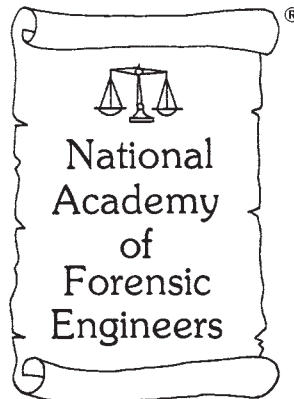


Journal of the
National
Academy OF
Forensic
Engineers[®]



Forensic Engineering Experience with Electrically Ignited Fires

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Abstract

After a fire that may have been caused by an electrical defect or malfunction, significant physical evidence is often what was most destroyed in the fire. The evidence void might be filled with fire investigators' inference or speculation that the cause was a specific electrical failure. This paper illustrates two fires in which the initial reconstructions claiming electrical ignition were subsequently found to be wrong. In one case, an investigator drew a conclusion about an extension cord from a floor fire pattern, and this interpretation was refuted when further evidence was unearthed. Investigators on another case retained evidence to support an obviously defective room air conditioner. However, the unit later was shown to be only a victim of the fire, and the needed evidence had been lost. Both cases involved extensive litigation.

Keywords

Electrical fire, electrical ignition, electrical failure, extension cord

Introduction

During fire investigations, sometimes determining the origin and cause of the fire might come down to "it must have been electrical" only after methodically ruling out all other possibilities. Then investigators might develop plausible arguments for scenarios involving electrical ignition of combustibles, including short circuits, overheated conductors, intermittent connections, arcing, and combinations of these effects.

On the other hand, sometimes the electrical cause in a fire scene is immediately apparent. The post-fire evidence is obvious, and the investigator can state with certainty that a specific electrical defect or malfunction caused the fire. But, as will be seen in the following cases, sometimes that investigator is wrong.

Case A, Extension Cord

Case A (all photographs for this section taken by Paul J. Boerner) involved an overnight fire in a house under construction (**Figure 1**) that resulted in extensive damage (**Figure 2**). The fire gutted most of the interior (**Figure 3**). Immediately after the incident, fire investigators observed numerous electrical extension cords (**Figure 4**) and propane heater hoses (**Figure 5**) that had been strung by various contractors working on the interior the day before the fire.

The investigators took note of the cans of paint and bottles of propane (**Figure 6**) stored at the site, observing the route of the fire (**Figure 7**) as it climbed through the roof. Interest centered, in particular, on one orange extension cord that wound through the



Figure 1

House under construction at the time of the fire.



Figure 2

Fire inside broke through the roof.

structure (**Figure 8**) and into an area exhibiting heavy fire damage (**Figure 9**).

The orange jacket of the extension cord had been burned away near a plug-and-socket junction with a black power cord (lower right of **Figure 10**). The junction was encrusted with debris (right side of **Figure**

11), and the power cord was found to originate from a dual-head halogen work light (**Figure 12**), which later was found to draw 1,000 watts of power.

Although a winter snowstorm impeded the fire examination, the plug-and-socket junction was retained for further examination (**Figure 13**). An investigator



Figure 3
Interior heavily damaged.



Figure 4
Various contractors' extension cords.



Figure 5
Propane tank and hoses.



Figure 6
Paint cans and propane tanks.



Figure 7
Fire damage from ground floor through roof.



Figure 8
Orange extension cord of particular interest.



Figure 9
Extension cord leading into area of heavy damage.

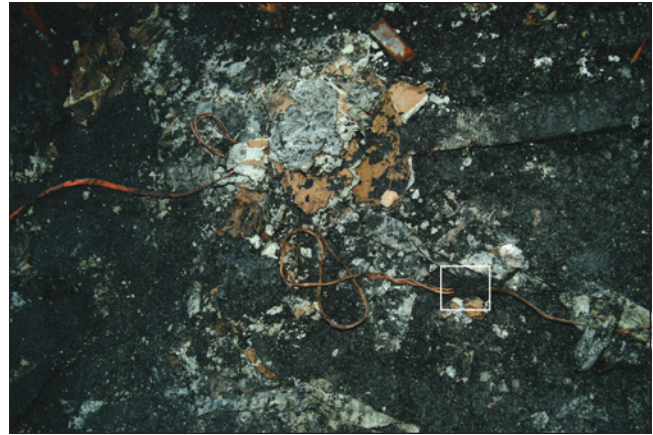


Figure 10
Plug-and-socket junction (at lower right of center).

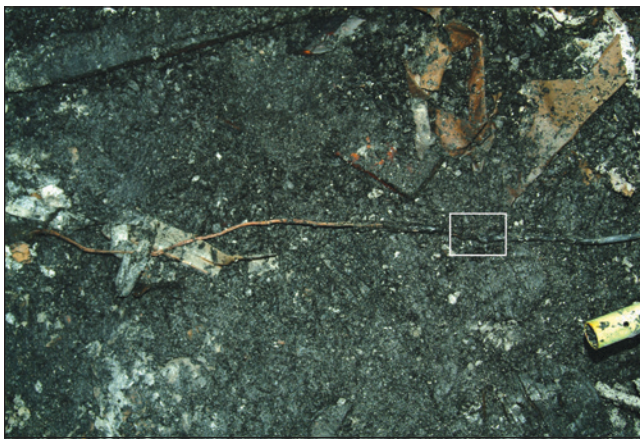


Figure 11
Plug-and-socket junction encrusted with debris.



Figure 12
Work light that was plugged into the extension cord.



Figure 13
Extension cord (on the left), work light cord (on the right).

for the property owner said he had observed a distinct pattern showing an imprint of the allegedly overheated plug-and-socket junction on the wood floor in the upstairs hallway as he cleared the debris for examination. Based on this observation, the investigator claimed that the overheated electrical junction where the work light power cord was plugged into the extension cord was the cause of the fire — and that the fire patterns on the

walls supported his findings. Accordingly, he retained the extension cord and work light and secured them in an evidence locker. Because he believed this electrical junction was the obvious cause of the fire, he did not retain any other evidence.

The extension cord and work light were attributed to one of several contractors who had been working at the site. However, that contractor's fire investigator identified other potential non-electrical causes. For example, he claimed that fire patterns showed the origin of the fire to be at the downstairs level (where propane heaters had been operating) and that the extension cord was merely a victim.

Engineering examination of the physical evidence was delayed by legal issues. The property owner (an individual) brought suit against the builder (a construction company). The individual and the company were insured by different carriers. Several contractors and subcontractors were all brought into the litigation as co-defendants and cross-claimers. In fact,

it took four years to complete all of the depositions, interviews, correspondence, affidavits, motions, and hearings about admissibility of the evidence.

Eventually, the physical evidence was to be made available for examination. When the big day came, the extension cord and work light were unwrapped (**Figure 14**), and the first peek at the allegedly burned electrical junction (**Figure 15**) showed it to be intact and unburned. The debris that encrusted the junction seemingly protected it from damage during the fire. Engineers retained by the accused contractor opined that this physical evidence indicated the contractor's electrical equipment was not responsible for the fire.

Not being deterred, the property owner's expert insisted that X-rays would show there was arcing or some other electrical damage at the junction. As a result, more time and money were spent obtaining high-resolution X-rays. Nevertheless, inspection of the resulting radiographs of the evidence (**Figure 16** and **Figure 17**) showed that the electrical connections between the plug and the socket were perfectly normal

and could not have been the cause of the fire. In addition, when examined under X-ray, the work light (**Figure 18**) and the far end (plug) of the extension cord (**Figure 19**) showed no electrical damage. Two more years transpired due to more expert reports, addendums, explanations, affidavits, and lawyers' correspondence about the matter. Finally, the initial investigator agreed under deposition cross-examination that his interpretation of the floor pattern may have been in error.

It is likely that the imprint he saw on the wood floor was not a burn pattern caused by an overheated junction, but rather the shadow from its area having been shielded from the heat of the fire. Simply put, the investigator may have misinterpreted the negative image as a positive and jumped to the wrong conclusion.

Although the cause of the fire remained undetermined, the investigators for the accused contractor argued that it was not due to the electrical extension cord, and the legal case was eventually settled by all parties.



Figure 14
Evidence when first opened for examination.



Figure 15
Plug (black) and socket (orange) showing minimal damage.

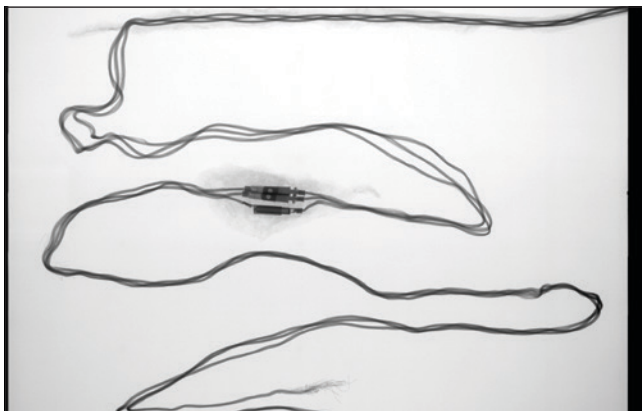


Figure 16
X-rays of power cords forming the junction.

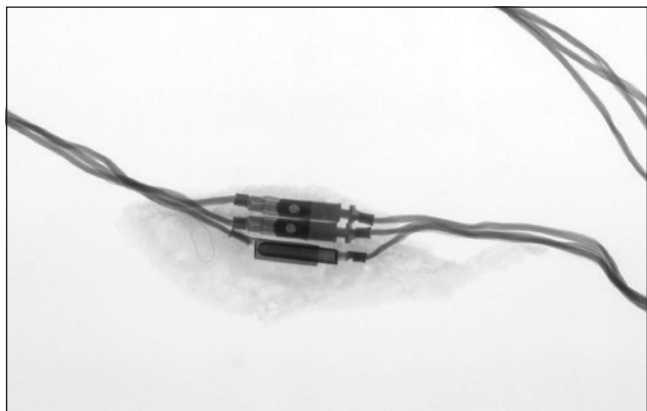


Figure 17
Enlargement showing no electrical defect.

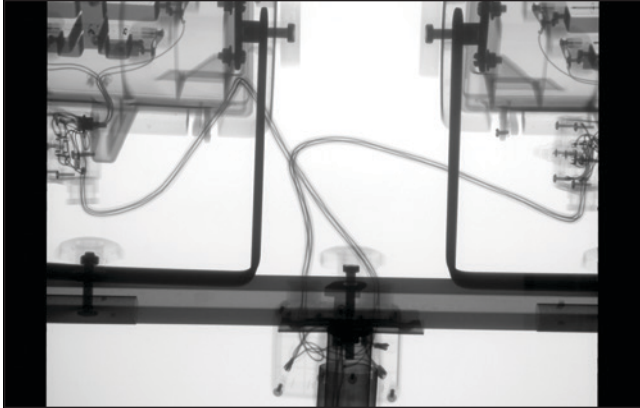


Figure 18

X-ray of work light showing no electrical abnormality.

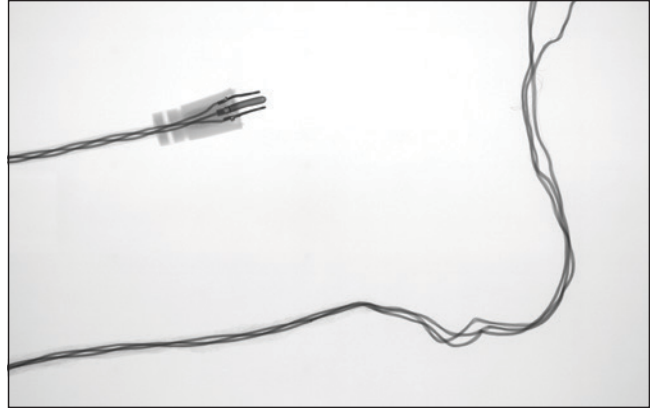


Figure 19

Extension cord plug also showing no electrical abnormality.

Case B, Air Conditioner

Case B (all photographs for this section taken by the author) was a fire that consumed everything in the room of origin. An eyewitness who suffered skin burns said the fire started in a free-standing in-room air conditioner while it was running. In fact, the witness said he saw the fire begin right at the bottom of the unit

and then blossom into a large area of flame before he was able to escape.

Fire investigators preserved the remains of the unit as evidence and presented them for examination (**Figure 20** and **Figure 21**). The allegation was that some electrical defect or malfunction caused



Figure 20

Front view of remains of room air conditioner.



Figure 21

Side view of remains of room air conditioner.



Figure 22

Exemplar of room air conditioner.



Figure 23

Interior of exemplar unit.

the unit to ignite; therefore, the manufacturer was responsible.

With this portable air conditioner (see exemplar in **Figure 22**), room air is blown through the evaporator coils at the top, and outside air is circulated through the interior by plastic ducts that run to an adjacent window. The molded plastic case can be removed to show the internal construction (**Figure 23**).

The exemplar exhibits electrical wiring, a compressor motor, and fan motors (**Figure 24**), all of which can be compared with the evidence unit to locate the presumed defect or malfunction. Upon investigation, such comparison revealed that the bottom of the evidence unit was surprisingly intact (**Figure 25**), considering that the fire was said to have begun there.

Examination of all the evidence, including the power cord (**Figure 26**) and the plug and wall receptacle (**Figure 27**), supported the allegation that

the air conditioner ignited first and spread to the rest of the room. It was curious, however, that the retained evidence was so thoroughly destroyed (**Figure 28**). It appeared as if a blowtorch had been applied to the unit rather than it being consumed in a plastic or wood fire. There was no damage pattern typifying a localized electrical event. Perhaps the air conditioner was merely a victim of the fire that had started elsewhere.

Information was pieced together from many witnesses. Everyone said the fire started near the front corner of the house. The layout of the premises is shown in **Figure 29**. The portable room air conditioner had been running to cool the room. The unit obtained its intake and exhaust from the front window.

The key witness said he entered the room and walked to the air conditioner as shown in **Figure 29**, seeing the flame begin there. Before he could do anything, the unit became engulfed in flames, and he ran out the front door to the street.

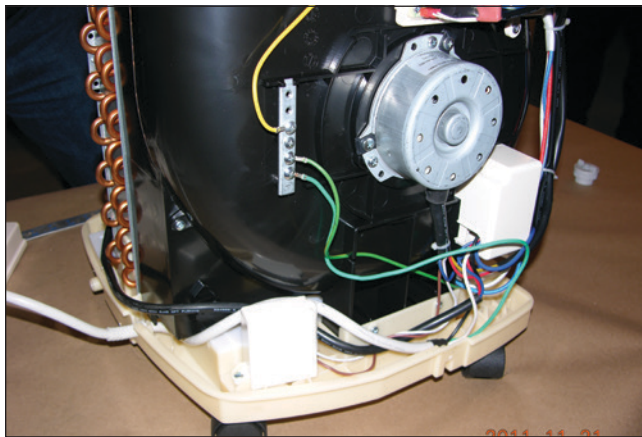


Figure 24
Fan motor and electrical wiring.



Figure 25
Underside of evidence unit showing little damage.



Figure 26
Power cord insulation burned away.



Figure 27
Plug and receptacle burned from outside in.



Figure 28

Evidence of intense fire consuming the entire unit.

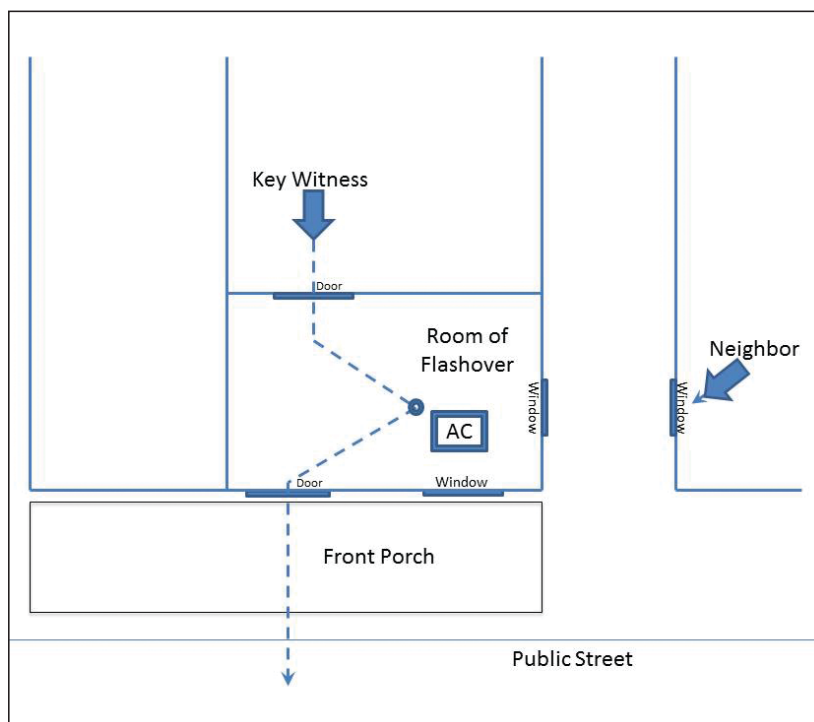


Figure 29

Layout of the house showing witness path.



Figure 30

Inadequately preserved debris from front window.

Shortly thereafter, the room exhibited flashover: nearly simultaneous ignition of the gaseous combustion products from the initial fire. These products would have diffused throughout the confined space. Upon the gases having been brought to a critical concentration and temperature, flashover results in fire damage to every exposed surface in the room.

Despite the simplicity of the defective air conditioner hypothesis, extensive litigation ensued. Buried in the text of witness interviews was a statement by the neighbor that he also saw the fire begin at the front of the house and progress from there into the structure.

An astute investigator for one of the parties obtained a photograph that showed the front of the house was really an enclosed porch, although most of the porch was burned away. This meant that the neighbor actually saw the initial burst of flame in or on the porch, not in the room containing the air conditioner. Incidentally, the house was in an area of town in which fire bombings had occurred in the past, so the possibility of an intentionally set fire was not out of the question.

An alternative hypothesis was offered by engineers retained by the manufacturer: The fire started on the porch and was drawn into the running air conditioner. So, in essence, what the key witness saw was not the initiation of the fire, but rather its first exposure from combustion inside the air conditioner. The ducts between the unit and window were consumed by the fire drawn in from outside, along with the unit's plastic enclosure.

While an electrically ignited fire usually shows a localized area of most intense destruction, this air conditioner exhibited uniform damage. That would be consistent with fire attacking the unit from the burning material circulating within it.

This alternative hypothesis of the air conditioner being the victim could not be disproved, because investigators on the scene had not considered the origin to be on the porch. Little material was retained from outside the window of the room, and that material was not well preserved for examination (**Figure 30**).

The ambiguity as to where the fire started, whether the air conditioner was actually the first combustible item, and why it showed no indication of an electrical defect or malfunction all contributed to the settlement of the legal case.

Conclusion

A fire investigator's initial opinion that "it must have been electrical" does not always prove true once further engineering examination takes place. This paper relates how the extension cord in Case A and the air conditioner in Case B were wrongly accused of being electrical ignition sources for fires. In both cases, other non-electrical events were likely causes.