

# NESC 2007 FLAME RESISTANT CLOTHING

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The NESC 2007 standard sets forth quite a challenge to electric and communication utilities in the area of clothing. The new standard, which becomes law in several states, says, "The employer shall require employees to wear clothing or a clothing system that has an effective arc rating not less than the anticipated level of arc energy." This compliance is required by January 1, 2009. The following challenges will require strategies and decisions by utilities to comply with the NESC standard.

## Challenge 1: What about face protection?

The standard doesn't address this at all, leaving many utilities confused. Even though NESC doesn't address it, OSHA general requirements for PPE require addressing protection of any body part exposed to a recognized hazard.

There are four approaches. One is to ignore the face protection issue. Until something happens or OSHA makes a clear statement on this issue, some companies refuse to move at all. However, inaction can be detrimental to employee safety and morale. The NFPA 70E approach is to require face protection at 4 cal/cm<sup>2</sup> exposure (HRC 2 exposure bottom limit), but the 2009 version is set to make a change of this to require face protection at 1-2 cal/cm<sup>2</sup> exposure. NESC doesn't address face protection but requires clothing protection at 2 cal/cm<sup>2</sup>. Some utilities are citing a study by Alan Privette showing that arc flashes generally require almost 3 cal/cm<sup>2</sup> to cause a second-degree burn when the exposure time is less than 0.5 seconds. Some utilities are choosing not to implement face protection at low-level exposure to allow line workers to have less constraint on their vision in doing hot line work in lower energy exposures (of course safety glasses will still be required at all levels).

The second approach is to require a face shield. This is an approach that is easier for meter service, substation workers and power plant workers but more difficult for line workers when climbing. Using a face shield when working from a bucket is easier than when climbing, but there is strong resistance from linemen and management for using a face shield in T&D because of fogging and other issues. From a protection perspective the face shield alone leaves part of the face and neck unprotected in some scenarios. Energy can come up under a face shield, especially when the worker is looking up (think about an older worker using his or her bifocals). Currently, this is the most frequently considered option.

The third approach is a newer one. Just two years ago Paulson Manufacturing and Salisbury came out with an Arc Goggle. The goggle is designed to be used with a balaclava to protect the face. Currently, NSA (National Safety Apparel) has a rating on a goggle/balaclava combination and Guard-line has a balaclava designed to totally interface with the arc goggle. The best design is to have a balaclava that leaves no skin exposed to the arc. This approach allows for full face protection and is less costly than most hoods designed for use over a hard hat and easier for the average line worker to wear. It also eliminates the additional hazard of shock when wearing cloth over a hard hat. Most utility rules would make this unacceptable in hot gloving line work. The other huge advantage is the price of the goggles, which is in the \$100 range. Goggle and balaclava should be tested in accordance with ASTM F2178 as a hood assembly to ensure compliance and should be used in the configuration tested.

The fourth approach is to use arc flash over-the-hard-hat hoods. This is common in industrial plants where live-line medium voltage work is very uncommon. In substations, many vault situations and power plants, these types of hoods are very simple to implement. However, it is impossible for many line worker situations. Arc flash hoods are actually a hazard for line workers for several reasons. First, arc flash hoods are NOT dielectric and would be on the outside of the hard hat/hard cap. When it's raining or wet (storm restoration work), the arc flash hood would be an additional shock hazard for the line worker. Additionally, the limited vision, fogging and reduced hearing are issues that the goggle helps limit while still providing 360° protection to the head, neck and face. The current hood/goggle combo is rated 38 cal/cm<sup>2</sup>, but with a design that can be worn underneath the dielectric hard hat and not increase shock hazard. These are also less susceptible to fogging than many of the hood systems.

## **Challenge 2: Arc Flash Hazard Calculations**

Utilities have a great challenge in this regard. Utilities were the first industry to do large scale arc flash studies and calculations. Duke Energy developed the first arc flash calculator and Ontario Hydro further perfected this type of tool in the ArcPro software introduced in the mid-1990s. But most of the utility research stopped there. Now there is a reasonable consensus standard for industrial settings in IEEE 1584, but this standard has many weaknesses for utilities. In the 480V range it can be helpful, but the NESC 2007 does not require calculations for the secondary system opting for a comprehensive flame-resistant clothing requirement for all secondary hot work.

IEEE 1584 is due for a major overhaul (funding is about 50% complete), but the current plan still focuses on industrial electrical systems and has no current plans to include

transmission voltages at all. EPRI has considered a utility-focused study but funding is not yet in place.

Some arc flash correlation work has been done on transmission lines. This work has been incorporated into ArcPro calculations, so they are still the most accurate for T&D. ArcPro's limitations are speed and ease of use. No software company has yet to incorporate ArcPro modeling into a CAD/CAM system for utility use like the IEEE 1584 equations. Several companies have the IEEE 1584 formulas built right into their software so an industrial plant (or even a power plant) can model their system with software like SKM, EasyPower, or EDSA.

ETAP and Milsoft are both more focused on utility design and have recently added IEEE 1584 to their packages, but this is not the best option for utilities on the primary side particularly. With these types of packages, the engineer can do a fault current and coordination study and an arc flash study including printing of labels in the software. This will be the method in the future and the leading software companies are rushing to fill this need for utilities as they have been doing for the industrial world.

Since IEEE 1584 has no data in utility ranges, it reverts to extrapolations from mostly lower voltage data or antiquated equations that, though adequate for limited use in an industrial plant, will not work for utilities. Testimony to OSHA points out that these equations predict second degree burns from 500 kV transmission lines at 46 feet away (they are only required by law to be 40 feet off the ground). To my knowledge, no one has ever been burned this far away by an arc in these lines.

The NESC 2007 has Tables 410-1 and 410-2 giving arc flash guidance and requires performing an arc hazard analysis. Most companies are opting to do their analysis using ArcPro 2.0 from Kinectrics, since the NESC tables only cover some of the T&D situations. The numbers from these tables came from ArcPro calculations, so using ArcPro is a reasonable approach.

### **Challenge 3: Upper torso protection in summer balanced with heat stress issues**

A note in NESC acknowledges that this could be an issue and allows for exemption if the company determines something like heat stress is a greater hazard, but it is not defined. Three options are being seriously considered by most utilities.

Flame-resistant t-shirts for non-energized work and adding a FR long-sleeved shirt for

additional protection. NSA, Workrite, Bulwark, Tyndale and others offer flame resistant t-shirts. Three options are on the market today: GehringGuard™ is a new lightweight material developed to help protect Marines from IED attacks, Pro-CFR™ Knit from SSM has captured a large market share since its inception, and Indura UltraSoft Knit has entered the market in the past two years and is gaining market share. Additional clothing such as arc flash raingear or coveralls. NASCO or Neese are two common brands (See Using Rainwear as a Switching Jacket by Hugh Hoagland, IEEE 1997).

Specialized shirts. Riverside Manufacturing has a patent pending approach in the Frontline double-layer shirt. This shirt has an arc rating of 23-25 cal/cm<sup>2</sup> on the front panels of the shirt depending on the style. With other PPE such as gloves and sleeves, the worker can be better protected in the areas that are most likely to get hit with electric arcs when greater protection is required. The Frontline shirt even offers a cape back vent with Nomex® netting that has been arc tested.

#### **Challenge 4: Barehand Work for Transmission and Arc Rating**

This challenge is most apparent in the summer. Most barehand work is done on transmission lines and the energy levels are not normally high; but with barehand work, IF something goes wrong, the worker would be IN the arc. I have recommended to NESC that they require barehand workers to wear flame-resistant, conductive suits much like the approach taken for secondary systems (the only suits used are from Euclid and have an arc rating of about 8 cal/cm<sup>2</sup> determined several years ago). This challenge is ongoing, but most utilities that do barehand work must depend on work practices to prevent electric arc.

#### **Challenge 5: Providing or Requiring FR clothing**

OSHA, NESC and even NFPA 70E to a great extent have sidestepped the issue of employer provision of FR clothing. The issue will become more intense as OSHA moves forward on a new 1910.269 standard (proposed June 2005), but this may not be addressed. Companies are looking for more sources of FR clothing, and much of the FR clothing production is no longer in the U.S. This excludes most of the specialty companies, but the largest FR clothing companies are manufacturing in South America, Africa, China and other countries.

This challenge requires more due diligence on the part of the utilities. Workrite, Bulwark, Walls Outdoors, Carhartt, Riverside Manufacturing and Tyndale are all brand names associated with quality clothing produced outside the U.S. I have full confidence these companies will address the safety issues that confront them, but the customer must ask

the questions about quality controls and make informed decisions about safety. Challenges have always been part of the utility culture. Our companies are well-equipped to ask the hard questions and to make the hard decisions to change cultures and methods that are not serving worker protection and productivity.

### **About Hugh Hoagland**

Hugh Hoagland is among the world's foremost experts on electrical arc testing and safety. His career change began with safety testing at LG&E Energy, later, he worked as R & D Director for NASCO, a manufacturer of protective outerwear solutions. He has helped develop most of the arc-resistant rainwear used in the world today as well as creating the first face shield to protect against electric arcs.

Before moving to full-time training and consulting. Hugh worked for Cintas developing their strategy for meeting the needs of OSHA 1910.269 and NFPA 70E standards before moving to full time training and consulting. He has helped development of legislation and standards in both the US and Europe. He sits on several industry committees and is a featured speaker at safety conferences and events.

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