**Antler Lecture 2005**

**The Evolution of Arc Fault Circuit Interrupters**

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Traditionally circuit breakers and fuses have provided overcurrent and short circuit protection in electrical distribution applications. Despite this protection, approximately 70,000 residential fires with more than 500 deaths and $1B in property damage occur each year in the U.S. that are attributed to electrical initiation. When investigated it was found that in some cases the circuit breaker had not tripped. The need for enhanced protection was recognized in the early 1990’s. The EIA, Consumer Products Safety Commission, Underwriters Laboratories, several major industrial electrical manufacturers and some forensic fire investigators became advocates for enhanced safety and did research and development to understand the phenomena involved and find practical solutions. It was found that if an electrical cord were damaged, intermittent and sputtering arcing could be initiated with characteristics that would not cause an rms sensing device to open the circuit. This was because the rms values of these faults could be much lower than the overload time current curves for which the devices were designed to respond. In the presence of suitable combustible materials, this arcing could continue until a fire was initiated. This was the initial thrust for the development of arc fault circuit interrupters (AFCI). AFCIs can recognize the unique signatures of arcing faults and initiate a trip condition to isolate and de-energize the arcing fault. These AFCI circuit breakers were first introduced in 1999 as described in the IAEI article “Arc- Fault Circuit Interrupters” by Dr. Clive Kimblin, Dr. Joe Engel and Bob Clarey. This paper will identify the conditions that can lead to fire hazards. These include arcs to ground, wiring failure modes, earth leakage conditions and high resistance faults such as glowing contacts, and in-line low current arcs (sometimes referred to as series arcs). The development of standards and codes for arc fault protection will be discussed together with the efforts of manufacturers, and organizations such as the National Association of State Fire Marshals (NASFM) and CPSC, to have the devices installed in residences. During the last six years, millions of devices have been installed in the field and the performance record has been excellent. NASFM has been most supportive in encouraging adoption of this technology. We continue to learn more about arc-fault fire initiation mechanisms and our current