ALERT
OCTOBER 24, 2012

SUBROGATION AND RECOVERY
News Concerning
Recent Subrogation and Recovery Issues

COZEN O'CONNOR
www.cozen.com

ATF Critiques Electrical Arc Bead Recognition Study

John E. Flaherty • 312.382.3138 • *jflaherty@cozen.com*

The Bureau of Alcohol, Tobacco & Firearms Fire Research Laboratory recently issued a Technical Bulletin (Tech. Bull. 001- 09/28/2012) critiquing the National Institute of Justice funded research report by Dr. Richard Roby of Combustion Science & Engineering, Inc. titled "*Forensic Investigation Techniques for Inspecting Electrical Conductors Involved in Fire*." The objective of the research was to determine if distinguishing characteristics existed between beads formed on energized and non-energized copper wires subjected to various types of fire exposures. The research report ultimately concluded that NFPA 921 definition of a *bead* was in error and required revision based on the findings of the research. NFPA defines a *bead* as:

> A rounded globule of re-solidified metal at the end of the remains of an electrical conductor that was caused by arcing and is characterized by a sharp line of demarcation between the melted and un-melted conductor surfaces. (2011 NFPA 921, 3.3.15)

It is the contention of the research report that beading on electrical conductors can be formed on energized and non-energized conductors alike and that there are no physically distinguishing characteristics to differentiate the causation. The ATF Fire Research Laboratory takes issue with the methodology of the study, results and conclusions. The ATF Technical Bulletin suggests under the right circumstances, fire investigators can visually differentiate between fire and arc melting when examining electrical conductors.

Testing Scenarios

The research study undertook four testing scenarios, direct flame impingement tests, radiant tunnel tests, 2/5-scaled compartment tests and full scale compartment tests. The researchers exposed four types of wire, 12 through 18 gauge, stranded and un-stranded wire in energized, energized with load, and non-energized electrical states in each of the four tests. The direct flame impingement test was set-up using a Benzomatic Max Power Propylene torch that produced a flame temperature of 1300 C at the point of contact with the wire samples. The melting temperature of copper is 1082 C. The radiant tunnel test exposed the four wire types in the three electrical scenarios to temperatures between 1050-1100 C. The ATF Fire Research Laboratory was critical of the two aforementioned tests in that they failed to reasonably represent a residential compartment fire. The tests conductors were exposed to heat and flame in a highly localized area, which is not typical of residential compartment fires. Furthermore, the ATF Fire Research Laboratory noted that temperatures in residential post-flash-over compartment fires do not routinely reach temperatures capable of melting copper conductors.

The 2/5-scaled compartment test again subjected the four types of conductors under three different electrical scenarios. The preliminary tests of the 2/5 scaled compartment test concluded that the maximum temperature reach within the compartment was only 930 C, insufficient to melt the copper wires. The researchers increased the temperature within the compartment using a forced air blower to increase the amount of oxygen available for combustion. The ATF Research Laboratory cites the artificial increase in temperature to cause temperatures capable of melting copper wire is inconsistent with conditions typically observed in a residential compartment fire. Furthermore, the ATF Research Laboratory stated a residential compartment fire that attains sufficient temperatures to melt copper does not guarantee that the conductor will melt. The heat transfer from the gas of the fire to the copper conductor requires time to allow the melting to take place. The combination

of the highly localized exposure in the testing scenarios combined with the higher than anticipated temperatures created a heat transfer rate that was greater than expected in a standard residential compartment fire. The study's analysis of the melted globules failed to identify visual evidence of thermal melting such as effects of gravity and blistering. Significantly, the ATF Fire Research Laboratory pointed out that the beads on the energized conductors of the tests met the current NFPA 921 descriptions of an arc bead, which the study failed to emphasize.

Deficiencies in Dr. Roby's Report

The deficiencies in the research study were most prevalent when compared to the study's test results from the full compartment test. The full compartment test was performed at the National Fire Academy in conjunction with the academy's fire origin and cause investigation course. The full compartment tests did not reach temperatures exceeding 950 C, which is typical of a residential compartment fire. The research study noted that the production of beads on the non-energized wires in the full scale compartment test was minimal and admitted that the lack of bead production occurred because the compartment did not exceed 950 C. The full scale compartment test was the one test environment that was most consistent with actual residential compartment fire conditions yet failed to produce beads on non-energized copper conductors contrary to the stated hypothesis of the study. Thus, the conclusion of the study is based upon unrealistic fire scenarios with temperatures exceeding those normally seen in a typical residential compartment fire.

On-Going Research

The appropriate identification of damaged conductors continues to be studied and reviewed in the realm of fire investigation and was the recent subject of a NFPA Task Group. The ATF Fire Research Laboratory advises analysis of arc melted conductors should be made after considering all the evidence from the scene investigation and should be consistent with evidence collected. A proposal was made to the NFPA 921 Task Group to improve the physical description of arc melting that can be identified in the field to include:

- Sharp line of demarcation between damaged and undamaged area
- Round smooth shape
- Localized point of contact
- Identifiable corresponding area of damage on opposing conductors
- Copper drawing lines visible outside the damaged area
- Localized round depressions
- Small beads and divots over a small area

Likewise, a proposal was made to improve the NFPA 921 descriptions of melted copper conductors due to heat to include:

- Extended are of damage without a sharp line of demarcation from undamaged material
- Visible effects of gravity in the artifact
- Blistering on the surface
- Gradual necking of the conductor
- Non-localized loss of integrity of individual strands on stranded conductors.

Fire investigators should familiarize themselves with the NFPA 921 definitions and descriptions of arc melted copper conductor and continue to keep abreast of the current research and training on this issue.

To discuss any questions you may have regarding the ATF Technical Bulletin discussed in this Alert, or how it may apply to your particular circumstances, please contact John E. Flaherty at jflaherty@cozen.com or 312-382-3183.