UNCONVENTIONAL WISDOM: THE LESSONS OF OAKLAND

By John J. Lentini, C.F.I., David M. Smith, C.F.I. and Dr. Richard W. Henderson, C.F.I. Submitted by the authors.

Every once in a while, we get the opportunity to investigate a fire which causes us to question the expectations which we carry into a fire scene. For the investigator with an open mind, such fires present an opportunity for learning and increasing one's experience, not in the sense of adding one more fire scene investigation to the resume', but in the sense of being a better investigator and being better able to determine the cause of other fires.

Some of the best opportunities for learning occur when a fire of known origin is detected early and extinguished early. We can then visit the scene and learn about the behavior of fires having this type of origin. For instance, any time there is a lightning induced fire nearby, many of us like to take the opportunity to visit the structure, even though everyone knows what caused the fire. Hopefully, by visiting such scenes, we will learn to recognize the indicators of lightning fires when we see them at scenes where the cause is not known. Fires set at training seminars serve much the same purpose, although far too many such fires are designed to help seminar attendees recognize arson, rather than helping them learn to investigate fires. Fortunately, there is an emerging trend toward simulating accidental fires at training seminars. While early detection and extinguishment produce fire scenes with instructional value, many of us are required to investigate fires which were neither detected nor extinguished early, and which result in what is known as a "black hole." The overwhelming majority of black holes are of unknown origin, and consequently, the conventional wisdom which we apply to these fire scenes is more subject to being incorrect than is the conventional wisdom applied to a less damaged structure. A fire investigator's expectations about a black hole are guided by his previous experiences. If, for instance, an investigator has found melted (or apparently melted) steel bedsprings in a scene, and the debris samples test positive for a flammable liquid, the investigator may associate melted bedsprings with flammable liquids. Similarly, crazed glass, associated with a fire of known incendiary origin, may be used as an indicator of incendiary origin at another scene, even though the debris samples from that scene may have been negative.

Much has been written and taught about the significance of melted or decomposed metal and melted or crazed glass, as these indicators apply to black holes. The question is, just how valid are these indicators?

On October 20, 1991, a seven-acre brush fire in the hills east of Oakland, California, was rekindled by strong winds, and the resulting fire destroyed nearly 3,000 homes. Almost all of the structures were total losses, i.e., they were reduced to piles of rubble and ash. After receiving information about the fire, the authors saw in this tragedy the possibility for learning about the characteristics of a "normal" unaccelerated fire which results in a black hole. Thus, the Oakland Black Hole Baseline Project was started.

Two weeks after the fire, a team of four investigators converged on the scene, which was still in almost the same shape it was in immediately after the fire. Whole neighborhoods were still under police protection to prevent looting (although there was very little left worth stealing), and to keep out the tourists.

During the next four days, the team visited fifty separate fire scenes, recording, photographing, and videotaping the evidence. We had initially planned to visit 100 sites, but because of the uniformity of the data obtained, the team members concluded that viewing an additional fifty sites was not likely to reveal anything new.

Although the project was carried out entirely at the expense of the investigators, invaluable support in terms of manpower and access was provided by the civil authorities, especially the Bureau of Alcohol, Tobacco and Firearms and the City of Oakland Police Department. After all the information was recorded, laboratory experiments were carried out in an attempt to answer some of the questions raised during the investigation, and the results were published in the August, 1992 issue of Fire Technology.[1] A 33 minute training video, outlining both the field and laboratory observations, was also prepared. Briefly summarized, what was learned is that bedsprings which appear to be melted are common in nonaccelerated residential structures that burn to completion. Melted copper is also common. Crazed glass is not a useful indicator of fire behavior, as it can only be produced when hot glass is rapidly cooled.

What Does It All Mean?

Any time a study produces results which cause questioning of conventional wisdom, the first issue which needs to be addressed is the validity of the study. Certainly, we do not want to "learn" things which aren't true. We would not, for instance, want to go to Dresden, after the fire bombing, in an attempt to learn about fire's normal behavior. The first question which arose in the Oakland study was whether or not the black holes examined by the investigators represented the typical black hole likely to be encountered in an isolated setting.

The three principal investigators all routinely examine isolated black holes, usually in a rural setting. The overall impression was that the Oakland black holes did not differ in any significant regard from the isolated black holes which they had examined in the past.

An overall examination of the site, both from the air and from the ground, revealed numerous pockets of undamaged combustible materials, including vegetation, fences, outbuildings, and surrounding residences, thus making it unlikely that we were looking at any special "firestorm" effects. Just to be on the "safe side," however, the majority of structures examined were those on the periphery of the fire, those areas which had become involved in the later stages, and which were immediately adjacent to undamaged blocks of houses. It was this concentration on the edges of the fire which gave us the first indications of the true meaning of crazed glass.

If we had been looking at the effects of a firestorm, we would have expected to find uniformly higher temperatures throughout the scene than we had been used to seeing in our isolated black holes. Much of the copper in the structures examined was largely intact, however, indicating that generally, the temperatures did not exceed the melting point of copper.

One aspect of these fires which we knew differed from most isolated black holes was the method of ignition. Most houses were ignited by firebrands falling from the sky; some were ignited by radiant heat. This exterior ignition most likely had the effect of causing the fires to burn somewhat cooler, due to early ventilation. The exterior ignition factor would therefore be expected to balance any "firestorm" effects, if indeed any such effects existed in the structures surveyed.

We were thus assured that it would be fair and reasonable to extrapolate our results to isolated black holes. What we were looking at was not the results of a firestorm, but the results of a wildland fire where over 3,000 homes were located.

After forming our initial hypotheses, based on the field observations, laboratory experiments were conducted, in order to further check the validity of our observations. The results obtained from these laboratory studies were consistent with the field observations.

Metals

Melted copper, either pipes or wires, was present in 84% of the structures examined. To our surprise, melted steel was identified in 98% of the structures examined. Since we know that steel has a higher melting temperature than copper, it was not at all clear why this should be so. To explore this question, we obtained some bedsprings upon which to experiment. The springs were exposed to temperatures ranging from 1,300 to 2,500°F, and then examined metallurgically. Additionally, four bedsprings from an isolated black hole (in another state) were also examined. The results were surprising. What we learned was that, while a bedspring may give the appearance of melting, it may be only heavily oxidized. Bedsprings which have been exposed to temperatures of 1,500° for any length of time are subject to deterioration which appears to be melting, but is not. The metallurgical evaluation is explained in the Fire Technology article, and in somewhat more detail, the evaluation is described in a recently published article in The National Fire and Arson Report.[2] The bottom line with melted steel is that you can't determine whether is has melted by visual examination alone. In order to make a determination that a piece of steel has melted, a microscopic metallurgical evaluation is required.

We noted during our inspection that the apparent melting of bedsprings occurred randomly, in lines, circles, on corners, and in the middle of the springs. Thus, a "pattern" of apparent melting was found to have no particular significance.

With respect to copper, we observed that black holes routinely achieve temperatures sufficiently high to cause melting. The relative position of the metal with respect to the house (i.e., upper or lower) also made no difference once the house had been reduced to a pile of rubble. Thus, there would be no particular significance to melting of copper near the floor, as opposed to near the ceiling, once the house has fallen in. Copper does seem to be a much more reliable indicator than steel, however, of the temperatures achieved by the fire. Unlike steel, copper does not undergo the extensive oxidation, so that when investigators see what appears to be melted copper, they are on firm ground in stating that the temperatures exceeded the melting point of copper (except in the case of alloying, caused by the presence of molten aluminum on the surface of the copper).

Glass

Glass of all descriptions was found throughout the Oakland fire. Some was crazed, some was melted, some was smoked, some was clear. Some was a combination of the above, and some glass even flowed down the hillside. Some of the clear glass had obviously been smoked at one time, and the smoke subsequently incinerated. Since some glass begins to soften at 1,200°F and most glass will melt at 1,500°F, most fire investigators looking at a black hole would not attribute a lot of significance to melted glass. Crazed glass, however, is another story. There are numerous references to crazed glass in "the literature," most of which state that the crazing of glass is caused by rapid heating. Some texts even go so far as to state that clear crazed glass is an indication of nearby accelerants.

In Oakland, crazed glass was identified in twelve of the fifty residences examined. Most of these residences were at the periphery of the fire, where some extinguishment had been attempted. We thus considered the possibility that the crazing was induced by rapid cooling, rather than by rapid heating. A series of laboratory tests, using various heating methods, was conducted, and in no case were we able to induce crazing by rapid heating. In every case, however, when the glass was heated above 500°F (whether rapidly or slowly), crazing could be induced simply by the application of water to the hot glass. In those areas which were sprayed with water, crazing occurred. In those areas which were not sprayed with water, crazing did not occur.

Our experiments have found no evidence whatsoever to indicate that crazing is caused by rapid heating. It is frequently stated that laboratory experiments cannot duplicate what happens in an actual fire, but in the case of crazed glass, one would think that it should be possible to duplicate the conventional wisdom through a laboratory experiment. The authors invite any reader who knows of any laboratory or field tests in which rapid heating alone produced crazed glass to share that information.

Absent that information, however, it seems that the rapid cooling of glass is not terribly significant with respect to interpreting the behavior of a fire, and that the significance of crazed glass has been overstated in the literature. The laboratory experiments conducted on glass are briefly outlined in the Fire Technology article, and are explained in great detail in an article entitled, "The Behavior of Glass at Elevated Temperatures," published in The Journal of Forensic Sciences in September, 1992.[3]

A Multiplicity of Indicators

Often, the presence of one indicator of an intentionally set fire will be used to bolster the interpretation of another indicator. For instance, finding several apparently melted bedsprings in a fire scene might lead an investigator using conventional wisdom to conclude that the fire burned hotter than normal. Crazed glass at the same scene might be interpreted as indicating that those hotter than normal temperatures were achieved in a faster than normal time frame, thus giving two indications of incendiary origin. In the Oakland fires, we found multiple "indicators" in the majority of the scenes. Thus, apparently melted steel is no more significant in the presence of melted copper or crazed glass than standing by itself.

The results of our study seem to offer dismal prospects for a fire investigator attempting to determine the cause of a fire which results in a black hole. There are still ways that an incendiary origin can be determined, besides relying on these conventional indicators which, as we have shown, are simply not reliable. A positive laboratory finding of accelerants still has as much significance as ever, even when the structure has been reduced to powder.

It should be noted that indicators other than physical evidence may prove valuable in black hole investigations. For example, evidence of prior knowledge of an incident allows one to safely conclude that the incident was not an accident. Prior knowledge can be demonstrated by showing the removal of personal items prior to a fire. If all the family photographs are found hidden in the chicken shed, it is unlikely that the fire was accidental. Of course, if certain valuable items in the house, such as guns, TVs, and jewelry are missing, then it is clear that something is wrong. A fire will not make all of these items disappear, nor is it likely that a burglary was immediately followed by an accidental fire.

The black hole requires more thorough investigation of the circumstances surrounding the fire. If someone was seen running from the house with a gas can, or if firemen can reliably testify to two distinct fires within a structure, then it is not necessary to call a fire undetermined simply because previously accepted conventional indicators have proven untrustworthy. While this approach casts a wider net, calling a fire incendiary based on melted copper, apparently melted steel, and crazed glass, has no scientific basis.

Conventional wisdom which associated incendiary fires with these indicators was based on coincidence and anecdotal evidence, and investigators should not factor these artifacts into their conclusions.

References

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JOHN J. LENTINI
Certified Fire Investigator
Fellow American Board of Criminalistics

1190 Atlanta Industrial Drive
Marietta, GA 30066
http://www.atslab.com

770 218-2180 Ext. 3047
Fax: 770 424-6415
Res: 770 984-0175
Email: fire@atslab.com

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