Electrical Fire Or Junk Science?
By Thomas Williams and Dave McIntyre

Is an arc or a bead definitive proof that an electrical fire has occurred? More to the point, is the shape of the damaged wire a definitive clue that an electrical event took place and was the cause of the fire? The fire investigator is in search of definitive answers. Those answers may prove to be elusive at this time.

We still hear of fire investigators who “eyeballed” the electrical wire and the scene. Based on that examination of the electrical wire they were able to determine the failure mode. It appears to be slightly more problematic than simply “eyeballing” of the electric wire.

This author is not addressing the obvious in which there is a localized fire and a beaded wire in a situation that is indisputable and cannot be anything but an electrical malfunction. The focus of this article is on full room involvement and damaged wires. Determining whether the damaged wire is “cause” or “consequence” of an electrical event has been the source of numerous studies, articles, and investigations. NFPA 921 includes a section on electrical fires*. A review of the scientific literature makes it obvious that the scientific community is not as certain as to determining cause and consequence in full room involvement as one might expect.

Dr. Vytenis Babraukas, one of the pioneers in employing science to fires noted “none of the proposed methods are promising”** in referring to several studies with regard to fire investigations and arcs and beads on wires. Over the years the authors have studied several test methods proposed to determine which came first - the arc or the fire. We hear terms such as elongated bead, change in color of copper, and other methods. The field investigator all too often “eyeballs” the wire and comes to a dramatic conclusion. It would appear that the worst method of determination is “eyeballing” of the wire. That method may be as reliable as using a divining rod to find water.

*NFPA 921 includes a section on electrical fires.

**None of the proposed methods are promising.

Figure 1: The question in this localized fire is one of determining if the failure mode of the wire is case or consequence.
There have been several methodologies presented over the years purported to be able to make conclusive determinations based on the gas content or molecular content of the beaded globule at the end of a copper wire. These methods were presented to put forward a scientific and conclusive way to determine if the wire was cause or victim of a fire. They appear to fail the test of rigorous scientific review.

Dr. Robert Anderson used a technique called the Auger electron spectroscopy method to do analysis***. There were other methods that have been used including electron spectroscopy for chemical analysis (ESCA). Examination of ion mass spectrometry has been used. In all of the aforementioned techniques a sample of the copper globule is sent to a laboratory and examination is made of the layers of the globule after the upper portions of the copper are etched away. Studies are then made, depending on the method, of the ion content, oxygen content, encapsulated in the bead, or chlorine in the bead.

We call your attention to the fact that no method leaves the analysis to a field investigator to simply "eyeball" the copper wire remains that are suspect.

There is an assumption made by the various disciplines that the globule is frozen in time once formed and that content can give definitive information. That presents a dilemma in full room involvement. A fire of full room involvement can reach a temperature over 2000 degrees F. Copper melts at approximately 1890 degrees F. The products of a modern house include styrene's, polyurethane, and enough other material that the heat release rate (HRR) is spectacular and probably can compare to gasoline in preflashover conditions.

There have been studies with regard to the grain of the copper or crystal structure in wire exposed to fire as opposed to the copper crystallization following manufacture.

The studies and evidence give few conclusive answers as to "cause" or "consequence". In fact, the reading and review of the literature leaves one in a dilemma. More to the point it leaves the on site investigator with a healthy respect for the fact that a scientist may come along and dispute your findings. It appears that they may have an abundant amount of evidence to support opposing theories. Caution is the operative word here. With the federal court Judges as "gatekeepers" of expert witnesses under Daubert rulings, a fire investigator should be prepared for a rough ride if a challenge is mounted in an electrical fire and there is no real science behind the conclusion.

** = Babrauskas, Dr. Vytenis, Fires due to electrical arcing: can "cause" be distinguished from "victim" by physical or chemical testing. Fire and Science Technology

Thomas Williams is a New England State Police Sgt and a Master Diver. He has attended numerous courses and conferences on fire origin and cause as well as engineering programs on computer modeling. He is a certified Fire and Explosion Investigator and the author of numerous articles on fire cause and origin and evidence preservation.

Dan McIntyre is a Professional Fire Fighter for the City of Troy, N.Y. He is also a certified Fire Investigator and a twelve-year veteran of NYS fire investigations. He is the author of numerous articles on fire investigations. He is a staff member of Corporate Investigative Services and has served as the Director of Investigations for the past ten years.