

The Right Stuff

To help electrical workers around arc hazards, companies are forging partnerships with product suppliers.

by Hugh Hoagland

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Dennis Murphy, a Guarantee Electrical Company (GECO) electrician, was burned badly in an arc flash incident in 1994 while working on a 480V panel. Like most companies, GECO was not fully aware of the hazards associated with arc flash. Some electricians wore cotton, but most wore a poly-cotton uniform. "If GECO had realized the hazard of the uniform, they would never have bought them," says Dean Kermicle, GECO's safety director. Tim Loy, a Project Foreman at GECO, said they had been looking for the "right stuff" to wear since that accident.

Murphy is still employed at the company. After years of recuperating and multiple skin grafts, finally he can wear short-sleeved shirts this year without substantial pain. That makes his pastimes much more comfortable in the summer. His most severe burns were on his arms and face. Most of Murphy's second- and third-degree burns were caused by the melting and burning of his shirt when it was ignited by an electric arc in the panel.

Steve Pivinski also works for GECO, but the arc in which he was involved recently is another matter. He and Mike Fanning were in an electric arc accident in an automotive plant, and Pivinski's exposure was similar to Murphy's. Before the National Fire Protection Association 70E standard (also known as the National Electric Safety Code) was published this year, GECO had been looking for "the right stuff" because of Murphy's accident. GECO had purchased FR clothing for higher voltage applications and had moved to work clothing of 100 percent natural fibers. But they still needed a lightweight, reasonably priced protective system for their workers to wear when working lower voltage energized parts and equipment.

GECO teamed up with Larry Berry at Shannon O'Tools and Safety (www.shannonotools.com), who had been working with NASCO, a manufacturer that had developed a lightweight, arc-resistant raingear material suitable for many electrical applications. Berry told the GECO team about a two-man kit he had put together to help protect workers for low voltage live work. GECO bought them for all of its teams.

The managers at Guarantee were not reacting to a standard; the 70E standard helped them find a solution. The increased education they received from salespeople in the field put the "right stuff" in the hands of a few hundred electricians. The "right stuff," in their case, was an arc-resistant faceshield and an arc resistant suit.

Many options are available on the market today. Many electricians are switching to flame-resistant clothing and to arc-protective jackets, faceshields, and hoods for high amperage electrical work. As in the case of these accidents, it is not just the high voltage work that is

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hazardous. Arc potentials are usually greater on the secondary side than on the primary side of the transformer, so electricians face as great or greater hazard as a utility lineworker does.

Having a good partner and up-to-date technical information is a key to safety today. Neither OSHA nor NFPA can educate everyone. The Internet is helping by vastly increasing the information on safety Web sites, but the "right stuff" is more often found in working with a safety partner who supplies products to your company to help you find solutions.

Inside the National Electric Safety Code

The information in the new National Electric Safety Code is hitting the streets and building awareness of protective options for the electric arc hazard. NFPA 70E was published April 15, 2000, and is available online at www.nfpa.org. (Search for 70E; you can download it or order a hard copy.) The new 70E is doing for industrial electricians what 1910.269 has been doing for the utilities, but there are important differences.

National Electric Safety Code (70E) 2000 Version	Electric Generation, Transmission & Generation Apparel Standard 1910.269
Applies to all electricians. May not be law in every state.	Applies to maintenance work done on generation, transmission, and distribution equipment. Construction work is covered by Subpart V and will likely be the same as 1910.269 in two years.
New 2000 version is a protective standard that provides help with hazard assessment, including a job table with protective clothing requirements.	A "non-contributory" standard. Requires employers to ensure workers do not have on clothing which may "increase the extent of the injury" of any worker exposed to electric arc and open flame.
Flame Resistant Clothing (FRC) is required and five protective levels are specified. Follows latest published information on arc hazards from IEEE (Institute of Electrical and Electronic Engineers) papers.	Does not require flame-resistant clothing, but that is a simple method of compliance.
In-depth hazard assessment guidance.	Hazard assessment is the most difficult part because there are no guidelines given.

Learning from an Arc Incident

Bob McGregor, Safety Director of a St. Louis chapter of the Bethesda, Md.-based National Electrical Contractors Association (www.necanet.org), has been working with contractors and local unions to get the workers into the "right stuff," too. He has been talking with electrical

contractors about Pivinski and Manning's accident because it will help drive home the fact that workers wearing the right clothing can walk away from accidents.

McGregor has been working to train and offer training experiences for the electricians for some time. Partnering with clothing suppliers and flame-resistant clothing specialists has been helpful. "Training is the key, but a story is the most effective way to get the point across," he said. "We'd rather have stories like Steve's than one like Dennis'."

The new National Electric Safety Code moves the focus toward flame-resistant clothing and away from a non-contributory focus to a protective focus.

IBEW Local 1, Pivinski's local union in St. Louis, says no one should get burned, adding, "Prevention is the answer, but employers who provide the right clothing and the right training is the most practical way because there are equipment failures that we can't predict."

This is how their accident happened:

The 1600A bus had less than the needed clearance and the ground fault was substantial. The energy received on Pivinski's and Fanning's arms was around 15 cal/cm². This is equivalent to an 8000A, 12-inch arc, clearing in 15 cycles with the worker about 12 inches away. The arc Pivinski and Fanning received was enough to ignite a cotton blue jean or any heavy cotton shirt. FR clothing was critical.

Pivinski and Fanning also had something in their favor. They were wearing a new faceshield that has arc-resistant properties. The faceshield was a polycarbonate shield with a slight green tint with IR and UV blockers. The faceshield received between 1 and 7 cal/cm² and prevented their faces from being burned. 70E would have required a faceshield for this operation. According to the 70E Standard, "FR clothing and Protective Equipment . . . includes shirts, pants, coveralls, jackets, and parkas worn . . . by workers . . . exposed to momentary electric arc. . . . Arc and flame resistant rainwear (are) included."

Typical Protective Clothing Systems			
Hazard Risk Category	Clothing Description (number of clothing layers is given in parentheses)	Total Weight, ounces/yd ²	Minimum Arc Thermal Performance Exposure Value (ATPV) or Breakopen Threshold Energy Rating of PPE, cal/cm ²
0	Untreated cotton (1)	4.5-7	N/A
1	FR shirt and FR pants (1)	4.5-8	5

2	Cotton underwear plus FR shirt and FR pants (2)	9-12	8
3	Cotton underwear plus FR shirt and FR pants plus FR coverall (3)	16-20	25
4	Cotton underwear plus FR shirt and FR pants plus double layer switching coat and pants (4)	24-30	40

Reprinted from NFPA 70E, see standard for notes. There are clothing systems which will protect to 40 cal/cm² in two lightweight layers. This table is designed to be properly used with any non-melting flame-resistant material. Many materials can outperform the table.

Arc Lessons

Many companies have been researching the electric arc for several years. We have learned a lot about preventing burns from arcs, but the best thing is to prevent the arc or greatly reduce its energy. New instantaneous breakers, touch save equipment, and new faster fuses are offering the opportunity to make the work safer--but very few of these new technologies are in place.

Here are some critical lessons about the electric arc:

The right stuff is non-igniting. OSHA hasn't made flame-resistant clothing (FRC) mandatory, but that is the easiest and safest way to comply with the standards for electric utilities. The new National Electric Safety Code moves the focus toward FRC and moves away from a non-contributory focus to a protective focus. OSHA's language has been of the non-contributory type when it says that workers exposed to electric arc shall not wear clothing that will "increase the extent of the injury." Arc-resistant FRC will always meet this standard if it meets the ASTM F1506 standard.

Non-igniting materials can be critical in electrical injuries.

When thinking of FRC in the electric arc, many don't consider the statistic that 77 percent of electrical injuries in a University of Chicago Electric Trauma Research Study included arc injuries. In the past two months, I have received information of two workers in FR shirts who received contact injuries that did not cause ignition of their clothing and prevented the kind of injury that was often blamed on the contact. When clothing ignites during a contact, it multiplies the injury. Non-igniting materials can be critical in electrical injuries.

The right stuff is non-melting. I have long worked on eliminating melting raingear from work around electrical hazards, but there are many other melting hazards from exposure to arc:

Winterwear should be non-melting, and undergarments should be non-melting. Many accidents have been made worse by melting winterwear.

A recent accident had a worker burned on his chin, face, and cornea when the lining of his winterwear burned up onto his face. I have long promoted eliminating melting undergarments from electrical workers such as poly cotton T-shirts, polyester or polypropylene undergarments, and melting materials in bras and underwear. In my presentations many listeners thought this was funny, and I facilitated the humor but emphasized the seriousness of the possibilities. In the past three months, I became aware of two accidents by e-mail, where women were wearing FRC and received burns from a melting bra material.

When choosing undergarments, limit elastic to necessary elements and eliminate as many metal parts as is possible. One woman was burned badly by the underwire. Cotton and silk are the best options for bra materials. Cotton is more available and silk has less ignition risk. Wool may work well for winter undergarments, but there are many new FR winter garments available now. Silk long underwear, one of the skiers' favorites, should be excellent. Just avoid any silk blended with synthetic fibers unless they have been arc-tested to determine their performance.

The right stuff is better when layered. Layers of FR clothing usually are much better than the same weight in one layer. This is due to the air gap and the ablative effect. Ablation is when a layer is removed by the arc in the explosion and carries energy away from the body. Some FR materials do this better than others. Nomex tends to double its protection when used as an outer layer. A new FR cotton-nylon blend has been shown to perform similarly.

Proper care is critical to maintain the FR integrity of all FR garments.

The right stuff should be wearable. Materials that are too hot, too heavy, too tight or non-absorbitive to sweat are more difficult to wear. Vast improvements have been made in materials in the past three years. Aramid-FR rayon blends are prevalent and capturing market share along with the new FR cotton-nylon blends. There are many very comfortable materials on the market, better pricing, and their protection is growing.

The right stuff should be tested. Many materials claim to be FR that do not perform in the electric arc. The most prevalent is melting "FR" materials. Materials which work in the electric arc should not be made of nylon or polyester unless they have been shown to perform well in electric arc conditions. Some nylon fall protection does extremely well; others do not. Melting rainwear does not perform well in the electric arc. Rainwear should meet the ASTM F1891 rainwear specification at a minimum, but avoid any nylon or polyester materials that claim to meet this standard because they can melt onto a worker's face in the explosive force and heat of the arc. Other clothing materials should meet the ASTM F1506 standard if you are using FRC.

The right stuff should be durable, cost-effective, and properly cared for. The first points make sense, and the last is also critical. Proper care is critical to maintain the FR integrity of all FR garments. Though there is little chance of "washing out the FR" of any of the major materials on the market today, the FR integrity can be compromised by using chlorine bleach, washing

Aramid fabrics with cottons, failure to remove oils in the cleaning process (difficult in home laundering and not accomplished by some industrial launderers; sorting by soils and proper wash formulas and water temperature are critical), or failure to repair garments properly.

Make sure you get the "right stuff" by educating yourself on the issues and finding the right partner to search out the materials for your hazard.

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