompany this article, it is still likely to do more harm than good.

Much has been learned about the behavior of fire in the last twenty years, and particularly in the last ten. The effects of flashover, not mentioned once in the recent article, are now much better understood than they once were, and, in fact, may account for many of the indicators formerly wrongly attributed to ignitable liquids, including many of those on the list.

All indicators (also known as "red flags") tend to become less meaningful as the extent of fire damage increases. For the purposes of this article, we can consider fires that do not achieve flashover in any compartment (pre-flashover fires), fires that have achieved flashover in at least one compartment (post-flashover fires), and black holes. Much interesting study has taken place over the last ten years on all three categories of these fires. Let us now examine the alleged indicators one at a time and make the cautions more explicit and more targeted to each indicator.

1. **Rapid lateral fire spread**. Witness statements such as "The fire spread from one end of the house to the other within minutes" are said to indicate flammable liquids. This may be valid only in pre-flashover fires. Much depends on when the witness first saw the fire. If the witness first observed the fire just prior to flashover in the compartment of origin (and there is research to suggest that this is often the case) spreading to the other end of the house within "minutes" is not at all unusual. Flashover forces gases out of the room and down hallways and into adjoining rooms at an amazing speed. This brings the adjoining spaces to flashover in a very short period of time. For an enlightening view of fire spread reports, see *Fire Findings,* "Fire Timing Test Results: Fires may only appear to spread rapidly, Vol. 3, No. 3, Summer, 1995.

2. **Smoke and flame color**. While it is true that flammable liquids produce black smoke, so does any petroleum-based product. The color of the initial flame and smoke might have been important in the 1940s and 1950s when our furniture was made of cotton and wood, but most furniture today is made of nylon, polyester, and polyurethane. Even wood fires, deprived of oxygen, will produce black smoke. According to NFPA 921, Paragraph 3.6:

   > "Smoke color is not necessarily an indicator of what is burning. While wood smoke from a well ventilated or fuel controlled wood fire is light colored or gray, the same fuel under low-oxygen conditions, or ventilation-controlled conditions in

> a post-flashover fire can be quite dark or black. Black smoke can also be produced by the burning of other materials including most plastics or ignitable liquids."

Light smoke may indicate that there are no petroleum products burning. Black smoke indicates nothing meaningful.

3. **Distinct burn patterns**. Distinct burn patterns may be produced on a tight surface by flammable liquids burning on that surface. However, the radiation from a burning fuel package can just as easily produce distinct burn patterns, even if flashover has not occurred. A major cause of distinct burn patterns is the protection provided by irregularly shaped objects, such as broken pieces of sheetrock wall or ceiling that fall on the floor during a fire. Clothing on the floor will also cause irregular burn patterns with sharp, continuous, irregular lines of demarcation between burned and unburned areas. "Irregular, curved, or 'pool shaped' patterns on floors and floor coverings cannot always be reliably identified as resulting from ignitable liquids on the basis of observation alone" (NFPA 921, 4-17.7.2). Be prepared to have this paragraph read to you and shown to the jury should you rely on "distinct burn patterns" as an indicator of ignitable liquids.

4. **Downward burning**. Everybody knows heat rises. Fire investigators know that heat travels by conduction, convection, and radiation. When they testify, however, most fire investigators only testify that heat rises, and they show the jury a V-shaped burn pattern, and imply that the fire must have had "help" to burn downward. Downward burning occurs in every fire in which flashover occurs. It occurs in every black hole. It even occurs in some accidental fires that are not accelerated.

> "The investigator should keep in mind that during the progress of a fire, burning debris often falls to lower levels and then burns upwards from there. This occurrence is known as 'falldown' or 'dropdown.' Falldown can ignite other combustible materials producing low burn patterns that may be confused with the area of fire origin" (NFPA 921, 4-16.4.2).

In a fire that goes to flashover, radiation is the primary means by which fire spreads. "Transfer of heat by radiation is less commonly appreciated than transfer by conduction or convection, and yet it plays the most critical role in fire growth and spread, particularly in larger fires. Radiation aids fire spread across a surface, promotes ignition of other fuels, and may produce burn patterns that survive the fire" (*Kirk's Fire Investigation*, 4th Edition, Page 28).

5. **Holes in flooring**. This indicator is based on the fact that liquids will flow to the lowest point, and therefore penetrate cracks and joints in flooring. Allegedly, the burning liquid will more rapidly burn out the joints, creating holes, than a nonaccelerated fire. Use this indicator only in pre-flashover compartments.

"Burning between seams or cracks of floorboards or around door thresholds, sills, and baseboards may or may not indicate the presence of ignitable liquid. **If the presence of an ignitable liquid is suspected, samples should be collected and laboratory tests used to verify their presence** (Emphasis added).

Burning from full room involvement can also produce burning of floors or around door thresholds, sills, and baseboards due to radiation, the presence of hot combustible fire gases, or air sources (ventilation) provided by the gaps in construction. These gaps can provide sufficient air for combustion of, on, or near floors. If the investigator develops a hypothesis that charring in these areas resulted from these effects samples can also be taken to indicate an ignitable liquid was not present.

Like other areas of low burning, holes burned in floors can be produced by the presence of ignitable liquids, glowing embers, or the effects of flashover after full room involvement. The collection of samples and laboratory verification of the presence or absence of ignitable liquid residues may assist the investigator in developing hypotheses and drawing conclusions concerning the development of the holes" (NFPA 921, 4-16.1.4).

6. **Burning beneath floors**. This is one indicator that may have validity in both pre- and post-flashover fires (but not in black holes). If a flammable liquid is suspected of causing burning beneath floors, samples should be submitted to the laboratory.

7. **Burning in protected areas**. Burning beneath furniture, door bottoms, and appliances causing charring to the underside but little or no damage to the upper surface is certainly worth noting. It is also worth noting whether the room has achieved flashover, and whether there were any objects on the upper surface. It is invalid to point out to a jury the charring on the underside of a bookshelf, and the relatively undamaged condition of the top side of the bookshelf, if the bookshelf was covered with books. The books protected the top and didn't protect the bottom.

   Once flashover has occurred, burning underneath furniture is to be expected in almost every case. Refer to NFPA 921, Figure 3.5.3.2(e), and look at the areas where the flames are.

8. **Straight up burn patterns on wall surfaces originating at the floor level**. The persistence of this particular alleged indicator is truly amazing. Actually, "The angle of the V-shaped pattern is dependent on several variables including the following: a) the heat release rate and geometry of the fuel; b) the effects of ventilation; c) the ignitability of the vertical surface on which it appears; d) the presence of interceding horizontal surfaces such as ceilings, shelves, tabletops, or the overhanging construction on the exterior of a building. The angle of the borders of the V pattern

does not indicate the speed of fire growth such as a wide V indicating a slowly growing fire or a narrow V indicating a rapidly growing fire" (NFPA 921, 4-17.1).

Recent tests conducted by the US Fire Administration confirm the invalidity of this alleged indicator.

9. **Signs of explosion**. This may be a valid indicator for all three types of fires, pre-flashover, post-flashover, and black holes. Certainly, clear glass blown away from the structure indicates an explosion at the very beginning of the fire. Walls pushed out at the bottom, however, are just as likely to occur from a natural gas explosion as from a propane gas explosion or an ignitable liquid explosion. The point at which a wall fails depends on its strength, and not necessarily on the location of the explosion.

   > "The vapor density of the fuel is not necessarily indicated by the relative elevation of the structural explosion damage above floor level. It was once widely thought that if the walls of a particular structure were blown out at floor level, the gas was heavier than air, and, conversely, if the walls were blown out at ceiling level, the fuel was lighter than air. Since explosive pressure within a room equilibrates at the speed of sound, a wall will experience a similar pressure-time history across its entire height. The level of explosion damage within a conventional room is a function of the construction strength of the wall headers and bottom plates, the least resistive giving way first" (NFPA 921, 13-8.2.2).

10. **Damage to metals such as copper and steel at low levels in the structure**. This alleged indicator is based on the misconception that accelerants burn at higher temperatures than ordinary combustibles. This is untrue, it has been shown to be untrue, and if you base your determination of a fire cause on evidence of "higher than normal" temperatures, you will be discredited. "Wood and gasoline burn at essentially the same flame temperature. The flame temperatures achieved by all hydrocarbon fuels (plastics and ignitable liquids) and cellulosic fuels are approximately the same, although the fuels release heat at different rates" (NFPA 921, 4-8.1).

    The difference between accelerated and non-accelerated fires is a difference in heat release rate, not a difference in temperature. The amount of energy released per unit time is greater, but the temperature is not.

    The presence of melted metals at floor level is particularly meaningless in the context of a black hole fire. A study of the 1991 Oakland fire that burned 3,000 homes revealed the presence of melted copper in over 80% of the burned structures, and what appeared to be melted steel in over 90% of the burned structures. With respect to steel, looks can be deceiving. What appears to be melted may be merely oxidized.

Interpret melted metals, particularly steel, with caution, and interpret the temperatures you infer from these melted metals with extreme caution. High temperatures are

more likely a result of increased ventilation than of the presence of ignitable liquid residues.

When an investigator believes that there is evidence of ignitable liquid residues at a fire scene, the investigator has formed a **hypothesis** that ignitable liquids were used to set the fire. This may be an entirely reasonable hypothesis, but it is not a useable hypothesis until it has been tested. An investigator who believes ignitable liquids are present should not only consider collecting samples for submission to a laboratory, that investigator should definitely collect those samples and submit them to a laboratory. Samples collected with the aid of a canine trained to detect ignitable liquids have a higher likelihood of testing positive than those collected without the canine's aid, and if a canine is available, certainly, it should be employed. Like the other "indicators," however, a canine's alert should not be considered evidence.

The only way to conclusively prove that an ignitable liquid is present in a fire scene that has gone through flashover is to have it identified by a competent analytical laboratory. (Avoid the temptation to declare that flashover has not occurred except in the most obvious cases.)

The publication of the "Ten Indicators Of Ignitable Liquids" was no doubt carried out with the best of intentions, to provide investigators with a handy list of "rules of thumb" to be used in evaluating fire scenes. When these indicators were first promulgated in the 1970s and before, they were taken as gospel, and investigators could, with a straight face and a pure heart tell a jury that they believed a fire was incendiary based on these indicators, regardless of the results of any laboratory analyses. The climate has changed.

In most cases, when somebody wants to dispute the call that a fire was incendiary, if they have the resources (and in the case of criminal defendants, even if they don't), they can find a qualified investigator who is familiar with the relevant authoritative texts to shoot down inferences based on indicators that have been proven to be invalid. Reliance on these alleged indicators, without the backing of a valid chemical analysis, can lead to ruination for the person falsely accused and severe professional embarrassment for the investigator. The days of unreviewed, unchallenged inferences based on outdated indicators are over. Get used to it.