Electrical Safety & Environmental Protection

Electrical Safety

Purpose

To eliminate unsafe conditions involving electrical equipment and tools, including faulty insulation, improper grounding, loose electrical connections, defective parts, ground faults in equipment and unguarded live electrical parts.

References

OSHA 29 CFR 1926.400 to 1926.449

National Electrical Code (NEC)

Policy

General Requirements

- Each project must provide a safe place to work for every employee, which includes protecting the employee from electrical hazards such as fault currents to ground.
- When an electrical ground fault occurs, the current flows through the path with minimum impedance to ground. It is imperative that an employee does not inadvertently become the conductor of the current.
- There are two approved methods of protecting the worker from a ground fault. These methods are in addition to other requirements for equipment grounding conductors. They are:
    - Use of ground fault circuit interrupters (GFCI).
    - An assured equipment-grounding conductor program.

GROUND FAULT CIRCUIT INTERRUPTER (GFCI)

The two major aspects in the effective use of GFCI's are:

- Attention shall be given to the proper installation and maintenance of GFCI's within the requirements of the National Electric Code (NEC). The system shall be tested prior to being activated into service and the test results documented and kept on file.
- If fault trip-out occurs after the circuit has been tested and activated into service, a thorough investigation must be made to determine the cause. The necessary repairs or corrections shall be made before re-using. Application of a silicone solution may be helpful if the fault trip-out is due to excessive moisture.

In purchasing GFCI's, the specifications shall state that GFCI's shall conform to Underwriters Laboratories Standard 943, "Ground Fault Circuit Interrupters."

Each circuit protected by a circuit breaker GFCI requires its own neutral conductor.

Receptacle type GFCI's may be used on common neutral systems and where receptacles are more than 250 feet from the breaker.

ASSURED EQUIPMENT GROUNDING POLICY

The major aspects in the establishment of an effective program are:

- To establish and implement a program to reduce the potential of injuries caused by electric shock from cord sets, receptacles, and equipment connected by cord and plug.
- To meet the requirements of local, state, and federal rules and regulations.

It is recognized that in order to prevent injury from a ground fault, the integrity of the grounding system must be maintained at all times. To achieve this, a program of inspection and testing shall be implemented.

The project supervisor shall be responsible for the inspection and testing of each cord set, electric tool, and piece of electrical equipment and receptacle:

- Before first use.
- Before equipment is returned to service following repairs.
- Before equipment is used after any incident which can be reasonably suspected to have caused damage.
- Every three months.

The quarterly inspections shall be the responsibility of the project supervisor. Each cord set, electric tool, receptacle, and piece of electrical equipment shall be tested to ensure a continuous ground circuit, and that equipment grounding conductor is connected to its proper terminal. The testing equipment shall be capable of testing for ground conductor continuity and resistance line fault, and proper connection of conductors to terminals.

Receptacles which are a permanent part of the wiring of permanent buildings are excluded from the quarterly testing and inspection requirements of this procedure.

Before use, each cord set, electric tool or piece of electrical equipment shall be visually inspected daily for signs of damage. They shall be inspected for signs of frayed or damaged insulation, crushed cable, loose or missing covers or screws, missing ground

prongs on plugs, and other similar substandard conditions. Equipment found to be damaged or defective shall not be used until repaired and equipment suspected of being damaged or defective shall be inspected and tested prior to using.

To verify inspection and testing, a piece of color-coded tape will be affixed to each item inspected by the inspector. Four colors of tape shall be used. The expiration date of each inspection period may be pre-printed on the tape to avoid conflicts with other similar color-coded tapes on the project. The color code system is as follows:

Color Coding Scheme (Quarterly)

January 1 through March 31	White
April 1 through June 30	Green
July 1 through September 30	Red
October 1 through December 31	Orange

The inspection tape shall not be used for any other purpose. The project supervisor shall strictly control use of tape. Color scheme may vary according to region.

Any electrical tool, cord set, or piece of electrical equipment which bears an expired inspection sticker, or no inspection sticker shall be considered defective and is not to be used until it is inspected.

Only the electrical inspectors are authorized to remove inspection tape. Unauthorized removal or defacing of inspection tape shall be cause for disciplinary action.

It shall be the responsibility of each subcontractor to ensure that his electric tools and electrical equipment are tested and documented.

LIGHTING

- All fluorescent light fixtures in job trailers should have either a full cover or individual plastic sleeves over the tubes.
- Temporary lighting shall have lamps that are protected from accidental contact or breakage.

DAMAGED EXTENSION CORDS

If the outer insulation is cut or torn open one-half inch or less ***and*** the insulation of the conductors are not damaged (bare copper showing), ***contact the Safety & Compliance Manager*** for approved weather proofing tape.

If the cut or torn area is more than one-half inch in length and/or the conductor insulation is cut, cracked, mashed, or has any bare copper showing, the cord is to be cut at the damaged area, tagged “out of service” (noting the problem), and sent back to the shop for repair.

If the insulation is pulled back away from either end connector (allowing the conductors to show - insulation may be good), the cord must be tagged “out of service” (noting the problem) and sent back to the shop for repair. Or, if you are qualified, you may field repair this situation so that the outer insulation is under the strain relief section of the connector.

Working with Energized Equipment

This section contains safety requirements that must be met in constructing electrical equipment and in working on energized electrical equipment. Special emphasis is placed on problems associated with personnel working on hazardous electrical equipment in an energized condition. Such work is permissible, but only after extensive effort to perform the necessary tasks with the equipment in a securely de-energized condition has proven unsuccessful, or if the equipment is so enclosed and protected that contact with hazardous voltages is essentially impossible.

Definitions:

The following definitions are used in this discussion of electrical safety.

Authorized Person: An individual recognized by management as having the responsibility for and expertise to perform electrical procedures in the course of normal duties. Such individuals are normally members of electronic or electrical groups.

Backup Protection: A secondary, redundant, protective system provided to de-energize a device, system, or facility to permit safe physical contact by assigned personnel. A backup protective system must be totally independent of the first-line protection and must be capable of functioning in the event of total failure of the first-line protective system.

Companion: A co-worker who is cognizant of potential danger and occasionally checks the other worker.

Electrical Hazard: A potential source of personal injury involving, either directly or indirectly, the use of electricity.

Direct Electrical Hazard: A potential source of personal injury resulting from the flow of electrical energy through a person (electrical shocks and burns).

Indirect Electrical Hazard: A potential source of personal injury resulting from electrical energy that is transformed into other forms of energy (e.g., radiant energy, such as light, heat, or energetic particles; magnetic fields; chemical reactions, such as fire, explosions, the production of noxious gases and compounds; and involuntary muscular reactions).

First Line Protection: The primary protective system and/or operational procedure provided to prevent physical contact with energized equipment.

General Supervision: The condition that exists when an individual works under a supervisor's direction but not necessarily in the continuous presence of the supervisor.

Grounding Point: The most direct connection to the source of a potential electrical hazard such as the terminals of a capacitor. Such a point must be indicated by a yellow circular marker.

Grounds, Electrical: Any designated point with adequate capacity to carry any potential currents to earth. Designated points may be building columns or specially designed ground-network cabling, rack, or chassis ground. Coldwater pipes, wire ways, and conduits must not be considered electrical grounds.

Grounds, Massive: Large areas of metal, concrete, or wet ground that make electrical isolation difficult or impossible.

Implied Approval: Approval is implied when a supervisor, knowing the qualifications of an individual, assigns that individual a task, or responsibility for, a device, system, or project.

Qualified Person: An individual recognized by management as having sufficient understanding of a device, system, or facility to be able to positively control any hazards it may present. Must, Should, and May: “Must” indicates a mandatory requirement. “Should” indicates a recommended action. “May” indicates an optional or permissive action, not a requirement or recommendation.

Safety Watch: An individual whose sole task is to observe the operator and to quickly de-energize the equipment, using a crash button or circuit breaker control in case of an emergency, and to alert emergency personnel. This person should have basic CPR training.

Arc Flash and Shock

Protection from Electric Shock and Arc Flash

About 50 electrical workers are killed in construction every year in the U.S. by electric current and many more are injured. Over half of the deaths are from working on energized ("live") electric circuits without proper protection – often when it was not necessary to work "live." At least one-third of the electrocutions occur at low voltage, under 600 volts.

Electric Hazards

Electricity-related hazards include electric shock and burns, arc-flash burns, arc-blast impacts, and falls.

- **Electric shock and burns.** An electric shock occurs when electric current passes through your body. This can happen when you touch an energized part. If the electric current passes across the chest or head, you can be killed. At high voltages, severe burns can result.
- **Arc-flash burns.** An electric arc flash can occur if a conductive object gets too close to a high-amp current source or by equipment failure (for instance, while opening or closing disconnects). The arc can heat the air to temperatures as high as 35,000° F and vaporize metal in the equipment. The arc flash can cause severe skin burns by direct heat exposure and by igniting clothing.
- **Arc-blast impacts.** The heating of the air and vaporization of metal creates a pressure wave that can damage hearing and cause memory loss (from concussion) and other injuries. Flying metal parts are also a hazard.
- **Falls.** Electric shocks and arc blasts can cause falls, especially from ladders or unguarded scaffolding.

Electric Safety Principles

Plan every job. Decide on your approach and step-by-step procedures. Write down first time procedures. Discuss hazards and procedures in a job briefing with your supervisor and other workers before starting a job. Your employer should already have or develop a permit system for working on live circuits, if a circuit must be worked live.

- **Identify the hazards.** Do a job hazard analysis (*see* fig. 1). Identify steps that could create electric shock or arc-flash hazards.
- **Minimize the hazards.** De-energize the equipment or insulate or isolate exposed live parts so you cannot contact them. If this is impossible, get proper personal protective equipment (PPE) and tools.

- **Anticipate problems**. If it can go wrong, it might. Make sure you have the right PPE and tools for the worst-case scenario.
- **Get training**. Make sure you and everyone working with you is a qualified person with appropriate training for the job.*

To De-Energize or Not to De-Energize

One of the most important decisions in planning an electric task is whether to de-energize. Whenever possible, live parts to which you might be exposed should be put into an **electrically safe work condition**, unless your employer can demonstrate that de-energizing creates more or worse hazards or is not practical because of equipment design or operational limitations.

You might need to work on live equipment to avoid interrupting life-support systems, de-activating emergency alarm systems, or shutting down ventilation equipment for hazardous locations, for instance. And de-energizing would not be practical during testing of live electric circuits or work on circuits that are part of a continuous process that cannot be completely shut down.

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* OSHA defines an electrical-qualified person as “one familiar with the construction and operation of the equipment and the hazards involved.”

De-Energizing

An Electrically Safe Work Condition

The most important principle of electric safety is, **assume electric circuits are energized unless you make sure they are not**. Test every circuit and conductor every time you work on them. The National Fire Protection Association lists six steps to ensure conditions for electrically safe work.

- Identify all sources of power to the equipment.
- Interrupt the load current, and then open the disconnecting devices for each power source.
- Where possible, visually verify that blades of disconnecting devices are fully open or that draw out-type circuit breakers are fully withdrawn.
- Apply lockout/tagout devices in accordance with a formal, written policy.
- Test each phase conductor or circuit part with an adequately rated voltage detector to verify that the equipment is de-energized. Check the voltage detector before and after each test to be sure it is working.

- Properly ground all possible sources of induced voltage and stored electric energy (such as, capacitors) before touching. If conductors or circuit parts that are being de-energized could contact other exposed conductors or circuit parts, apply ground-connecting devices rated for the available fault current.

The process of de-energizing is "live" work and can result in an arc flash due to equipment failure. When de-energizing, follow the procedures described below in "Working on or Near Live Circuits."

Lockout/Tagout Program

Lockout/tagout application.

Each person who could be exposed to electric energy must be involved in the lockout/tagout process.

- After de-energizing, each employee at risk should apply an individual lockout/tagout device to each source of electric energy. Pushbuttons or selector switches cannot be used as the only way to de-energize.
- A lockout device is a key or combination lock with a tag that can be attached to a disconnecting device to prevent the re-energizing of the equipment being worked on without removal of the lock. The lockout device should have a way of identifying whose lock it is. Individual lockout devices with your name and picture on them are preferred. You must be the only person who has the key or combination for a lockout device you install, and you should be the only person to remove the lock after all work has been completed.
- A tagout device is a tag and a way to attach it that can withstand at least 50 pounds of force. Tagout devices should be used alone only when it is not possible to install a lockout device.
- The tag used in conjunction with a lockout or tagout device must have a label prohibiting unauthorized operation of the disconnecting means or unauthorized removal of the device.
- Before beginning work, you must verify through testing that all energy sources have been de-energized.
- Electric lockout/tagout procedures should be coordinated with all other site procedures for controlling exposure to electric energy and other types of energy sources.

Individual qualified-employee control procedure.

For minor servicing, maintenance, inspection, and so on, on plug connected equipment, work may be done without attaching lockout/tagout devices if the plug is next to where you are working and is always easy to see, and you do not ever leave the equipment alone.

Working On or Near Live Circuits

Working on live circuits means actually touching energized parts. Working near live circuits means working close enough to energized parts to pose a risk even though you make be working on de-energized parts. Common tasks where you need to work on or near live circuits include:

- Taking voltage measurements
- Opening and closing disconnects and breakers.
- Racking breakers on and off the bus
- Removing panels and dead fronts
- Opening electric equipment doors for inspection.

There should be standard written procedures and training for these common tasks. For instance, when opening and closing disconnects, use the **left-hand rule** when possible (stand to the right side of the equipment and operate the disconnect mechanism with your left hand). For other situations where you could work on or near live circuits, your employer should institute a written live work permit system which must be authorized by a qualified supervisor.

Live-work permit system

A live work permit should, at a minimum, contain this information:

- A description of the circuit and equipment to be worked on and location.
- The date and time covered by the permit.
- Why live work will be done.
- Results of shock hazard analysis and determination of shock protection boundaries
- Results of flash hazard analysis and determination of flash protection boundary
- PPE to be worn and description of safe work practices to be used.
- Who will do the work and how unqualified persons will be kept away?
- Evidence of completion of job briefing, including description of job-specific hazards.

Approach distances to exposed live parts.

The National Fire Protection Association defines three approach distances for shock hazards and one for arc flash.

Electric shock *(see* table 1).

The **limited approach boundary** is the closest distance an unqualified person can approach, unless accompanied by a qualified person.

The **restricted approach boundary** is the closest distance to exposed live parts a qualified person can approach without proper PPE and tools. Inside this boundary, accidental movement can put a part of your body or conductive tools in contact with live parts or inside the prohibited approach boundary. To cross the restricted approach boundary, the qualified person must:

1. Have a documented plan that is approved by the manager responsible for the safety plan.
2. Use PPE suitable for working near exposed live parts and rated for the voltage and energy level involved.
3. Be certain that no part of the body enters the prohibited space.
4. Minimize the risk from unintended movement, by keeping as much of the body as possible out of the restricted space; body parts in the restricted space should be protected.

The **prohibited approach boundary** is the minimum approach distance to exposed live parts to prevent flashover or arcing. Approaching any closer is comparable to making direct contact with a live part. To cross the prohibited approach boundary, the qualified person must:

1. Have specified training to work on exposed live parts.
2. Have a documented plan with proper written work procedures and justifying the need to work that close.
3. Do a written risk analysis.
4. Have (2) and (3) approved by the manager responsible for the safety plan.
5. Use PPE appropriate for working near exposed live parts and rated for the voltage and energy level involved.

Arc flash.

The **flash protection boundary** is the distance at which PPE is needed to prevent incurable burns (2nd degree or worse) if an arc flash occurs. (You still can get 1st or 2nd degree burns.) For systems of 600 volts and less, the flash protection boundary is 4 feet, based on an available bolted fault current of 50 kA (kilo amps) and a clearing time of 6 cycles (0.1 seconds) for the circuit breaker to act, or any combination of fault currents and clearing times not exceeding 300 kA cycles. For other fault currents and clearing times, *see* NFPA 70E.

Remember; when you have de-energized the parts you are going to work on, but are still inside the flash protection boundary for nearby live exposed parts: If the parts

cannot be de-energized, you must use barriers such as insulated blankets to protect against accidental contact or you must wear proper PPE.

Proper Personal Protective Equipment

When working on or around live circuits, be sure to wear the right PPE to protect against electric shock and **arc flash.**

Never wear clothing made from synthetic materials, such as acetate, nylon, polyester, or rayon – alone or combined with cotton. Such clothing is dangerous because it can burn and melt into your skin. The type of PPE worn depends on the type of electric work being done (*see* table 2).

Once the hazard/risk category has been identified, check requirements for clothing and other PPE when working on or near energized equipment within the flash protection boundary (*see* tables 3 and 4). These PPE requirements protect against electric shock and incurable arc-flash burns. They do not protect against physical injuries from arc blasts.

The **minimum** PPE required would be an untreated natural fiber long-sleeve shirt and long pants with safety glasses with side shields (hazard/risk category 0).

Table 1- Approach Distances

Approach Distances for Qualified Employees - Alternating Current	
Voltage range (phase to phase)	**Minimum approach distance**
300V and less	Avoid contact
Over 300V, not over 750V	1 ft. 0 in.
Over 750V, not over 2kV	1 ft. 6 in.
Over 2kV, not over 15kV	2 ft. 0 in.
Over 15kV, not over 37kV	3 ft. 0 in.
Over 37kV, not over 87.5kV	3 ft. 6 in.
Over 87.5kV, not over 121kV	4 ft. 0 in.
Over 121kV, not over 140kV	4 ft. 6 in.

Types of Electrical Hazards

Table 2. Hazard Risk Category Classification

Electrical Safety Matrix Task (Assumes Equipment Is Energized, and Work, Is Done Within the Flash Protection Boundary)	Hazard Risk Category	V-rated Gloves	V-rated Tools	Natural Fiber Clothing	Long sleeve Shirt	11 cal/cm² Hooded Jacket	Denim Jeans	Hardhat	Safety Glasses	Hearing Protection	8 cal/cm² Face shield	45 cal/cm² Flashsuit	Hot Work Form 12.1	Qualified Standby Person
Panel boards 240 V (nominal) and below														
Circuit breaker (CB) or fused switch (FS) operation with covers on	0			•			•	•	•					
Opening hinged covers (to expose bare, energized parts)	0			•			•	•	•					
CB or FS operation with covers off	0			•			•	•	•					
Work on energized parts, including all testing	1	•	•	•	•	•	•	•	•				•	
Remove/install CBs or fused switches	1	•	•	•	•	•	•	•	•				•	
Removal of bolted covers (to expose bare, energized parts)	1			•	•	•	•	•	•				•	
Panel boards or Switchboards rated 250– 600 V (nominal) (with molded case or insulated case circuit breaker)														
CB or FS operation with covers on	0			•			•	•	•					
Opening hinged covers (to expose bare, energized parts)	1			•	•	•	•	•	•				•	
Removal of bolted covers (to expose bare, energized parts)	2	•	•	•	•	•	•	•	•	•	•		•	
CB or FS operation with covers off	1			•	•	•	•	•	•				•	
Work on energized parts, including all testing	2	•	•	•	•	•	•	•	•	•	•		•	
Remove/install CBs or fused switches	2	•	•	•	•	•	•	•	•	•	•		•	
Opening hinged covers (to expose bare, energized parts)	1			•	•	•	•	•	•				•	
600 V (nominal) Class Motor Control Centers (MCCs)														
CB or FS or starter operation with enclosure doors closed	0			•			•	•	•					
Reading a panel meter while operating a meter switch	0			•			•	•	•					
Opening hinged covers (to expose bare, energized parts)	1			•	•	•	•	•	•				•	
Application of safety grounds, after voltage test	2	•		•	•	•	•	•	•	•	•		•	
CB or fused switch or starter operation with enclosure doors open	1			•	•	•	•	•	•				•	
Work on energized parts, including all testing, conductor insertion/removal	2	•	•	•	•	•	•	•	•	•	•		•	
Work on control circuits with energized parts 120V or below, exposed	0	•	•	•			•	•	•					
Work on control circuits with energized parts >120V, exposed	2	•	•	•	•	•	•	•	•	•	•		•	
Insertion or removal of individual starter "buckets" from MCC	3	•		•	•		•	•	•	•		•	•	•
600 V (nominal) Class Switchgear (with power circuit breakers or fused switches)														
CB or fused switch operation with enclosure doors closed	0			•			•	•	•					
Reading a panel meter while operating a meter switch	0			•			•	•	•					
Removal of bolted cover (to expose bare, energized parts)	3			•	•		•	•	•	•		•	•	•
Application of safety grounds, after voltage test	2	•		•	•	•	•	•	•	•	•		•	
CB or fused switch operation with enclosure doors open	1			•	•		•	•	•				•	
Work on energized parts, including all testing	2	•	•	•	•	•	•	•	•	•	•		•	

Electrical Safety Matrix

Task (Assumes Equipment Is Energized, and Work, Is Done Within the Flash Protection Boundary)	Hazard Risk Category	V-rated Gloves	V-rated Tools	Natural Fiber Clothing	Long sleeve Shirt	11 cal/cm² Hooded Jacket	Denim Jeans	Hardhat	Safety Glasses	Hearing Protection	8 cal/cm² Face shield	45 cal/cm² Flashsuit	Hot Work Form 12.1	Competent Standby
600 V (nominal) Class Switchgear (with power circuit breakers or fused switches) (continued)														
Work on control circuits with energized parts I20V or below, exposed	0	•	•	•			•	•	•					
Work on control circuits with energized parts >120V, exposed	2	•	•	•	•	•	•	•	•	•	•		•	
Insertion or removal (racking) of CBs from cubicles, doors open	3			•	•		•	•	•	•		•	•	•
Insertion or removal (racking) of CBs from cubicles, doors closed	2			•	•	•	•	•	•	•	•		•	
Application of safety grounds, after voltage test	2	•		•	•	•	•	•	•	•	•		•	
Conductor insertion/removal	3	•	•	•	•		•	•	•	•		•	•	•
Other 600 V Class (250 V through 600 V, nominal) Equipment														
Lighting or small power transformers (600 V maximum)														
Removal of bolted covers (to expose bare, energized parts)	2			•	•	•	•	•	•	•	•		•	
Opening hinged covers (to expose bare, energized parts)	1			•	•	•	•	•	•				•	
Work on energized parts, including all testing	2	•	•	•	•	•	•	•	•	•	•		•	
Application of safety grounds, after voltage test	2	•		•	•	•	•	•	•	•	•		•	
Revenue meters (kW-hour, at primary voltage and current)														
Insertion or removal	2	•		•	•	•	•	•	•	•	•		•	
Cable trough or tray cover removal or installation	1			•	•	•	•	•	•				•	
Miscellaneous equipment cover removal or installation	1			•	•	•	•	•	•				•	
Work on energized parts, including all testing	2	•	•	•	•	•	•	•	•	•	•		•	
Application of safety grounds, after voltage test	2	•		•	•	•	•	•	•	•	•		•	
NEMA E2 (fused contactor) Motor Starters, 2.3kV through 7.2 kV (nominal)														
Contactor operation with enclosure doors closed	0			•			•	•	•					
Reading a panel meter while operating a meter switch	0			•			•	•	•					
Removal of bolted covers (to expose bare, energized parts)	4			•	•		•	•	•	•		•	•	•
Contactor operation with enclosure doors open	2			•	•	•	•	•	•	•	•		•	
Work on energized parts, including voltage testing	3	•	•	•	•		•	•	•	•		•	•	•
Work on control circuits with energized parts 120V or below, exposed	0	•	•	•			•	•	•					
Work on control circuits with energized parts >120V, exposed	3	•	•	•	•		•	•	•	•		•	•	•
Insertion or removal (racking) of starters from cubicles, doors open	3			•	•		•	•	•	•		•	•	•
Insertion or removal (racking) of starters from cubicles, doors closed	2			•	•	•	•	•	•	•			•	
Application of safety grounds, after voltage test	3	•		•	•		•	•	•	•	•	•	•	•
Opening hinged covers (to expose bare, energized parts)	3			•	•		•	•	•	•		•	•	•

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Task (Assumes Equipment Is Energized, and Work, Is Done Within the Flash Protection Boundary)	Hazard Risk Category	V-rated Gloves	V-rated Tools	Natural Fiber Clothing	Long sleeve Shirt	11 cal/cm² Hooded Jacket	Denim Jeans	Hardhat	Safety Glasses	Hearing Protection	8 cal/cm² Face shield	45 cal/cm² Flashsuit	Hot Work Form 12.1	Competent Standby
Metal Clad Switchgear, 1 kV (nominal) and above														
CB or fused switch operation with enclosure doors	2			•	•	•	•	•	•	•	•		•	
Reading a panel meter while operating a meter switch	0			•			•	•	•					
CB or fused switch operation with enclosure doors open	4			•	•		•	•	•	•		•	•	•
Work on energized parts, including all testing	4	•	•	•	•		•	•	•	•		•	•	•
Work on control circuits with energized parts 120V or below, exposed	2	•	•	•	•	•	•	•	•	•	•		•	
Work on control circuits with energized parts >120V, exposed	4	•	•	•	•		•	•	•	•		•	•	•
Insertion or removal (racking) of CBs from cubicles, doors open	4			•	•		•	•	•	•		•	•	•
Insertion or removal (racking) of CBs from cubicles, doors closed	2			•	•	•	•	•	•	•	•		•	
Application of safety grounds, after voltage test	4	•		•	•		•	•	•	•		•	•	•
Removal of bolted covers (to expose bare, energized parts)	4			•	•		•	•	•	•		•	•	•
Opening hinged covers (to expose bare, energized parts)	3			•	•		•	•	•	•		•	•	•
Opening voltage transformer or control power transformer compartments	4			•	•		•	•	•	•		•	•	•
Other Equipment 1 kV (nominal) and above														
Metal clad load interrupter switches, fused or un-fused														
Switch operation, doors closed	2			•	•	•	•	•	•	•	•		•	
Work on energized parts, including all testing	4	•	•	•	•		•	•	•	•		•	•	•
Removal of bolted covers (to expose bare, energized parts)	4			•	•		•	•	•	•		•	•	•
Opening hinged covers (to expose bare, energized parts)	3			•	•		•	•	•	•		•	•	•
Outdoor disconnect switch operation (hook-stick operated)	3	•	•	•	•		•	•	•	•		•	•	•
Outdoor disconnect switch operation (gang-operated, from grade)	2			•	•	•	•	•	•	•	•		•	•
Insulated cable examination, in manhole or other confined space	4	•		•	•		•	•	•	•		•	•	•
Insulated cable examination, in open area	2	•		•	•	•	•	•	•	•	•		•	
Direct Current Equipment 36V - 72V (nominal)														
Work on energized parts, including all testing	1	•	•	•	•	•	•	•	•				•	

Figure 1. Hazard / risk analysis flow



Source: Adapted from figure D-1 of NFPA 70E, *Electrical Safety Requirements for Employee Workplaces*. Tables are reprinted with permission. Copyright ©2000 National Fire Protection Association, Quincy, MA 02269. This reprinted material is not the complete and official position of the National Fire Protection Association on the referenced subject, which is represented only by the standard in its entirety.

Energized Work Form

Requesting Person_____ **Division**_____

Job Number_____ **Job Name**_____

Equipment/Machine to be Locked Out and Tagged Out_____

Equipment and/or Circuits to be worked on energized_____

Date(s) of work to be performed _____

Work to be performed _____

Energy Source and Location _____

Statement of why equipment cannot be de-energized_____

_____

Is it possible to reschedule work at a later date when equipment may be de-energized? YES NO

Hazards (risk to personnel, property, production) _____

_____

Results of Shock/Flash Hazard Analysis: Hazard Risk Category _____

Flash Protection Boundary _____ Limited Approach Boundary _____

Restricted Approach Boundary _____ Prohibited Approach Boundary _____

Employees who will be performing the energized work
_____

Have employees been properly trained? Yes No

Have affected employees been notified of procedures and hazards? Yes No

Date of Notification _____ Competent person assigned _____

Energized Work Category: < 50v 50 – 250v 250 - 600v ≥600v

List personal protective equipment needed_____

Date equipment last tested _____ Tested by: _____

Has written plan/Task Safety Analysis (TSA) been completed for energized work? _____ attach copy.

Authorized Customer representative approval_____ Date _____

Customer representative understands all risks: injury, damage and loss of production (Required for all energized work)

Job Supervisor _____ Date _____

(Required PM / PCM _____ Date _____

(Required for energized work, ≥ 600v)

Branch Manager _____ Date _____

(Required for energized work, ≥ 600v)

Lock-Out / Tag-Out Procedures

When you have to perform maintenance work on a machine, take these four steps to protect yourself and your co-workers from injury:

1) De-energize the machine if possible. Positively disconnect the machine from the power source. If there is more than one source of power, then disconnect them all.

2) If possible, lock out all disconnect switches. You must be given a lock and a key for each disconnect before you begin working on the machine.

3) Tag all disconnect switches. Use the yellow or Red safety tags which state in large letters

"**Danger! Do Not Operate**," or "**Danger! Do Not Energize**"

and which give the name of the individual who locked out the equipment, date and time. The tag must also state

"**DO NOT REMOVE THIS TAG**"

(The person who placed the tag may remove it only after the machinery maintenance has been completed.)

4) Test the equipment to ensure it is de-energized before working on it. First, attempt to operate the equipment by turning it on normally. Next, check all electrical lines and exposed areas with test equipment or a "lamp." Finally, short to ground any exposed connections using insulated grounding sticks. This test must be done even if the electrical connection is physically broken, such as pulling out a plug, because of the chance of discharging components.

A TAG OUT ONLY PROCEDURE MAY BE USED IF THE MACHINE CANNOT BE LOCKED OUT. IF THE MACHINE IS SUPPLIED ELECTRICAL POWER FROM A SINGLE SOURCE, WHICH IS UNDER THE EXCLUSIVE CONTROL OF A TRAINED AND QUALIFIED REPAIR PERSON AT ALL TIMES AND THERE ARE NOT ANY OTHER PERSONS IN THE REPAIR AREA WHO COULD BE HARMED BY THE ACCIDENTAL ENERGIZING OF THE MACHINERY, THEN TAG OUT MAY BE USED INSTEAD OF LOCK-OUT/TAG OUT.

Be aware that many accidents occur at the moment of re-energizing. If the machinery is to be re-energized, all persons must be kept at a safe distance away from the machinery. The re-energization can be performed only by a person who either performed the lock-out/tag out, a person acting under the immediate and direct commands of the original

lock-out/tag out person, or in the event of a shift change, or otherwise unavailability of the original person, then the original shall, before leaving, appoint a surrogate original person and show him or her all steps taken to lock-out/tag-out the equipment.

More than 300 Volts

To work on systems with voltages greater than 300 volts (CLASS B OR C HAZARD):

Open the feeder breaker, roll out if possible, tag out, and lock if in an enclosure. If work is on circuits of 600 V or more, positive grounding cables should be attached to all three phases. The tag should contain who, why, and when information, and it is of vital importance because a person's life may depend on it. "Vital" in this case means that the presence and status of the tag are inviolate, and the tag must not be altered or removed except by the person who attached it.

Less than 300 Volts

To work on systems with voltages less than 300 volts (CLASS A HAZARD): Turn off and tag the feeder breaker. Tag is inviolate except on projects where an established circuit checkout procedure allows a qualified person to remove it and energize the circuit after checkout is complete.

Motor Generator Systems

For motor or generator work, the primary feeder breaker must be opened, tagged, and locked out if possible. For generator-load work, a motor-start permissive key must be removed by the person doing work and restored when work is complete.

High Voltage

To work on high voltage power supplies and enclosures use Class B or Class C hazard procedure specified in the safety requirements. Access should always be by a permissive key that interrupts input power when the key is removed from the control panel. Grounding of power supply output must occur either automatically when the key is removed from the control panel or manually before the access door can be opened.

High Current

To work on high current power supplies (normally for magnets), treat the system as a high voltage power supply if energy storage is 5 joules or more when the system is off. If not, the requirements for working on the magnet are as follows: *If the power supply is equipped with Kirk (trademark) or equivalent interlock, turn the key and remove it.* This locks the input breaker in the "Off" position until the key is reinserted and turned. If the

power supply is not equipped with a Kirk (trademark) or equivalent interlock, turn off and tag the input circuit breaker.

Working on Power Supplies

The minimum requirement for working on any power supply is to turn the power off and properly tag the feeder circuit breaker external to the power supply.

Storage Batteries

(a) Battery charging installations shall be located in areas designated for that purpose. Employees assigned to work with storage batteries shall be instructed in emergency procedures such as dealing with accidental acid spills.

(b) The area shall be adequately ventilated to prevent concentrations of flammable gases exceeding 20 percent of the lower explosive limit and to prevent a harmful concentration of mist from the electrolyte.

(c) Where corrosive liquids are regularly or frequently handled in open containers or drawn from reservoirs or pipelines, adequate means shall be provided to neutralize or dispose of spills and overflows promptly and safely.

(d) Carboy tilter, siphon, hand-operated bulb or hand-operated pump shall be provided and used for dispensing electrolyte or acid.

(e) Facilities shall be provided for protecting the charging apparatus from damage by mobile equipment.

(f) Appropriate mechanical lifting and material handling devices or equipment shall be provided for handling batteries.

(g) Smoking shall be prohibited in the charging area.

(h) Precautions shall be taken to prevent open flames, sparks, or electric arcs in battery charging areas. When racks are used for support of batteries, they shall be made of materials nonconductive to spark generation or coated or covered to achieve this objective. Tools and other metallic objects shall be kept away from the top of uncovered batteries. Chargers shall be turned off when leads are being connected or disconnected.

(i) Electrolyte (acid or base, and distilled water) for battery cells shall be mixed in a well-ventilated room. Acid or base shall be poured gradually into the water while stirring. Water shall never be poured into concentrated (greater than 75 percent) acid solutions.

(j) Mobile equipment shall be properly positioned and brake applied before attempting to change or charge batteries.

(k) When charging batteries, the vent caps shall be kept firmly in place to avoid electrolyte spray. Care shall be taken to assure that vent caps are functioning. The battery compartment cover(s) shall be open to dissipate heat.

(l) Facilities for quick drenching or flushing of the eyes and body shall be provided unless the storage batteries are:

(1) equipped with explosion resistant or flame arrestor type vents; or

(2) located in a compartment or other location such as to preclude employee exposure.

EXCEPTIONS: Automotive servicing facilities and parts stores where:

1. A suitable neutralizing agent is available.
2. An adequate supply of clean water is readily available.
3. The transfer system is essentially a closed system and does not involve handling acid in open containers.

(m) When taking specific gravity readings, the open end of the hydrometer shall be covered with an acid-resistant material while moving it from battery to battery to avoid splashing or throwing the electrolyte.

(n) Electrolyte shall only be placed in suitable containers and shall not be stirred with metal objects.

(o) When a jumper battery is connected to a battery in a vehicle, the ground lead shall connect to ground away from the vehicle's battery. Ignition, lights, and accessories on the vehicle shall be turned off before connections are made.

(p) Vent caps shall be in place when batteries are being moved.

EXCEPTIONS: Portable equipment battery systems:

Batteries and battery charging equipment of fewer than 100 watt-hours are exempt.

Environmental Protection

Purpose

To provide specific guidelines for handling hazardous waste in ways that will protect human health and the environment and to provide a means to control hazardous waste from the moment it is generated until its ultimate disposal.

References

Except to the extent that more explicit or more stringent requirements are written directly into these procedures, the primary regulatory references relating to environmental protection practices during the conduct of S.C. Swiderski, LLC operations shall be:

- Title 40 Code of Federal Regulations Part 261
- Title 49 Code of Federal Regulations Part 172
- Title 29 Code of Federal Regulations Part 1910

Additional references:

- US EPA Document #530-SW-86-019; *Understanding the Small Quantity Generator Hazardous Waste Rules: A Handbook for Small Business*, September 1986.
- US EOA Document #530-SW-90-027; *Does Your Business Produce Hazardous Waste?* January 1990
- Federal Register: March 24, 1986

Policy

Risk Reduction

S.C. Swiderski, LLC operation will operate in a manner designed to minimize environmental, health, or safety hazards. S.C. Swiderski, LLC will minimize risk and protect our employees, and others in the vicinity of our operations, by providing specific hazard awareness training and information programs to employees, and where applicable, community residents. Additional chemical protection safeguards will be provided through the application of safe management technologies and operating procedures and by being prepared for emergencies.

S.C. Swiderski, LLC will make available to our employees, and to the public, information related to any of our operations that we believe could cause environmental harm or pose health or safety hazards.

S.C. Swiderski, LLC will encourage employees to report any condition that creates a danger to the environment or poses health or safety hazards and will provide a confidential means for them to do so.

Waste Reduction, Recycling, Treatment and Disposal

S.C. Swiderski, LLC shall work to minimize the volume and toxicity of waste generated by S.C. Swiderski, LLC operations. Minimization of waste results from the initiation and maintenance of process/production reviews, which will enable substitution, and/or reuse of potentially hazardous chemicals to take place.

S.C. Swiderski, LLC will initiate and maintain waste recycling programs, to the extent possible, as an effort to minimize the volume of generated wastes and to provide renewable resources within other industries.

S.C. Swiderski, LLC will not initiate activities that produce a demand for extensive chemical treatment operations, except for small scale, waste stabilization efforts relating to transport of wastes.

Disposal of generated hazardous wastes shall be performed in accordance with the requirements established by Title 40 CFR Part 261, which details three important considerations related to waste management.

- That, depending on quantities generated, a generator must comply with specific storage time, quantity, and handling requirements for containers and tanks.
- That *S.C. Swiderski, LLC*, as a generator, may have to obtain specific storage, treatment, or disposal permits if storage, treatment, or disposal of wastes at the project location(s) is anticipated.

That *S.C. Swiderski, LLC*, as a generator, will be required to implement adequate precautions to prevent accidents, and that *S.C. Swiderski, LLC* must be prepared to handle them properly in the event that they do occur.

DEFINITIONS

US EPA – Untied States Environmental Protection Agency

Waste Generator – Any person or organization whose act or process produces hazardous waste, or whose act first causes a hazardous waste to become subject to

regulation. The generator designation determines who is responsible for recordkeeping and compliance.

RCRA – Resource Conservation and Recovery Act (1976, 1984); Administered by the US EPA, the act regulates management and disposal of hazardous materials and disposal of

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