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NFPA 70E urges industry to turn it off or put it on

Application Note

For more than five years the NFPA 70E, *Standard for Electrical Safety in the Workplace*, has delivered a simple message.

To work safely on electrical installations, turn off the power. And if you can't avoid working on energized systems, put on the appropriate personal protective equipment (PPE) to protect against the hazards of shock and arc flash.

Sounds easy. But for some in the industry, it's just not happening.

"I would say the large industrial base is accepting the fact that they can help safeguard their employees (through 70E)," said John Luke, safety director for ESCO Group in Marion, Iowa. But Luke, who delivered some 200 electrical safety training classes in 2006, added that "your smaller contractors, a lot of them are probably not doing it. A lot of people haven't experienced an arc flash incident. It's not on their radar screen."

"It's an education process," added Jeff Morris, vice president for electrical PPE manufacturer W. H. Salisbury & Co. "Fifty to sixty percent of people are aware of it, but they're not doing it. But from electrical contractors up to Fortune 100 companies, there's awareness that we've got to protect our people who are working on potentially energized equipment. People are now saying 'I can't ignore it,' and the best thing out there is the 70E standard."

An OSHA endorsement

NFPA 70E was first developed in 1979, with encouragement from the U.S. Occupational Safety and Health Administration (OSHA). It was designed as an industry consensus standard for electrical safety, aimed at helping workers meet OSHA safety requirements while complying with the National Electrical Code (NEC). Since then, 70E has been expanded and revised seven times. The latest 2009 version clarifies PPE guidelines while still mandating steps for avoiding the hazards of electric arc flash.

OSHA's support for 70E is clear. In a letter of interpretation dated Nov. 14, 2006, OSHA's Edwin G. Foulke, Jr. said "OSHA recommends that employers consult consensus standards such as NFPA 70E-2004 to identify safety measures that can be used to comply with or supplement the requirements of OSHA's standards for preventing or protecting against arc-flash hazards."

What is arc flash? As described in 70E, "When an electric current passes through air between ungrounded conductors or between ungrounded conductors and grounded conductors, the temperatures can reach 35,000 °F. Exposure to these extreme temperatures both burns the skin directly and causes ignition of clothing, which adds to the burn injury. The majority of hospital admissions due to electrical accidents are from arc-flash burns, not from shocks. Each year more than 2,000 people are admitted to burn centers with severe arc-flash burns"[i]. Arc-flashes can and do kill at distances of 3 m (10 ft).

The damage can be crippling, even deadly. While there is no "typical" arc flash accident, the costs in worker's compensation alone can reach multiple millions of dollars, according to Todd Hohn, assistant vice president for risk control for commercial insurer CNA. Add in lost production, pain and suffering, possible fines and damage to the company's reputation, and the cost can put a company out of business.

i Annex K, paragraph K.3, NFPA 70E *Standard for Electrical Safety in the Workplace*, 2009 Edition.

Hohn said as larger firms have come to understand their compliance requirements, some are choosing to subcontract out electrical work they would normally do in-house, in order to limit their risk.

Safe work practices up front

It's no accident that 70E covers safe work practices in Chapter 1, right up front. It also provides a formula to calculate the arc flash energy available and determine a "flash protection boundary" (calculations that must be performed by a professional engineer).

Inside that boundary, flash protective PPE is required, and 70E includes tables that specify what gear is required to protect workers in five hazard/risk categories. Noteably, that gear list includes using only test tools that are IEC-category rated for the electrical environment. Just as important, 70E re-emphasizes that working on live parts is "the last alternative work practice."

"OSHA has said for a long time now that you couldn't work with stuff live unless there was some major compelling reason," said Joseph V. Sheehan, P.E., NFPA chief engineer and staff liaison to the NFPA 70E committee. "It was never based on convenience. It was never based on economics. It was based on the fact that you would avoid a greater hazard if you shut it off. The simplest thing is to shut it off, lock it off: lockout/tagout. Nobody gets hurt, nobody needs PPE, have a nice day and everybody goes home for dinner."

But there are times, as OSHA and 70E both acknowledge, when work on live equipment is necessary. According to OSHA, equipment must be deenergized "unless the employer can demonstrate that deenergizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations." Examples include circuit testing, as well as work on circuits that form "an integral part of a continuous industrial process."[ii]

"OSHA is the **shall**, and 70E is the **how**," said Palmer Hickman, director of safety, codes and standards for the National Joint Apprenticeship and Training Committee (NJATC). A joint program of the National Electrical Contractors Association (NECA) and the International Brotherhood of Electrical Workers (IBEW), the NJATC develops the courses used to train the majority of union electricians.

ii OSHA Standard 1910.333(a)

We have a solution

"NFPA 70E steps in and says we have a solution," Sheehan added. "How to shut it off safely with a lockout/tagout program, and then if you have to work it live, how to dress, how to act, and what tools to use. It's really a very prescriptive standard that deals with a performance requirement."

Part of that solution is to encourage workers and employers to think again about working with live equipment. Annex J of 70E provides an example of a detailed "Energized Electrical Work Permit" to be filled out by the qualified electricians assigned to do the work, and signed by management. It's designed to ensure that those responsible understand exactly what they are doing, why the work must be done live, what safe work practices they will follow, what level of flash hazard is present, and that necessary PPE is available.

"Because of that permit, it makes everybody think," said Sheehan. "It's a last-ditch effort to get everybody to stop and think, do we really need to work this live?"

"For so many years, we just worked it hot," said a 30-year veteran electrician who works at a California semiconductor factory. "We need to change that, to find ways of working it cold. We found that there were a number of situations, to my surprise, where by taking the time and going through it, we were able to shut down, by either doing off-shift, by coming in at five o'clock in the morning, or doing it on a weekend, or asking for a window."

Not so easy

So why is 70E compliance not universal? Blame a lack of awareness and education, say the experts—and a production-focused, can-do tradition among electricians. Top it off with issues as pragmatic as how to properly launder fire retardant clothing, and you have a compliance shortfall.

Though they are dramatic and costly, arc flash accidents are not common. Many professionals have never experienced an arc flash. "Those injuries, you just don't see them that often. I've seen two incidents in 24 years," said Luke. "That's in 12 to 15 million hours of work. I think there are so may other things that smaller contractors have to concentrate on."

Luke added that in his view, facility managers should pay more attention to analyzing arc flash risk, then reducing arc flash dangers by engineering them out. Installing fast-trip current protection devices, for instance, can dramatically reduce the level of risk. "Say you have available fault current of 22,600 amps and an arc flash analysis based on six cycles of clearing time for that device," he said. "Change that down to half a cycle and you've considerably reduced the hazard for the individual working on it."

"The biggest challenge for most people is to understand the hazard," said Morris. "What is the risk? It takes time, money and effort to determine what your risk is. Once you've done that, the 70E piece becomes much simpler."

"I think that 70E makes it about as easy as it can be," said Hickman, "but having said that, it's not easy. There are no shortcuts. Everyone's looking for easy answers, but really, there's none."

Compliance with OSHA and 70E can even appear to be a competitive disadvantage, Hickman added. "If they try to do the right thing, many times the customer will say 'You're asking me to shut it down, and you're asking me to use an energized electrical work permit, where your competition doesn't bother me with those things.' Our contractors are trying to do the right thing, but the customer looks at that as a problem. They don't necessarily understand what the hazards are."

Sheehan said habit and culture are also barriers to compliance, but those old habits are starting to change. "This standard uses the latest technology, but people are not up to speed with technology," he said. "This document (70E) is changing the culture. The skill of the electrician was to be quick and know his stuff, to know how to balance his tools. Those days are gone. You can't use your skill as PPE anymore."

As awareness has grown, so has the demand for training. "We can't keep up with the requests," said Sheehan. "Right now it is a training frenzy. In the electrical business, I think 70E is the single hottest issue." Industry and labor groups like NFPA, the Independent Electrical Contractors, Inc. (IEC), NECA and the IBEW deliver training on 70E, as do insurers like CNA, manufacturers such as Salisbury and Fluke and a host of private training contractors.

Up on the roof

Still, there are those pragmatic issues that face managers like Mark Kerney, president of Hill York Service Corporation, a heating, ventilation and air conditioning firm based in Fort Lauderdale, Fla. His team of 115 HVAC mechanics is trained in 70E—now he must determine what kind of PPE package to provide, and how to convince the mechanics to use it as they test and repair equipment that often must be running for proper diagnosis.

"The issues are the cost of the PPE equipment, because you have to have an IEC Category-rated meter, and because of the time involved in suiting up before and after using," Kerney said. "Then of course the main concern is will the mechanics do it in 90 degree heat on a roof? I get the feeling that most of the mechanics will say hey, I've been doing this for years, safely. What's changed? Nothing's changed. I get the feeling this standard was written for a manufacturing plant."

Faced with similar issues, ESCO specified flame resistant (FR) clothing as standard wear for all of its electricians. "They look like the jeans and shirt I've always worn to work," said Luke. "If you show up for work and you don't have your flame-resistant clothing on here, we send you home. It's not that uncomfortable and it's not that cumbersome."

"At one time the clothing was pretty hot and heavy, but the clothing has gotten much more lightweight," said John Masarick, manager of codes, standards and safety for the IEC. "But there's still the situation where, if you're working in the south on a real hot day, and you need the highest level of protection which may include a hood, it can be pretty warm." Luckily the hoods have gotten better, too. And in some electrical environments, the 2009 edition of 70E now allows wearing a special balaclava head cover under an arc-rated face shield, in place of the hood.

That laundry issue? Washing a flame resistant garment with the wrong laundry products or contaminating it with other fibers can damage its performance. Workers may resist the hassle of sending clothes to a commercial laundry, even if the employer pays.

"It's hard to get people to wear PPE," Salisbury's Morris said. "When you're out in your yard mowing or weed whacking you should use safety glasses and hearing protection, but how many people do?" Yet Morris sees great hope in the industry's progress toward compliance with 70E.

"70E is the best thing out there," he said. "Is it perfect? No. That's why it goes through a five-year review process. My comment when people complain about something is that you can get involved and participate. The process to me is a good process, so you can't blame 70E.

"What's neat now is we're starting to hear some victories," Morris said. "They're harder to get, because they don't make the news."

Note: If test occurs in the proximity (within four feet) of an energized environment, then the PPE standards for the energized environment apply.

Hazard/Risk categories are described by the National Fire Protection Association (NFPA) Standard 70E. The higher the electrical environment, the stronger the personal protective equipment (PPE) must be to withstand an arc flash incident.

Hazard/Risk Category 1: < 240 V electrical environments (110 V/120 V/208 V/220 V panels, 0 to 50 hsp motors and drives) **Minimum arc rating for FR clothing:** 16.74 J/cm(2) or 4 cal/cm(2)	• Flame-resistant (FR) long-sleeved shirt and/or jacket with sleeves rolled down and front fully buttoned up (FR clothing must fully cover all skin and ignitable clothing) • FR pants • Rubber insulating gloves with leather protectors worn over top • Arc-rated face shield and safety glasses • Hard hat and hearing protection • Leather work boots • No jewelry, keys, or watch • Insulated hand tools
Hazard/Risk Category 2*: 240 V to 600 V electrical environments (270/480/600 V electrical panels, MCCs, switchgear, transformers, bus bars, UPS, and lighting; 100+ hsp motors and drives) **Minimum arc rating for FR clothing:** 33.47 J/cm(2) or 8 cal/cm(2)	• FR long sleeved shirt and/or jacket with sleeves rolled down and front fully buttoned up • FR work pants (not denims) or coveralls • Rubber insulating gloves with leather protectors worn over top • Heavy-duty leather work boots • Switching hood or a balaclava hood combined with an arc-rated face shield • Hard hat, hearing protection, and safety glasses • No jewelry, keys, or watch • Insulated hand tools
Hazard/Risk Category 3: High voltage environments (1600 A or higher, substations, utility transformers, big facility service entrances) **Minimum arc rating for FR clothing:** 104.6 J/cm(2) or 25 cal/cm(2)	• Full flash suit (jacket, overalls, and hood) • Rubber insulating gloves with leather protectors worn over top • Heavy-duty leather work boots • No jewelry, keys, or watch • Insulated hand tools • Hard hat, hearing protection, and safety glasses

Reference: NFPA (National Fire Protection Association) Standard 70E Tables 130.7 (C)(9), (C)(10), (C)(11)
Note: Category 2* is a higher risk than Category 2. This chart only lists PPE for 2*, not for 2. See NFPA 70E Table 130.7 (C)(10) for the specific distinctions between Category 2 and Category 2*.

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