ELECTRICAL SAFETY PROGRAM: KEEPING US SAFE

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Having a comprehensive Electrical Safety Program (ESP) and following it is a critical part of keeping electrical workers safe. The path to better safety requires very hard work and total commitment to the values involved. So, what is an ESP, and what are the major stumbling blocks to developing an organization where everyone goes home injury-free every day?

Figure 1 shows how an ESP could be structured. First, the safety policies describe the overall plan. Second, the safety procedures are created for the all-important tasks. A procedure consists of short sequential steps. Each step will have a check box to document that the task has been completed. Third, forms are created with spaces and boxes to fill in the information required.

The following list describes how to model an ESP. The list is not comprehensive; rather, it is meant to cover major points without being confusing.

1. The development and maintenance of an ESP require commitment from upper management to provide the resources needed. This would include adequate time for the qualified persons responsible and the financial resources to fully develop it (refer to Annex E of NFPA 70E). Involve as many individuals as reasonable. Ownership and buy-in are vital to the program's success.
2. Then create the policies. These describe what an ESP is and the safety issues covered. It is in text form and needs to be reviewed and accepted by all who are affected by it. As Shermco's Jim White puts it: "If it isn't simple, it won't be used."
3. Once you have the policies, develop clear, easy-to-understand, specific safety procedures and forms. Test the procedure under actual field conditions. Any issues with the procedure should be resolved before it is implemented.
4. Perform thorough training for every person on the policies, procedures, and forms, with annual (or more frequent, if necessary) refresher training.
5. Require demonstration of trainee proficiency on the topics taught.
6. Conduct regular, knowledge-building auditing of each person to ensure they understand and follow the policies and procedures. Be certain to document the training and auditing of their proficiency as required by NFPA 70E.
7. Improve the policies and procedures when standards and best practices change or problems are revealed during auditing. Then, retrain to the new improvements. Again, the job is not finished until the paperwork is completed. Document everything.

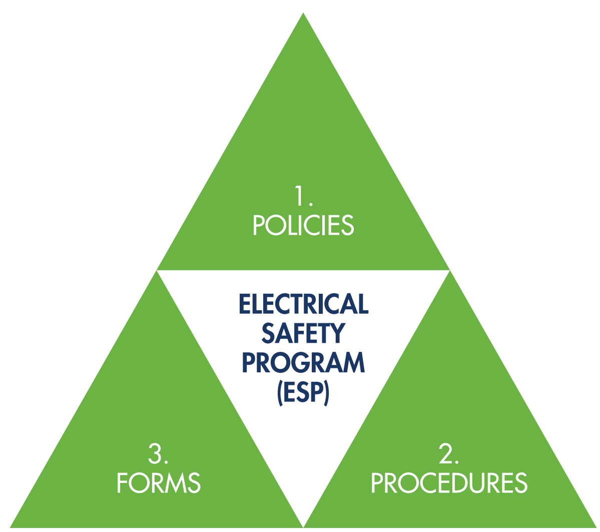


Figure 1: *Electrical Safety Program Components*

8. Consider these items to be a continuing cycle of betterment. All of this is done with the spirit that every person is enabling everyone else to be successful at their job. Assume people want to be good at what they do.

9. The people performing the work are the ones who know how to improve what you do. Include your qualified persons at every step.

Do the preceding items sound familiar? There is nothing new in them, and they have been taught many times, in many ways, for the last 40-plus years.

The excellent news is that, as a result of all the ESPs we have and the safety training we perform, there has been a substantial reduction in incidents. In 1994, there was approximately one fatality per day from electrocution, about 365 total. In 2013, that number was down to 139. Considering how the American workforce has increased, this represents a huge drop in electrical shock fatalities.

The bad news is that too many injuries continue to happen. Our reaction is to take another class, create another policy or procedure, and train more. Even though we have achieved good results for our investments in the past, it seems a glass ceiling has been hit.

We reviewed seven serious shock/arc-flash injuries and found several examples of incidents that continue to occur. They happened in our geographical area in the past 10 years. Each incident had substantial similarities. The injuries happened to experienced electrical workers in the major industrial facilities. They all had a minimum of 5 to 10 years journeymen experience, and several of them had over 20 years of experience. All worked for companies with an ESP. All had received electrical safety training for the tasks they were performing when they got hurt. All were preventable.

This is not stated lightly. This is not utopia, and people are not perfect. We are not talking about utopia or perfection in this article. We are talking about people getting hurt, and nobody wants to be injured. So, what went wrong?

PROCEDURES AND FORMS

The ESP described in Figure 1 shows three parts. Large industry, in general, has done a good job developing comprehensive policies. However, they have not performed well in using procedures and forms. Way too often, we observe no written procedures at job sites, and our peers often tell us they do not use written procedures. Following is an example of a procedure that makes an electrical working condition much safer for all of us.

Establishing an Electrically Safe Work Condition Procedure

NFPA 70E Article 120, if followed correctly, will help achieve an electrically safe work condition:

- [ ] Determine all possible sources of electrical supply to the specific equipment. Check applicable up-to-date drawings, diagrams, and identification tags.
- [ ] After properly interrupting the load current, open the disconnecting device(s) for each source.
- [ ] Whenever possible, visually verify that all blades of the disconnecting devices are fully open or that the drawout-type circuit breakers are withdrawn to the fully disconnected position.

Figure 2: *Notice the single voltage setting. It detects ac and dc voltages. This eliminates the possible error of having your voltmeter on the wrong setting.*

☐ Apply lockout/tagout devices in accordance with a documented and established policy.

☐ Use an adequately rated voltage detector to test each phase conductor or circuit part to verify they are de-energized. For circuits less than 1,000 volts, use an instrument such as the Fluke T5-1000 (see Figure 2) and test each phase conductor or circuit part both phase-to-phase and phase-to-ground. Before and after each test, determine that the voltage detector is operating satisfactorily.

☐ Do not rely solely on proximity voltage detectors for the absence of voltage testing. If used, always follow that test with a direct-contact test instrument to verify the absence of voltage.

☐ Where the possibility of induced voltages or stored electrical energy exists, ground the phase conductor or circuit parts before touching them. Where it could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed electrical conductors or circuit parts, apply ground connecting devices rated for the available fault duty.

There is also a lack of forms, especially quality Job Hazard Analysis (JHA) forms. In 2015, NFPA 70E made a new requirement to include risk analysis to establish the risk of every task as a part of the condition for job safety; however, this has not been well implemented. Refer to Figure 3 for a sample of a JHA with the job hazards and risks considered. Having a procedure with written steps to follow and a form to fill out requires the person(s) performing the work to stop and think first.

THE HUMAN FACTOR

Some of the problems humans have include:

A. We rush people, and people allow themselves to be rushed.

B. Lack of crew harmony — some people just don't get along. This can lead to poor communications that may result in injuries.

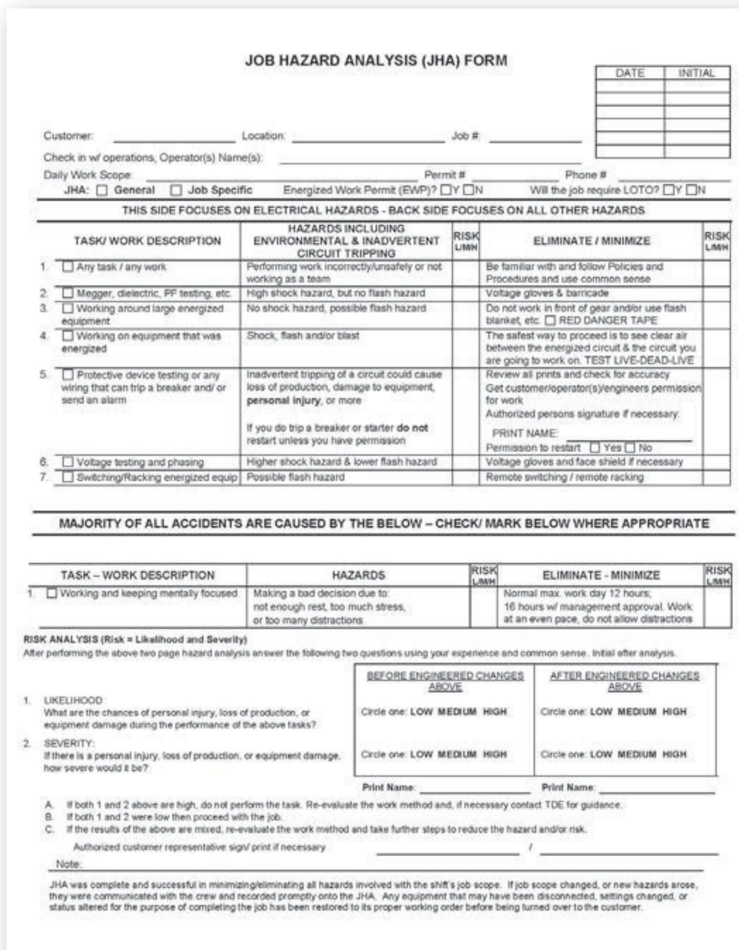
C. People forget, get distracted, get tired, and just make mistakes.

D. People like to take risks. High-voltage electrical workers accept high risk as a regular part of their work. Taking risks is genetic, and people drawn to electrical work tend to be wired for risk.

Items A through D present unique challenges to preventing injuries. By themselves, these behaviors are difficult, if not impossible, to control and eliminate. In the safety community, we now call such barriers human nature or the human factor.

The traditional methods of solving these problems — creating another policy or having more training — will not work. Therefore, a new way of looking at this issue needs to be developed. A good solution to deal with this subject is demonstrated in the Swiss Cheese Model (Figure 4).

This model uses successive layers of defense. It acknowledges that humans get in a rush, may not



JOB HAZARD ANALYSIS (JHA) FORM

DATE	INITIAL

Customer: ______ Location: ______ Job #: ______

Check in w/ operations, Operator(s) Name(s): ______

Daily Work Scope: ______ Permit # ______ Phone # ______

JHA: ☐ General ☐ Job Specific Energized Work Permit (EWP)? ☐Y ☐N Will the job require LOTO? ☐Y ☐N

THIS SIDE FOCUSES ON ELECTRICAL HAZARDS - BACK SIDE FOCUSES ON ALL OTHER HAZARDS

	TASK/ WORK DESCRIPTION	HAZARDS INCLUDING ENVIRONMENTAL & INADVERTENT CIRCUIT TRIPPING	RISK L/M/H	ELIMINATE / MINIMIZE	RISK L/M/H
1.	☐ Any task / any work	Performing work incorrectly/unsafely or not working as a team		Be familiar with and follow Policies and Procedures and use common sense	
2.	☐ Megger, dielectric, PF testing, etc.	High shock hazard, but no flash hazard		Voltage gloves & barricade	
3.	☐ Working around large energized equipment	No shock hazard, possible flash hazard		Do not work in front of gear and/or use flash blanket, etc. ☐ RED DANGER TAPE	
4.	☐ Working on equipment that was energized	Shock, flash and/or blast		The safest way to proceed is to see clear air between the energized circuit & the circuit you are going to work on. TEST LIVE-DEAD-LIVE	
5.	☐ Protective device testing or any wiring that can trip a breaker and/ or send an alarm	Inadvertent tripping of a circuit could cause loss of production, damage to equipment, **personal injury**, or more If you do trip a breaker or starter **do not** restart unless you have permission		Review all prints and check for accuracy Get customer/operator(s)/engineers permission for work Authorized persons signature if necessary: PRINT NAME: ______ Permission to restart ☐ Yes ☐ No	
6.	☐ Voltage testing and phasing	Higher shock hazard & lower flash hazard		Voltage gloves and face shield if necessary	
7.	☐ Switching/Racking energized equip	Possible flash hazard		Remote switching / remote racking	

MAJORITY OF ALL ACCIDENTS ARE CAUSED BY THE BELOW – CHECK/ MARK BELOW WHERE APPROPRIATE

	TASK – WORK DESCRIPTION	HAZARDS	RISK L/M/H	ELIMINATE - MINIMIZE	RISK L/M/H
1.	☐ Working and keeping mentally focused	Making a bad decision due to: not enough rest, too much stress, or too many distractions		Normal max. work day 12 hours; 16 hours w/ management approval. Work at an even pace, do not allow distractions	

RISK ANALYSIS (Risk = Likelihood and Severity)

After performing the above two page hazard analysis answer the following two questions using your experience and common sense. Initial after analysis.

	BEFORE ENGINEERED CHANGES ABOVE	AFTER ENGINEERED CHANGES ABOVE
1. LIKELIHOOD: What are the chances of personal injury, loss of production, or equipment damage during the performance of the above tasks?	Circle one: **LOW MEDIUM HIGH**	Circle one: **LOW MEDIUM HIGH**
2. SEVERITY: If there is a personal injury, loss of production, or equipment damage, how severe would it be?	Circle one: **LOW MEDIUM HIGH**	Circle one: **LOW MEDIUM HIGH**
	Print Name: ______	**Print Name:** ______

A. If both 1 and 2 above are high, do not perform the task. Re-evaluate the work method and, if necessary contact TDE for guidance.
B. If both 1 and 2 were low then proceed with the job.
C. If the results of the above are mixed, re-evaluate the work method and take further steps to reduce the hazard and/or risk.

Authorized customer representative sign/ print if necessary ______ / ______

Note: ______

JHA was complete and successful in minimizing/eliminating all hazards involved with the shift's job scope. If job scope changed, or new hazards arose, they were communicated with the crew and recorded promptly onto the JHA. Any equipment that may have been disconnected, settings changed, or status altered for the purpose of completing the job has been restored to its proper working order before being turned over to the customer.

Figure 3: *Sample JHA with Job Hazards and Risks Considered*

get along, forget, make mistakes, and take too many risks. These are the holes in the Swiss cheese. The layers of cheese show that a mistake may get through on one layer but will be blocked by the next layer. Each layer may represent a written policy, a form to fill out, or a second person witnessing and verifying each step with a check sheet.

CONCLUSION

Companies should develop better procedures and forms, train personnel to understand them, and then audit the work to assure they are being utilized. Account for the human factor by implementing the policies, procedures, and forms in such a way that layers of safety are created, thereby significantly reducing the risk and the injuries.

What is agreed upon in the safety community is that we are on a journey. Knowledge of the ESP is one thing; changing people to follow it is another. The journey will take some time and require our very best efforts.

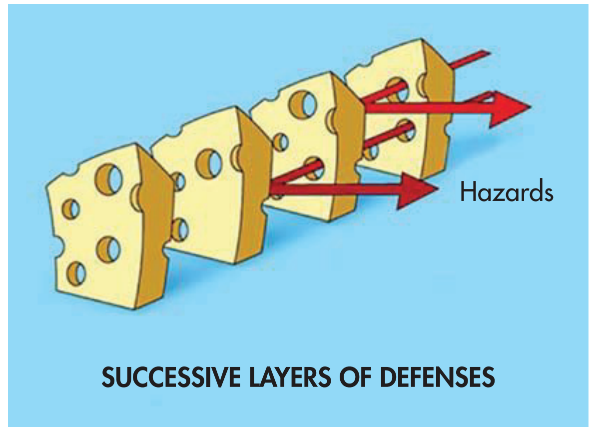


Figure 4: *For a catastrophic error to occur, the holes need to align at each step in the process, allowing all defenses to be defeated and resulting in error. This would be unlikely.*

REFERENCE

Duke University School of Medicine, *www.patientsafetyed.duhs.duke.edu*

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