

Faster Detection Adds Safety

New technology speeds arc flash detection, allowing employees to do more of their work with the minimal PPE needed.

BY NELLA LETIZIA

The three electricians from the International Brotherhood of Electrical Workers (IBEW) Local Union No. 5 related variations of the same experience:

At a building, Jon Beley was closing a disconnect door next to his working partner, Don Stewart. In an elementary school's boiler room, Andy Tomko had just disconnected a defective switch for a bucket retrofit. Each man saw an intensely bright light, heard deafening noises, and felt an explosion, all in an instant. Each suffered terrible, life-threatening injuries that kept them in the hospital for

times hotter than the sun's surface. Along with the intense heat, an arc flash generates enormous explosive force. Even a relatively small 10,000-amp arc at 480 volts can create an explosion equivalent to 8 megawatts, or roughly eight sticks of dynamite.

OSHA and other federal agencies track electrical accidents of all kinds, but not arc flash incidents specifically. The Institute of Electrical and Electronic Engineers (IEEE) and the National Fire Protection Association (NFPA) are working to change that through a collaborative research project to conduct extensive testing on arc flash⁵. At present, only data on all electrical accidents are available.

Between 1992 and 2002, 3,378 workers in the United States died and 46,598 were injured from electrical events on the job⁶. Of those individuals, 1,436 fatalities and 32,878 injuries resulted from contact with electric current of machines, tools, appliances, or light fixtures or contact with wiring, transformers, or other electrical components. Quantifying the economic impact of non-fatal electrical injuries is difficult. Using cost estimates between 1990 and 1992⁷ and between 1986 and 1992⁸, one paper suggests that the cost to U.S. employers from 1992 to 1998 was between \$500,000 and \$189 million each day⁹.

Ideally, the best way to reduce arc flash hazards is to work on de-energized equipment, but electrical workers can't always control whether the equipment is energized or not. One solution is applying protective relays on elec-

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– Bob Hughes, senior marketing engineer at Schweitzer Engineering Laboratories

many painful months.

“I would have to say that my family didn't deserve that mistake that I made,” Tomko said in an interview for a video by the National Institute for Occupational Safety and Health (NIOSH)¹. “If you could actually see this light and explosion that take place and the devastation after the fact — if you could witness that, you would never work on anything that was hot.”

According to an AVO Training Institute white paper and research by electrical safety pioneer Ralph H. Lee^{2,3,4}, an electrical arc occurs whenever insulation breaks down between phases or ground. Electrical workers performing tasks inside energized electrical equipment, with or without conductive tools, can cause an arc if they make contact between phases or phase and ground. Arc temperatures may reach 35,000 degrees Fahrenheit, or four

trical systems that quickly detect arc-flash conditions and send a trip signal to a circuit breaker to interrupt current. But what is quick in terms of an arc-flash event? Even a half-second trip time is too long. Arc faults must be detected in bare milliseconds, matching the speed of arc-flash light.

Detecting Arc Flash More Quickly

Interrupting arc-flash energy very early reduces this hazard significantly, according to Bob Hughes, senior marketing engineer at Schweitzer Engineering Laboratories (SEL). Adding a new arc flash detection technology to a feeder protection relay dramatically cuts the time it takes for the relay to detect and send a trip signal to a circuit breaker, thereby interrupting arc flash current that much faster. The key to the technology is combining the relay's

overcurrent protection with a fiber-optic light sensor, providing the fastest fault detection and tripping possible and eliminating false trips from lighting unrelated to an arc flash.¹⁰

When an arc flash is triggered by a line-to-ground short, for example, fault current travels from the source, through the arc flash, and then to ground. Shortly after the fault current begins, the arc flash produces a very bright flash of light, which the relay's light sensor picks up. Sensing the flash and the overcurrent condition simultaneously, the relay issues a trip signal to the circuit breaker in as fast as 2 milliseconds. The breaker then clears the fault.

Without this arc flash detection technology, Hughes said, the relay doesn't send a signal to the breaker for a much longer period of time: 667 milliseconds, or two-thirds of a second.

"This is the difference between someone who sees a flash, hears the boom, but can go home to tell his family about it afterward and someone who ends up being in a hospital in a coma for nine months, which is what would happen if this technology wasn't there," Hughes said.

In January 2009, Hughes and other engineers from the company tested relays equipped with arc flash detection technology at Kinectrics' High-Current Lab Facility in Toronto, Canada.

In one notable case, Kinectrics' evaluators conducted a personal protective equipment test simulating a single-phase arc fault at 3,000 volts and 5,000 amps, with a mannequin dressed in arc flash PPE standing about 3 feet from the electrodes. The relay immediately detected the arc flash and sent a trip signal. The test continued for five cycles, or 83 milliseconds, the time it takes for a breaker to clear a fault once it receives a trip signal. The mannequin's flame-resistant shirt and faceshield showed no damage afterward.¹¹

The same test with arc flash detection disabled continued over 46 cycles, or 750 milliseconds — the time it would take a relay without light-sensing capability to send a trip signal to the breaker, plus the time for the breaker to clear the fault. Inspection of the mannequin's PPE, not rated for the arc flash hazard risk category of the test, showed extensive burning on the front of the flame-resistant shirt.¹²

Arc Flash Detection Adds to Productivity

Adding arc flash detection to a feeder re-

lay already in the field costs roughly \$700, slightly more than the Category 4 PPE "moon suit" electrical workers would wear to protect themselves from arc flash hazards, Hughes said. Such gear can include an arc flash coat, bib overalls, and protection hood with faceshield, all meeting the requirements of NFPA 70E, *Standard for Electrical Safety in the Workplace*. But it is difficult to work in PPE for this hazard risk category.

"Customers are telling me that Category 2 PPE — cotton flame-resistant clothing — is

easier to work in, and they can be more productive," Hughes said. "So there's a productivity issue there that this technology can bridge. You can do more of the work you're supposed to do with the minimal protection needed."

But arc flash detection technology is primarily concerned with gaining precious time, time that will save more lives and prevent serious injuries. IBEW electrician Jon Beley knows it is not a question of whether an arc flash incident will happen, but when it will.



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While recovering in the hospital after his accident, he talked to electricians who had their own arc flash stories. Most of them walked away unharmed. "It would probably be hard to talk to an electrician that never was exposed to an arc that he had caused or was around," Beley said in the NIOSH video. "Now, we as electricians should know this and be ready for it. . . . We may not stop them from happening, but we can stop them from hurting us." **OHS**

Nella Letizia, a technical editor at Schweitzer Engineering Laboratories in Pullman, Wash., has almost 25 years of experience writing and editing for publications as a newspaper reporter, magazine associate editor, university feature writer, and freelancer. She can be reached at Nella_Letizia@selinc.com. The author expressed appreciation to SEL's Bob Hughes, Mark Zeller, Donna Smith, and James Smallwood, as well as AVO Training Institute Director Dennis Neitzel and Cap-Schell Inc.'s Dr. Mary Capelli-Schellpfeffer, for their assistance with this article.

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