

APPLICATION NOTE

The busy person's guide to assessing risk and using Energized Electrical Work Permits (EEWPs)

by Jim White, Shermco Industries

Electrical workers seem to be able to identify and quantify the hazards associated with particular tasks well enough, but risk seems to be a vague concept to most. In actuality, electrical workers assess risk constantly. Every time we start up our car to drive somewhere, cross the street, ride in an airplane, hit a round of golf or ski the black diamond slope, we assess the risk associated with that task, without realizing it.

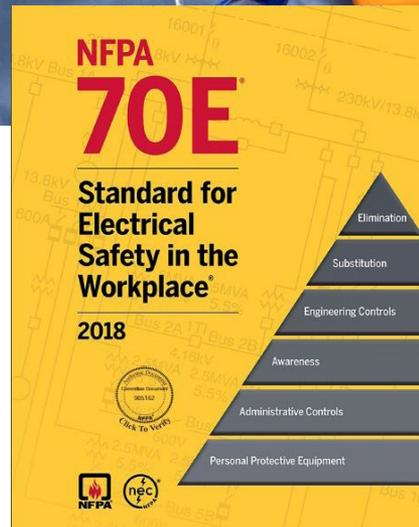
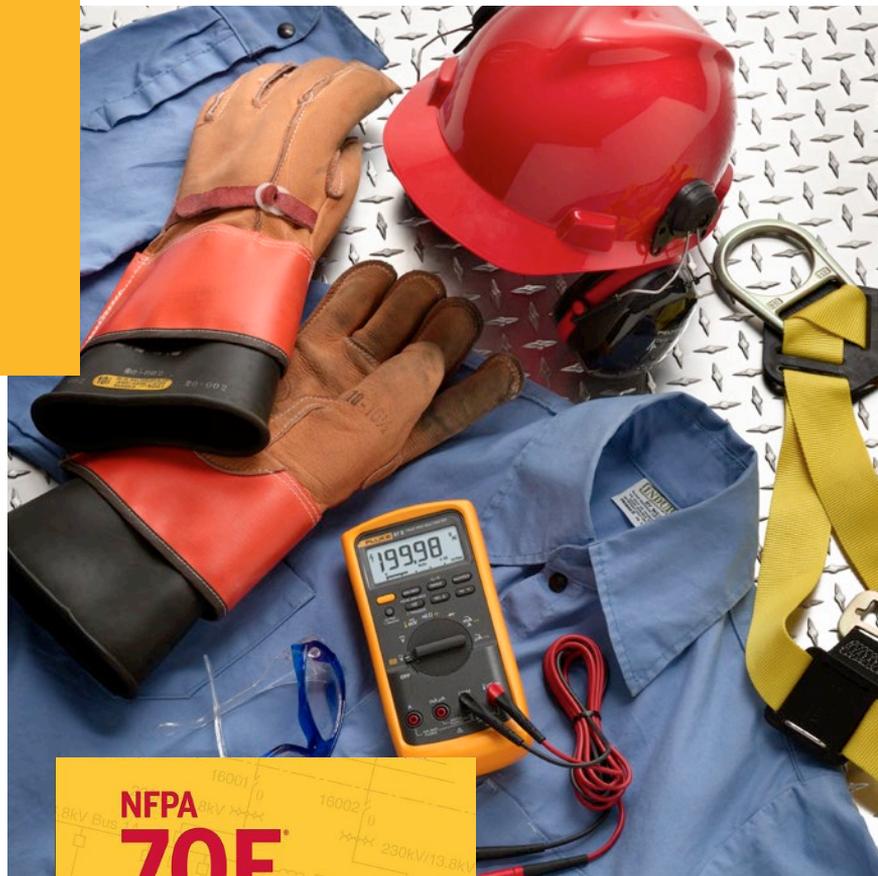
The 2018 edition of NFPA 70E puts more emphasis on risk assessments, as qualified persons must be able to assess risk in order to work safely. Remember, even though OSHA has a single-point responsibility policy (always the employer), your supervisor or foreman will not be the one laying in a hospital bed wondering what the rest of their lives will be like.

Large projects require each crew leader assess the risk involved in the task and document it. If the task conditions change and could create additional or different risk, a new risk assessment must be completed and documented.

The scenario

A 480 V motor control circuit is malfunctioning and troubleshooting is required to determine the cause. Because the circuit powers an emergency system, repairs may have to be performed while energized. Depending on the specific circumstances and requirements, there may be no choice.

One of the exemptions OSHA uses in 29CFR1910.333(a)(1) is "infeasibility". It needs to be emphasized that inconvenience and infeasibility are two different things. The best way to view infeasible is to view it from OSHA's perspective. If there is any way to deenergize electrical circuits or equipment, that is what is expected. OSHA has a Letter of Interpretation concerning "continuous industrial processes" and infeasibility dated 4/11/2012 which explains their reasoning. To summarize that LOI, turn it off.



Where to begin

Typically, companies will have a Job Hazard Analysis or Job Safety Analysis form that must be completed. This is helpful for most general tasks, but many don't address electrical hazards adequately. NFPA 70E, 2018 edition provides guidance in Article 130. New to the 2018 70E is Section 110.1(I)(1), Job Safety Planning and Briefing. In previous editions the job safety plan was lumped into the job briefing. The 70E committee believes the job safety plan is every bit as important as the actual briefing. In 110.1(I)(1) the job is planned by "a qualified person" and must be documented. A shock and arc flash risk assessment is required, LOTO, any special precautions that are needed and tools, equipment, or other needs must be fully documented. Half a plan is worse than no plan.

Once the job safety plan is completed, that must be communicated to all affected workers. Section 110.1(I)(2) covers job briefing requirements. The requirements are essentially the same as in the 2015 edition of NFPA 70E and requires the job safety plan and the energized electrical work permit elements be covered during the job briefing. An example job briefing checklist is included in Informative Annex I, Figure I.1.

Electrically safe work conditions (Section: 130.2)

- This section directs electrical workers to place electrical conductors and circuit parts into an electrically safe work condition if they are within the restricted approach boundary or the arc flash boundary when interacting with equipment in a manner that could cause failure. This is not intended to include operating equipment, which is normal operation, but for tasks such as racking circuit breakers and installing and removing MCC buckets and bus plugs.
 - This element created a lot of discussion during the 2018 cycle meetings, as many companies require arc-rated clothing and PPE to be worn when operating electrical equipment. NFPA 70E sets the minimum requirements and safe work practices, not the best. A company may have data from past incidents that indicates to them that such PPE is required. If your company requires PPE when operating electrical equipment, that is the best safe work practice and you would be expected to follow those requirements.
- Perform an initial visual examination of the equipment to be worked on. Note the condition of the equipment, its environment, whether its location is indoors or outdoors, the available

working space (18" is the typical minimum for under 600 V class equipment), the presence of unusual smells or noises, the presence or absence of a test or calibration decal, such as recommended by NFPA 70B section 11.27, the date of the last maintenance or testing.

- A three-year maintenance interval is usually recommended. Refer to the following documents for more information:
 - ANSI NETA MTS "Maintenance Testing Specifications for Electrical Power Systems Equipment"
 - NFPA 70B "Recommended Practice for Electrical Equipment Maintenance"
 - CSA Z463 "Guideline on Maintenance of Electrical Systems"

Energized electrical work permit (130.2(B))

- An EEWP is required for any energized work, except for the specific exceptions listed in 130.2(B)(3). Voltage testing, visual inspections where the restricted approach boundary is not crossed and troubleshooting exceptions, so an EEWP would not be required for troubleshooting, but would assist in evaluating the risk and hazards associated with the task. Complete the EEWP as part of the risk assessment process, but signatures by management would not be required.
 - Figure 1 is a standard EEWP from Informative Annex J.
 - The EEWP, since it is in the annex material, can be modified to more closely fit the needs and circumstances of a company or task.
 - Shock risk assessment 130.4—determining the nominal phase-to-phase voltage of the system or equipment along with the approach boundaries (limited and restricted) and shock protective PPE. The likelihood of occurrence and severity of the shock must also be estimated.
 - A new requirement is contained in 130.4(B) Additional Protective Measures. If the risk assessment determines that there is a risk of electrical shock involved in a task, the qualified person is directed to follow the hierarchy of control methods, not just choose PPE. Additional protective measures is discussed under new requirements for risk assessments.
 - Arc flash risk assessment 130.5—determining if an arc flash hazard exists. If you're exposed to energized electrical conductors

ENERGIZED ELECTRICAL WORK PERMIT

PART I: TO BE COMPLETED BY THE REQUESTER:

Job/Work Order Number _____

- (1) Description of circuit/equipment/job location: _____

- (2) Description of work to be done: _____

- (3) Justification of why the circuit/equipment cannot be de-energized or the work deferred until the next scheduled outage:

Requester/Title _____

Date _____

PART II: TO BE COMPLETED BY THE ELECTRICALLY QUALIFIED PERSONS *DOING* THE WORK:

Check when complete

- (1) Detailed description of the job procedures to be used in performing the above detailed work: _____

- (2) Description of the safe work practices to be employed: _____

- (3) Results of the shock risk assessment: _____
 - (a) Voltage to which personnel will be exposed
 - (b) Limited approach boundary
 - (c) Restricted approach boundary
 - (d) Necessary shock, personal, and other protective equipment to safely perform assigned task
- (4) Results of the arc flash risk assessment: _____
 - (a) Available incident energy at the working distance or arc flash PPE category
 - (b) Necessary arc flash personal and other protective equipment to safely perform the assigned task
 - (c) Arc flash boundary
- (5) Means employed to restrict the access of unqualified persons from the work area: _____
- (6) Evidence of completion of a job briefing, including discussion of any job-related hazards: _____
- (7) Do you agree the above-described work can be done safely? Yes No (If no, return to requester.)

Electrically Qualified Person(s) _____

Date _____

Electrically Qualified Person(s) _____

Date _____

PART III: APPROVAL(S) TO PERFORM THE WORK WHILE ELECTRICALLY ENERGIZED:

Manufacturing Manager _____

Maintenance/Engineering Manager _____

Safety Manager _____

Electrically Knowledgeable Person _____

General Manager _____

Date _____

Note: Once the work is complete, forward this form to the site Safety Department for review and retention.

Figure 1. Example Energized Electrical Work Permit Form from 2018 edition of NFPA 70E, Informative Annex J

or circuit parts, the answer would be yes. Determine arc flash boundary, appropriate working distance, condition of maintenance of the equipment or circuit, arc flash protective clothing and PPE. Again, the qualified person is directed to implement the hierarchy of control methods.

- A new table has been added to the 2018 edition of NFPA 70E to assist in determining the likelihood of occurrence of an arc flash event. Table 130.5(C) can be used for both the incident energy method or the table method.
 - A caution concerning this table. Since it is general in nature, it cannot be a substitute for a full risk assessment. Only the person about to perform the task can determine the applicability of the table. When equipment is in normal operating condition, it can provide guidance. However, in our example the task is to troubleshoot a MCC, which means it is not in normal operating condition.
- If an arc flash warning label is present, refer to Table 130.5(G), which is another new table in the 2018 NFPA 70E. This was Table H.3(b) in previous editions, but the information concerning non-arc-rated clothing and PPE was removed and it can be used for the incident energy analysis method. Do not use it with the table method.
- If no arc flash warning label is present, refer to Tables 130.7(C)(15)(a), 130.7(C)(15)(Bb) and 130.7(C)(15)(c), if the available short circuit current and fault clearing time of the over-current protective device is within the limits of Table 130.7(C)(15)(a) or Table 130.7(C)(15)(b). If these limits are exceeded, an incident energy analysis must be conducted.
- How unqualified workers will be protected from shock or arc flash. This usually involves setting up safety barriers or signage, but may require the use of an attendant, in accordance with 130.7(E) Alerting Techniques. The safety barrier or barricade is to be set up at the limited approach boundary or the arc flash boundary, whichever is farther out, 130.7(E)(2) Barricades.
 - Note that Lookalike Equipment has been separated into 130.7(F) to give it more prominence. Numerous cases have been reported to the 70E committee where workers have entered into the wrong piece of equipment because it looks exactly like the one they had deenergized, or have entered partially-energized equipment without realizing the risk involved.

- Other non-electrical equipment that may be required, such as respirators or body harnesses.
- Assess other risks and hazards that may be present, such as ice or water, confined or enclosed work spaces, pedestrian or vehicular traffic and so on.
- Other safe work practices that may be required:
 - Use of a safety backup. The training, experience and PPE for the safety backup should be documented.
 - Shielding or guarding nearby energized electrical circuits to prevent incidental contact.
 - Specialized test instruments that may be required, such as circuit analyzers or recorders.
 - Grounding of the equipment, if necessary, including the means to account for temporary personal protective grounds and equipment.
 - Inspection of all tools and equipment prior to the start of work, including test instruments, leads and accessories, live-line tools, insulated tools, rubber insulating blankets, shield or gloves, arc-rated clothing and PPE, as required. Inspect everything, even if it is "known to be good."
- If the equipment needs troubleshooting it can no longer be considered "normally operating." It's in distress and has to be approached as if it could fail at any moment, including when its circuit breaker is opened to de-energize it.

New requirements for a risk assessment

The 2018 edition of NFPA 70E added new requirements for the risk assessment procedure. Section 110.1(H)(2) requires that the risk assessment procedure "address the potential for human error and its negative consequences.....". One committee member asked how human error could be addressed, as there are thousands of ways to make a mistake. The answer is, do the best that you can. No one can foresee all possibilities, but we can account for some of the more obvious and even the less obvious human errors if we try.

As an example, what would happen if a worker dropped an uninsulated wrench on an energized bus? What could be done to prevent this from occurring? Are new or different tools and equipment needed to prevent this, such as insulated hand tools, tying off tools so they cannot drop onto the bus, even if they are insulated. Viewing

Task	Equipment Condition*	Arc flash PPE required
Reading a panel meter while operating a meter switch	Any	No
Performing infrared thermography and other non-contact inspections outside the restricted approach boundary. This activity does not include opening of doors or covers.		
Working on control circuits with exposed energized electrical conductors and circuit parts, nominal 125 volts ac or dc, including opening of hinged covers to gain access.		
Examination of insulated cable with no manipulation of cable.		
For dc systems, maintenance on a single cell of a battery system or multi-cell units in an open rack		

Figure 2. Table 130.5(C) Partial from 2018 edition of NFPA 70E

Task	Equipment Condition*	Arc flash PPE required
Reading a panel meter while operating a meter switch	Any	No
Normal operation of a circuit breaker (CB), switch, contactor, or starter	All of the following: <ul style="list-style-type: none"> • The equipment is properly installed • The equipment is properly maintained • All equipment doors are closed and secured • All equipment covers are in place and secured • There is no evidence of impending failure • All equipment covers are in place and secured • There is no evidence of impending failure 	No
	All of the following: <ul style="list-style-type: none"> • The equipment is not properly installed • The equipment is not properly maintained • Equipment doors are open or not secured • Equipment covers are off or not secured • There is no evidence of impending failure • Equipment covers are off or not secured • There is evidence of impending failure 	Yes
For ac systems: Work on energized electrical conductors and circuit parts, including voltage testing	Any	Yes

Table 130.7(C)(15)(A)(a) provides some assistance in risk assessment.

the requirement from this perspective makes more sense than trying to account for every possible error a person could make.

Section 110.1(H)(3) now requires the hierarchy of risk control methods be used if “additional protective measures” are needed. If the task seems to require the use of PPE to complete it, the hierarchy of risk control methods in 110.1(H)(3) must be implemented. The first risk control method is elimination of the hazard. Placing equipment in an electrically-safe work condition is one such elimination method. If elimination is not possible, then the remaining risk control methods must be considered and implemented, if possible.

110.1(H)(3) Informational Note No. 1 explains how the first three risk control methods are most effective, while the last three are the least effective. Elimination, substitution and engineering controls are applied at the source, while awareness, administrative controls and PPE are not.

Determining the likelihood of occurrence of an arc flash event

Table 130.5(C) can provide some assistance in the risk assessment, but should not be relied upon completely. Figure 2 is a portion of that table.

- Determine the task(s) that may be needed to complete the primary goal. If troubleshooting, as in the example being used, the equipment may have to be de-energized or operated to open the door to gain access. Since it is no longer “normally operating,” arc-rated clothing and PPE is required. Refer to the arc flash risk assessment for the proper protection.
 - Once the door is opened, the equipment has to be reenergized. This would also be operating equipment and would no longer be considered “normal operation” and requires arc-rated clothing and PPE.
 - Arc-rated clothing and PPE are required to perform troubleshooting, since the worker would be exposed to electrical hazards.
- Once the cause is found, the equipment may require repair. Repair would include any replacement or manipulation of the conductors or circuit parts, such as removing and installing components, tightening or replacing conductors and so on.
 - At this point, work must stop. Repair activities can only be performed by using an EEWP, which must have management approval.
 - Re-evaluate the conditions of work. The risk will be greater, since energized conductors or circuit parts are being handled or replaced. Consider if the planned work practices are adequate for the new task(s). Note that Section 130.2(B) requires an EEWP whenever energized work is performed within the restricted approach boundary.
 - Table 130.5(C) indicates the task “For ac systems, work on energized electrical conductors and circuit parts, including voltage testing” always requires the use of arc-rated clothing and PPE to perform that task, which would include troubleshooting.

Residual risk

There is no such thing as a risk-free task where energized electrical conductors and circuit parts are concerned. If it’s energized, the hazard is present and, therefore, so is the risk. We can reduce the risk by operating equipment remotely or by covering adjacent circuits with rubber insulating shields, but the risk can never be zero. The remaining risk is the residual risk. Once all steps have been taken to reduce risk, the residual risk must be evaluated. If the residual risk is still too great, the work cannot be performed while the equipment is energized.

If the technician evaluates the risk and he or she and the technician’s supervisor believe the task can be performed safely, then it can be done energized. In our example scenario it may be that due to the appearance, smell, and sounds as well as the technician’s experience, that troubleshooting is just too risky. Plan B must be formulated, which would probably include de-energizing the equipment and testing the individual components to determine which one is likely to fail. Sometimes this approach does not determine the cause of the problem. If that is the case, the equipment could be energized using a low-power source to troubleshoot. Even if the technician believes the task can be done safely, all requirements of Article 130 are still in effect.

Summary

Training, of course, is a huge part of the equation. If workers are not following policies or procedures, often it is a lack of training that's at fault. "Check-the-box" training may satisfy a paper trail, but does little or nothing to promote safety. Employees must be trained to understand the importance of what they do, not just how to do it. People need to understand why it needs to be done one way, instead of another, more convenient way.

Assessing risk is a vital part of safety, not just electrical safety. The employer can only do so much, as it is the employee who is at the scene and observing the equipment and conditions. One good truism is "Always be responsible for your personal safety." Relying on others could result in a less-than-satisfactory outcome. Listen to your gut feelings. Often, accidents could have been avoided if the worker stopped when that little voice in their ear said "I wouldn't do that, if I were you." Step back and reevaluate the situation. Maybe something was missed, or maybe not, but having a second look is never a bad thing.

About Jim White

Jim White, CEMCP, is the vice president of training services for Shermco Industries and a principle member of the NFPA 70E technical committee. Jim is a NETA certified Level IV Senior Substation Technician and is an NFPA Certified Electrical Safety Compliance Professional. Shermco provides NETA-certified technicians for electrical power system testing and maintenance. With offices stretching from Houston, TX to Regina, Saskatchewan, CN Shermco have hundreds of field service technicians in the field at any one time.

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