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Electrical Safe Work Practices Policy

Purpose

This policy will provide for the safety of employees working on or near electrical circuits or equipment. This policy is intended to meet, the requirements of OSHA Subpart S, *Electrical Safety Related Work Practices*, 29 CFR 1910.331-335, and 29 CFR 1910.137 *Electrical Protective Equipment*, MIOSHA Part 40. *Electrical Safety-Related Work Practices* and NFPA 70E *Standard for Electrical Safety in the Workplace* (2009).

Extent

Provisions of these standards cover electrical safety related work practices and procedures for both qualified and unqualified persons exposed to potential electrical hazards. This applies to all Billerud NA employees, contractors and visitors (while working on Billerud property).

Training

All affected employees shall be trained and familiar with the safety-related work practices covered by this policy and how it applies to them.

This training shall be classroom or on-the-job training under the direct supervision of a qualified person.

Qualified Persons

An employee who has demonstrated skills and knowledge related to the construction and operation of the electric equipment and installations in the plant and has received safety training to identify and avoid the electrical hazards involved in working on or near exposed energized parts.

To be considered qualified, employees shall receive at a minimum training in the following:

1. The skills and techniques necessary to distinguish exposed energized electrical conductors and circuit parts from other parts of electrical equipment.
2. The skills and techniques necessary to determine the nominal voltage of exposed energized electrical conductors and circuit parts.
3. The minimum approach distances as specified in this procedure and the corresponding voltages to which the person will be exposed.
4. The knowledge necessary to determine the degree and extent of the hazard and the personal protective equipment and job planning necessary to perform the task safely.
5. The proper use of special precautionary techniques, personal protective equipment, insulating and shielding materials, and insulated tools for working on or near exposed energized parts of electrical equipment.
6. The proper selection and use of an appropriate voltage detector and shall demonstrate how to use a

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device to verify the absence of voltage, including interpreting indications provided by the device and proof of working test.

Unqualified Persons

A person who does not have the necessary background to be working on or near electrical hazards

At a minimum, unqualified persons shall be trained in the following:

1. A basic understanding of electricity: What it is, its effects, its characteristics, and inherent hazards such as high voltages, electrical current, arcing, grounding, and lack of guarding.
2. General concepts of safe approach boundaries.
3. An understanding of the facility Control of Hazardous Energy/Lockout Policy.

Qualified Non-Electrical Person

A person who is not electrically qualified to work on live electrical circuits but has operating and lockout responsibilities that involve equipment associated with or in the proximity of potential electrical hazards. Qualified Non-Electrical personnel will receive electrical safety training to understand the facility electrical safety program, be able to recognize general electric hazards, and properly operate disconnect switches and breakers rated up to 600V. Qualified Non-Electrical persons may be trained to properly operate disconnect switches and breakers rated higher than 600V in certain cases which requires additional training on hazards and PPE needs. This person may perform one-time external breaker resets only. Subsequent breaker trips require notification of qualified personnel to correct.

Emergency Procedures Training

Employees working on or near exposed energized electrical conductors or circuit parts shall be trained in methods of release of victims from contact with exposed energized conductors or circuit parts.

Employees who are frequently exposed to electrical hazards shall be trained to provide cardiopulmonary resuscitation (CPR). CPR certification/training shall be updated annually.

Personnel Certification and Record Keeping

Certification shall be made when an employee demonstrates proficiency in the work practices stated in this section. Documentation of this certification shall be maintained for the duration of the employee's employment or job assignment whichever is most appropriate.

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Retraining

Qualified and unqualified employees will be retrained upon changes in the policy or changes in the regulations on the applicable elements of this policy.

Work Practices & Procedures

Arc Flash Hazard

A dangerous condition associated with the possible release of energy caused by an electric arc.

An arc flash hazard may exist when energized electrical conductors or circuit parts are exposed or when they are within equipment in a guarded or enclosed condition, provided a person is interacting with the equipment in such a manner that could cause an electric arc.

“Interacting” or “working on” shall include, and will apply, when crossing the Restricted Approach Boundary of exposed energized conductors.

Approach Boundaries to Energized Electrical Conductors or Circuit Parts

Both Qualified and Unqualified workers must keep a safe distance from electrical conductors and equipment.

Shock Protection Boundaries

The shock protection boundaries identified, as Limited, Restricted, and Prohibited Approach Boundaries are applicable to the situation in which approaching personnel are exposed to energized electrical conductors or circuit parts. See **Figure 1** (Section 4.2.7) and **Table 130.2(C)** for the distances associated with various system voltages.

Limited Approach Boundary

1. An approach limit at a distance from an exposed energized electrical conductor or circuit part within which a shock hazard exists.
2. Unqualified persons shall not cross the Limited Approach Boundary unless continuously escorted by a qualified person.
3. Under no circumstance shall the escorted unqualified person(s) be permitted to cross the Restricted Approach Boundary.

Restricted Approach Boundary

An approach limit at a distance from an exposed energized electrical conductor or circuit part within which

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there is an increased risk of shock, due to electrical arc over combined with an inadvertent movement, for personnel working in close proximity to the energized electrical conductor or circuit part.

To cross the Restricted Approach Boundary and enter the restricted space, qualified persons must do the following:

Have an approved *Electrical Hot Work Permit* if required.

Use personal protective equipment as determined by the arc flash hazard analysis and specified by the Arc Flash and Shock Hazard Warning Label on the equipment. If an analysis has not been performed and a warning label does not exist, **Table 130.7(C)(15)(A)(b) or Table 130.7(C)(15)(B)** when the requirements of these tables apply.

Be certain no body part or conductive material enters the prohibited space.

Minimize the risk from inadvertent movement by keeping as much of the body out of the restricted space as possible, using only protected body parts in the space as necessary to accomplish the work.

Prohibited Approach Boundary

An approach limit at a distance from an exposed energized electrical conductor or circuit part within which work is considered the same as making contact with the electrical conductor or circuit part.

Arc Flash Boundary

The arc flash boundary shall be the distance at which the incident energy equals 1.2 cal/cm².

Figure 1: Limits of Approach

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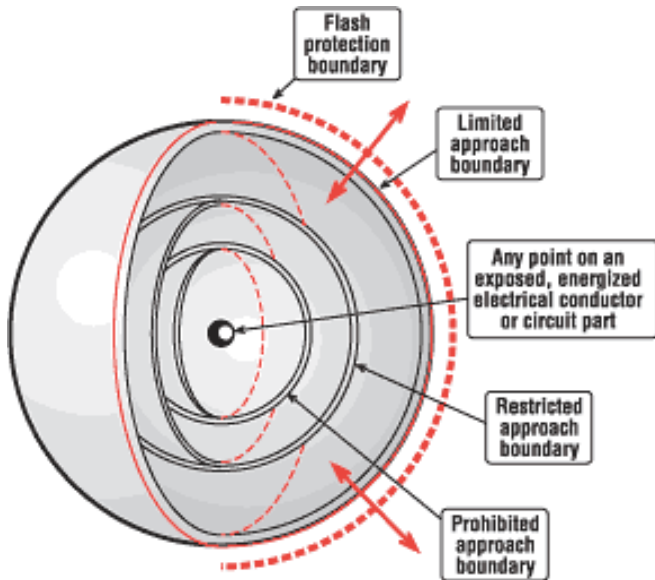


Table 130.2(C)

APPROACH BOUNDARIES TO LIVE PARTS FOR SHOCK PROTECTION			
Nominal System Voltage Range, Phase to Phase	Limited Approach Boundary		Restricted Approach Boundary – Includes Inadvertent Movement Adder
	Exposed Movable Conductor	Exposed Fixed Circuit Part	

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Less than 50 V	Not specified	Not Specified	Not Specified	Not Specified
50 to 300 V	10 ft. 0 in.	3 ft. 6 in.	Avoid contact	Avoid contact
301 to 750V	10 ft. 0 in.	3 ft. 6 in.	1 ft. 0 in.	0 ft. 1 in.
751 to 15kV	10 ft. 0 in.	5 ft. 0 in.	2 ft. 2 in.	0 ft. 7 in.
15.1 kV to 36 kV	10 ft. 0 in.	6 ft. 0 in.	2 ft. 7 in.	0 ft. 10 in.
36.1 kV to 46kV	10 ft. 0 in.	8 ft. 0 in.	2 ft. 9 in.	1 ft. 5 in.
46.1kV to 72.5kV	10 ft. 0 in.	8 ft. 0 in.	3 ft. 3 in.	2 ft. 2 in.
72.5kV to 121kV	10 ft. 8 in.	8 ft. 0 in.	3 ft. 4 in.	2 ft. 9 in.
138kV to 145kV	11 ft. 0 in.	10 ft. 0 in.	3 ft. 10 in.	3 ft. 4 in.
161kV to 169kV	11 ft. 8 in.	11 ft. 8 in.	4 ft. 3 in.	3 ft. 9 in.
230kV to 242kV	13 ft. 0 in.	13 ft. 0 in.	5 ft. 8 in.	5 ft. 2 in.
345kV to 362kV	15 ft. 4 in.	15 ft. 4 in.	9 ft. 2 in.	8 ft. 8 in.
500kV to 550kV	19 ft. 0 in.	19 ft. 0 in.	11 ft. 10 in.	11 ft. 4 in.
765kV to 800kV	23 ft. 9 in.	23 ft. 9 in.	15 ft. 11 in.	15 t. 5 in.

Flash Hazard Analysis

An arc flash hazard analysis has been done in order to protect personnel from the possibility of being injured by an arc flash. The analysis shall be used to determine the Flash Protection Boundary and the personal protective equipment that people within the boundary shall use.

The arc flash hazard analysis shall be updated when a major modification or renovation takes place.

The arc flash hazard analysis shall be reviewed every 5 years.

Labeling of Panel Boards

All designated panels will be labeled with the appropriate arc flash warning labels as determined by the ach flash study. **Figure 2** (Section 4.4.2) shows on example Arc Flash Warning Label. The following information

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must be included:

1. The Flash Protection Boundary (4.0 ft. if not calculated).
2. The Flash Hazard expressed in calories per square centimeter.
3. The Hazard Category.
4. The Shock Hazard.
5. The Glove Class.
6. Limited Approach Boundary.
7. Restricted Approach Boundary.
8. Prohibited Approach Boundary.
9. Equipment “bus” that is applicable to the information provided.
10. Protection device used to determine the arc hazard information.

Figure 2: Arc Flash Warning Label


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**Arc Flash and Shock Risk
Appropriate PPE Required**

FLASH PROTECTION		SHOCK PROTECTION	
2.8 cal/cm ²	Flash Risk at 18 in	Shock Hazard	480 VAC
	Flash Risk Boundary: 30 in	Limited Approach	42 in
		Restricted Approach	12 in
Min. Arc Rating: 4 cal/cm ²		Glove Class:	00
FR Shirt & Pants			

August 27, 2015

Bus: 01-8-8035-88 (Fire Pump Controller) Prot: 5T3_2-1 AC PRO

Work Practices

Live parts to which an employee may be exposed shall be de-energized before the employee works on or near them unless the employer can demonstrate that de-energizing the parts introduces additional or increased hazards or is infeasible due to equipment design or operational limitations. Live parts that operate at less than 50 volts to ground need not be de-energized if there will be no increased exposure to electrical burns or to explosion due to electric arcs. Examples of increased or additional hazards include the interruption of life-support equipment, the deactivation of emergency alarm systems, the shutdown of hazardous location ventilation equipment, or the removal of illumination for an area. Examples of work that may be performed on or near energized circuit parts because of infeasibility due to equipment design or operational limitations include the testing of electric circuits that can only be performed with the circuit energized and work on circuits that form an integral part of a continuous industrial process that would otherwise need to be completely shut down to permit work on 1 circuit or piece of equipment

Electrical Design and Installation

Code Compliance

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Facility management will ensure compliance with applicable electrical requirements of the National Fire Protection Association (NFPA), ANSI C 2, and respective parts of 29 CFR 1910 and 29 CFR 1926. All electrical installations and equipment are subject to inspection and the approval of the Authority Having Jurisdiction (AHJ). Facility Management will ensure that resources are available to provide for compliance with applicable codes and standards. In addition, they will ensure that:

- Inspections are performed by qualified personnel on electrical work and equipment, including utilization equipment. These inspections will be in accordance with 29 CFR 1910 Subpart “S”.
- Inspections will be documented. Inspection records, deficiencies, and corrective actions will be maintained in a department file.
- Examinations are performed on equipment that is not listed or labeled by a Nationally Recognized Testing Laboratory (NRTL). Record drawings of electrical systems and equipment are maintained and a system exists for recording changes and correcting the drawings to reflect those changes.

Equipment and Materials Approval

Electrical equipment and materials for facilities wiring, as defined by NFPA 70 will be approved in accordance with Article 90-7, Examination of Equipment for Safety, and with Article 110-3, Examination, Identification, and Use of Equipment

An electrically safe work condition shall be achieved to safeguard employees from exposure to electrical hazards while they are working on or near electrical conductors or circuit parts that are likely to result in injury from inadvertent or accidental contact or equipment failure. An electrically qualified person shall use adequately rated test equipment to test circuit elements and electrical parts of equipment to which employees will be exposed and verify all elements and parts de-energized. The test shall also determine if any energized condition exists as a result of inadvertently induced voltage or unrelated voltage back feed even though specific parts of the circuit have been de-energized and presumed to be safe. Test equipment shall be checked for proper operation immediately before and immediately after this test.

Conductors and parts of electric equipment that have been de-energized but have not been locked out or tagged in accordance with the facility Control of Hazardous Energy Policy, shall be treated as energized and work shall be in compliance with this section.

Working on or near Exposed Energized Parts

Only qualified persons may work on or near exposed energized electric circuit parts on equipment operating at 50 volts or more. Work performed on exposed energized parts within the Restricted Approach Boundary requires an approved **Energized Work Permit** (Section 11). See section 4.6.2 for exceptions.

Exceptions to the requirement of an energized electrical work permit.

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1. Work performed on or near live parts by qualified persons related to tasks such as testing, troubleshooting, measurements, etc., shall be permitted to be performed without an energized electrical work permit, provided appropriate safe work practices and personal protective equipment are used.
2. When work is to be performed on energized 110V equipment per section 4.5.1, the precautions and safety procedures as indicated by the energized electrical work permit shall be followed. Permit approvals and submission are not required.

If work is to be performed near overhead lines, the lines must be de-energized and grounded, or protective measures taken prior to starting work. Such protective measures may include guarding, isolating, or insulating to prevent employees from contacting the energized lines either directly or indirectly through conductive materials, tools, or equipment. Unqualified employees must always maintain a 10-foot clearance distance from overhead lines as indicated in **Table 130.2(C)(4.2.8)**.

Any vehicle or mechanical equipment capable of having parts of its structure elevated near energized overhead lines shall be operated so that a clearance of ten feet is maintained.

Energized Work Permit

An Approved **Energized Work Permit** (Section 11) is required prior to implementing necessary repairs to electrical equipment or circuits operating in excess of 50 volts that cannot be de-energized under the reasons stated above. See section 4.6.2 for exceptions. The permit must include the following information:

1. Description of work: Clear and concise description of work to be performed identifying equipment, associated voltage levels, and who will be performing the work.
2. Justification: Identify reason for performing work on or near exposed energized parts versus taking a shutdown.
3. Special Precautions: Identify additional precautions that will be used such as insulating barriers, flash protection, and critical work procedures to perform the job safely.
4. Approval will be by E/I supervision (verbal or written).

Job Briefings

Before starting each job, a pre-job huddle shall take place with the employees involved. The huddle shall cover such subjects as hazards associated with the job, work procedures involved, special precautions, energy source controls, and personal protective equipment requirements.

Whenever work conditions or methods change that could potentially compromise personnel safety, additional

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huddles shall be held.

Protective Clothing and PPE for Application of an Arc Flash Hazard

Employees working in areas where there are possible electrical hazards shall use protective equipment/clothing appropriate for the hazard.

Where it has been determined that work will be performed by qualified persons within the Restricted Approach Boundary, the flash hazard analysis and associated warning labels shall determine and document the incident energy exposure of the worker (in calories per square centimeter). Flame-resistant (FR) clothing and PPE must be used by the employee based on the incident energy exposure associated with the specific task. Rings, watches, and synthetic fiber clothing shall not be worn.

For tasks that do not involve entering the Restricted Approach Boundary or in the event that an arc flash hazard analysis has not been completed, the PPE requirements specified in **Table 130.7(C)(9)** (Section 12) from the NFPA 70E *Hazard/Risk Category Classifications and Use of Rubber Insulating Gloves and Insulating Hand Tools* shall be used.

Once the hazard/risk category has been identified, **Table 130.7(C)(10)** (Section 13) from NFPA 70E, *Protective Clothing and Personal Protective Equipment* shall be used to determine appropriate clothing.

Employees entering MCC or substation rooms shall be required to dress in long sleeve/long pant cotton or other 100% natural fiber. Clothing can not have vinyl decals or silk screening. Embroidery is acceptable if the thread is cotton or natural fiber.

When employees are exposed to the hazards of flames or electrical arcs, they are prohibited from wearing clothing and underwear with synthetic blends such as acetate, nylon, polyester, or rayon. Garments with silk screening shall not be worn. Only 100% natural fibers such as cotton will be permitted. This may be in combination with a Flame Resistant (FR) outer layer (work uniform). *Exception: An incidental amount of elastic used on non-melting fabric underwear or socks shall be permitted.*

De-energizing Equipment

Procedures for safely de-energizing circuits and equipment shall follow Escanaba's Lock-Out policy.

Operating 600 volt and below circuit breakers (non feeder breakers) or disconnects with doors closed can be performed by qualified non-electrician employees and qualified employees. For non-dangerous busses, this activity is considered category 0 as per **Table 130.7(C)(15)(A)(a)**.

Operating circuit disconnects above 600 volts, feeder breakers, circuit disconnects near open busses and

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circuit disconnects on dangerous rated (\leq Category 2) busses will be performed by properly trained qualified non-electricians, and qualified personnel only.

Operating circuit disconnects above 600 volts, feeder breakers, circuit disconnects near open busses and circuit disconnects on dangerous rated (>math>\geq</math> Category 3) busses will be performed by qualified personnel only.

Temporary Protective Grounding of Equipment

Temporary protective grounds shall be placed at such locations and arranged in such a manner as to prevent each employee from being exposed to hazardous differences in electrical potential.

Temporary protective grounds shall be capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault.

Temporary protective grounding equipment shall meet the requirements of ASTM F855, Standard Specification for Temporary Protective Grounds to be used on De-energized Electric Power lines and Equipment, 1997.

Temporary protective grounds shall have impedance low enough to cause immediate operation of protective devices in case of accidental energizing of the electrical conductors or circuit parts.

Re-energizing Equipment

Before re-energizing electrical equipment and circuits on which electrical work has been performed, the following requirements must be met in the order given.

1. An inspection shall be conducted by a qualified person to verify that all tools, electrical jumpers, shorts, grounds, and other such devices have been removed, so that equipment can be safely re-energized.
2. All employees exposed to the hazards associated with re-energizing the equipment shall be warned to stay clear of the circuits and equipment.
3. Each personal lock and/or tag shall be removed by the employee who applied it as per Escanaba's Lock-out policy.

Safeguards For Personal Protection

Electrical PPE shall be maintained in a safe, reliable condition.

The following requirements apply to insulating blankets, covers, line hose, gloves and sleeves made of rubber.

1. Insulating equipment shall be inspected before each day's use and immediately following any incident that might have caused damage.

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2. Insulating equipment found to have defects that might affect the insulating properties must be removed from service and tested.
3. Protector gloves must be worn over insulating gloves.
4. Insulating equipment shall be cleaned as needed to remove foreign substances and shall be stored in locations protected from light, temperature extremes, excessive humidity, ozone, and other damaging conditions.
5. Insulating equipment failing to pass inspections or electrical tests shall be removed from service and discarded.
6. Electrical PPE shall be periodically tested in accordance with the appropriate ASTM standard.

Protective Equipment and Tools

Insulated tools or handling equipment rated for the circuit voltage are required when working on or near exposed energized circuits if there is a possibility of contacting conductors or parts.

Protective barriers, shields, or insulating materials shall be used to protect employees from electrical shock, burns, or other related injuries while working near exposed energized parts which might be accidentally contacted or near possible dangerous arcing or electric heating.

Alerting Techniques

When normally enclosed live parts are exposed for maintenance or repair, they shall be guarded to protect unqualified persons from contact with the live parts. The following alerting techniques shall be used to warn and protect employees from hazards which could cause injury due to electric shock, burns, or failure of electric equipment parts.

1. Safety signs, safety symbols, or accident prevention tags shall be used where necessary to warn employees about electrical hazards which may endanger them.
2. Barricades shall be used in conjunction with safety signs where it is necessary to prevent or limit employee access to work areas containing energized conductors or circuit parts.
3. If signs or barricades do not provide sufficient warning and protection from electrical hazards, an attendant(s) will be stationed at the entrance(s) to these areas to prevent employee access.
4. A 3 foot clearance must be maintained around electrical services.

Use of Equipment

Grounded Tools

All portable electrical hand tools (unless double insulated) must contain an equipment grounding conductor

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that is connected to the tool frame and through the supply cord back to the service entrance enclosure. In the case of double insulated tools, the case must be non-conductive plastic with no continuity to either conductor.

All portable powered hand tools shall be used with GFCI equipped cords.

All electrical power tools must be listed by Underwriters Laboratories (UL).

Visual Inspection of Tools and Cords

Tools and their cords must be inspected before use. If defects are found, they should be taken out of service until repaired.

Cord and Plug Equipment

Flexible cords and cables must be suitable for conditions of use and location.

Flexible cords may not be used for raising or lowering equipment, nor fastened with staples or used in a manner which would cause damage to the outer jacket or insulation

Portable tools or cords shall not be used in locations where water or other high conductivity liquids are present unless the equipment is designed and rated for such use.

Extension cords must not be used as a substitute for the fixed wiring in a structure and shall be approved only for temporary use.

Test Instruments and Equipment

Only Qualified persons shall perform testing on electrical equipment or circuits.

All test equipment and related accessories shall be visually inspected before each use. If there is evidence of damage that might expose someone to injury, the damaged items shall be removed from service until repairs can be rendered.

All test equipment and related accessories shall be rated for the equipment and circuits to which it will be connected and shall be adequately designed for the environment in which it is being used.

Electrical equipment capable of igniting flammable materials shall not be used where flammable or ignitable materials are occasionally present.

Incident Investigation

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All electrical contacts, near misses, and switching errors shall be investigated per the systems established by the safety department for near-miss investigations.

Periodic Electrical Safety Reviews

This facility will conduct a periodic review of electrical systems, of maintenance and operating practices and for compliance with these standards.

Contractors

All contractor work on electrical related equipment and/or systems shall be in accordance with this procedure. Any electrical work not specifically addressed in this procedure shall be done in accordance with NFPA 70E, 2015 Edition.

References:

NFPA 70E 2015 Edition, *Standard for Electrical Safety in the Workplace*

29 CFR 1910.331-335, *Electrical Safety-Related Work Practices*

29 CFR 1910.269, *Electrical Power Generation, Transmission and Distribution*

29 CFR 1910.137, *Electrical Protective Equipment*

MIOSHA Part 40, *Electrical Safety-Related Work Practices*

Energized Electrical Work Permit:

PART I: TO BE COMPLETED BY THE REQUESTOR:

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:

Requested By: _____

_____ Date

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

- 1) Detailed job description procedure to be used in performing the above work:
- 2) Hazard Risk Category:
- 3) Required personal protective equipment to safely perform the assigned task:
- 4) Means employed to restrict the access of unqualified persons from the work area:
- 5) Was a pre-job huddle held that included discussion of any job-related hazards? Yes No
- 6) Do you agree the above described work can be done safely? Yes No (If no, contact supervisor)

_____ Date _____
Electrically Qualified Person(s)

_____ Date _____
Electrically Qualified Person(s)

PART III: APPROVALS TO PERFORM THE WORK WHILE ELECTRICALLY ENERGIZED:

Submit completed forms to the Safety Department

_____ Date _____
E/I Supervisor if contacted by phone after hours

_____ Date _____
E/I Supervisor signature

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Table 130.7(C)(15)(A)(a) Arc Flash Hazard Identification for Alternating Current (ac) and Direct Current (dc) Systems

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: 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	No
	One or more of the following: 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 evidence of impending failure	Yes
For ac systems: Work on energized electrical conductors and circuit parts, including voltage testing	Any	Yes
For dc systems: Work on energized electrical conductors and circuit parts of series-connected battery cells, including voltage testing	Any	Yes
Voltage testing on individual battery cells or individual multi-cell units	All of the following: The equipment is properly installed The equipment is properly maintained Covers for all other equipment are in place and secured There is no evidence of impending failure	No
	One or more of the following: 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 evidence of impending failure	Yes
Removal or installation of CBs or switches	Any	Yes
Removal or installation of covers for equipment such as wireways, junction boxes, and cable trays that does not expose bare energized electrical conductors and circuit parts	All of the following: The equipment is properly installed The equipment is properly maintained There is no evidence of impending failure	No
	Any of the following: The equipment is not properly installed The equipment is not properly maintained There is evidence of impending failure	Yes
Removal of bolted covers (to expose bare energized electrical conductors and circuit parts). For dc systems, this includes bolted covers, such as battery terminal covers.	Any	Yes

(continues)

**TABLE 130.7(C)(15)(A)
(a)**

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Table 130.7(C)(15)(A)(a) *Continued*

Task	Equipment Condition*	Arc Flash PPE Required
Removal of battery intercell connector covers	All of the following: The equipment is properly installed. The equipment is properly maintained Covers for all other equipment are in place and secured There is no evidence of impending failure	No
	One or more of the following: 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 evidence of impending failure	Yes
Opening hinged door(s) or cover(s) (to expose bare energized electrical conductors and circuit parts)	Any	Yes
Perform infrared thermography and other noncontact inspections outside the restricted approach boundary. This activity does not include opening of doors or covers.	Any	No
Application of temporary protective grounding equipment after voltage test	Any	Yes
Work on control circuits with exposed energized electrical conductors and circuit parts, 120 volts or below without any other exposed energized equipment over 120 V including opening of hinged covers to gain access	Any	No
Work on control circuits with exposed energized electrical conductors and circuit parts, greater than 120 V	Any	Yes
Insertion or removal of individual starter buckets from motor control center (MCC)	Any	Yes
Insertion or removal (racking) of CBs or starters from cubicles, doors open or closed	Any	Yes
Insertion or removal of plug-in devices into or from busways	Any	Yes
Insulated cable examination with no manipulation of cable	Any	No
Insulated cable examination with manipulation of cable	Any	Yes
Work on exposed energized electrical conductors and circuit parts of equipment directly supplied by a panelboard or motor control center	Any	Yes
Insertion and removal of revenue meters (kW-hour, at primary voltage and current)	Any	Yes
For dc systems, insertion or removal of individual cells or multi-cell units of a battery system in an enclosure	Any	Yes
For dc systems, insertion or removal of individual cells or multi-cell units of a battery system in an open rack	Any	No

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Table 130.7(C)(15)(A)(a) *Continued*

Task	Equipment Condition*	Arc Flash PPE Required
For dc systems, maintenance on a single cell of a battery system or multi-cell units in an open rack	Any	No
For dc systems, work on exposed energized electrical conductors and circuit parts of utilization equipment directly supplied by a dc source	Any	Yes
Arc-resistant switchgear Type 1 or 2 (for clearing times of <0.5 sec with a prospective fault current not to exceed the arc-resistant rating of the equipment) and metal enclosed interrupter switchgear, fused or unfused of arc resistant type construction, tested in accordance with IEEE C37.20.7: <ul style="list-style-type: none"> •Insertion or removal (racking) of CBs from cubicles •Insertion or removal (racking) of ground and test device •Insertion or removal (racking) of voltage transformers on or off the bus 	All of the following: 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	No
	One or more of the following: 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 evidence of impending failure	Yes
Opening voltage transformer or control power transformer compartments	Any	Yes
Outdoor disconnect switch operation (hookstick operated) at 1 kV through 15 kV	Any	Yes
Outdoor disconnect switch operation (gang-operated, from grade) at 1 kV through 15 kV	Any	Yes

Note: Hazard identification is one component of risk assessment. Risk assessment involves a determination of the likelihood of occurrence of an incident, resulting from a hazard that could cause injury or damage to health. The assessment of the likelihood of occurrence contained in this table does not cover every possible condition or situation. Where this table indicates that arc flash PPE is not required, an arc flash is not likely to occur.

*The phrase *properly installed*, as used in this table, means that the equipment is installed in accordance with applicable industry codes and standards and the manufacturer's recommendations. The phrase *properly maintained*, as used in this table, means that the equipment has been maintained in accordance with the manufacturer's recommendations and applicable industry codes and standards. The phrase *evidence of impending failure*, as used in this table, means that there is evidence of arcing, overheating, loose or bound equipment parts, visible damage, deterioration, or other damage.

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TABLE 130.7(C)(15)(A)(b)

Table 130.7(C)(15)(A)(b) Arc-Flash Hazard PPE Categories for Alternating Current (ac) Systems

Equipment	Arc Flash PPE Category	Arc-Flash Boundary
Panelboards or other equipment rated 240 V and below Parameters: Maximum of 25 kA short-circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)	1	485 mm (19 in.)
Panelboards or other equipment rated >240 V and up to 600 V Parameters: Maximum of 25 kA short-circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)	2	900 mm (3 ft)
600-V class motor control centers (MCCs) Parameters: Maximum of 65 kA short-circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)	2	1.5 m (5 ft)
600-V class motor control centers (MCCs) Parameters: Maximum of 42 kA short-circuit current available; maximum of 0.33 sec (20 cycles) fault clearing time; working distance 455 mm (18 in.)	4	4.3 m (14 ft)
600-V class switchgear (with power circuit breakers or fused switches) and 600 V class switchboards Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.5 sec (30 cycles) fault clearing time; working distance 455 mm (18 in.)	4	6 m (20 ft)
Other 600-V class (277 V through 600 V, nominal) equipment Parameters: Maximum of 65 kA short circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)	2	1.5 m (5 ft)
NEMA E2 (fused contactor) motor starters, 2.3 kV through 7.2 kV Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.24 sec (15 cycles) fault clearing time; working distance 910 mm (36 in.)	4	12 m (40 ft)
Metal-clad switchgear, 1 kV through 15 kV Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.24 sec (15 cycles) fault clearing time; working distance 910 mm (36 in.)	4	12 m (40 ft)
Arc-resistant switchgear Type 1 or 2 [for clearing times of < 0.5 sec (30 cycles) with a prospective fault current not to exceed the arc-resistant rating of the equipment], and metal-enclosed interrupter switchgear, fused or unfused of arc-resistant-type construction, tested in accordance with IEEE C37.20.7, 1 kV through 15 kV	N/A (doors closed)	N/A (doors closed)
Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.24 sec (15 cycles) fault clearing time; working distance 910 mm (36 in.)	4 (doors open)	12 m (40 ft)
Other equipment 1 kV through 15 kV Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.24 sec (15 cycles) fault clearing time; working distance 910 mm (36 in.)	4	12 m (40 ft)

Note: For equipment rated 600 volts and below, and protected by upstream current-limiting fuses or current-limiting circuit breakers sized at 200 amperes or less, the arc flash PPE category can be reduced by one number but not below arc flash PPE category 1.

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Table 130.7(C)(15)(B) Arc-Flash Hazard PPE Categories for Direct Current (dc) Systems

Equipment	Arc Flash PPE Category	Arc-Flash Boundary
Storage batteries, dc switchboards, and other dc supply sources 100 V > Voltage < 250 V Parameters: Voltage: 250 V Maximum arc duration and working distance: 2 sec @ 455 mm (18 in.)		
Short-circuit current < 4 kA	1	900 mm (3 ft)
4 kA ≤ short-circuit current < 7 kA	2	1.2 m (4 ft)
7 kA ≤ short-circuit current < 15 kA	3	1.8 m (6 ft)
Storage batteries, dc switchboards, and other dc supply sources 250 V ≤ Voltage ≤ 600 V Parameters: Voltage: 600 V Maximum arc duration and working distance: 2 sec @ 455 mm (18 in.)		
Short-circuit current 1.5 kA	1	900 mm (3 ft)
1.5 kA ≤ short-circuit current < 3 kA	2	1.2 m (4 ft)
3 kA ≤ short-circuit current < 7 kA	3	1.8 m (6 ft.)
7 kA ≤ short-circuit current < 10 kA	4	2.5 m (8 ft)

Note: Apparel that can be expected to be exposed to electrolyte must meet both of the following conditions:

- (1) Be evaluated for electrolyte protection in accordance with ASTM F1296, *Standard Guide for Evaluating Chemical Protective Clothing*
- (2) Be arc-rated in accordance with ASTM F1891, *Standard Specification for Arc Rated and Flame Resistant Rainwear*, or equivalent

(16) Protective Clothing and Personal Protective Equipment (PPE). Once the arc flash PPE category has been identified from Table 130.7(C)(15)(A)(b) or Table 130.7(C)(15)(B), Table 130.7(C)(16) shall be used to determine the required PPE for the task. Table 130.7(C)(16) lists the requirements for PPE based on arc flash PPE categories 1 through 4. This clothing and equipment shall be used when working within the arc flash boundary.

Informational Note No. 1: See Informative Annex H for a suggested simplified approach to ensure adequate PPE for

electrical workers within facilities with large and diverse electrical systems.

Informational Note No. 2: The PPE requirements of this section are intended to protect a person from arc flash hazards. While some situations could result in burns to the skin, even with the protection described in Table 130.7(C)(16), burn injury should be reduced and survivable. Due to the explosive effect of some arc events, physical trauma injuries could occur. The PPE requirements of this section do not address protection against physical trauma other than exposure to the thermal effects of an arc flash.

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TABLE 130.7(C)(10)

Informational Note No. 3: The arc rating for a particular clothing system can be obtained from the arc-rated clothing manufacturer.

Table 130.7(C)(16) **Personal Protective Equipment (PPE)**

PPE Category	PPE
1	<p>Arc-Rated Clothing, Minimum Arc Rating of 4 cal/cm² (see Note 1) Arc-rated long-sleeve shirt and pants or arc-rated coverall Arc-rated face shield (see Note 2) or arc flash suit hood Arc-rated jacket, parka, rainwear, or hard hat liner (AN)</p> <p>Protective Equipment Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Heavy duty leather gloves (see Note 3) Leather footwear (AN)</p>
2	<p>Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm² (see Note 1) Arc-rated long-sleeve shirt and pants or arc-rated coverall Arc-rated flash suit hood or arc-rated face shield (see Note 2) and arc-rated balaclava Arc-rated jacket, parka, rainwear, or hard hat liner (AN)</p> <p>Protective Equipment Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Heavy duty leather gloves (see Note 3) Leather footwear</p>
3	<p>Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 25 cal/cm² (see Note 1) Arc-rated long-sleeve shirt (AR) Arc-rated pants (AR) Arc-rated coverall (AR) Arc-rated arc flash suit jacket (AR) Arc-rated arc flash suit pants (AR) Arc-rated arc flash suit hood Arc-rated gloves (see Note 1) Arc-rated jacket, parka, rainwear, or hard hat liner (AN)</p> <p>Protective Equipment Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather footwear</p>
4	<p>Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 40 cal/cm² (see Note 1) Arc-rated long-sleeve shirt (AR) Arc-rated pants (AR) Arc-rated coverall (AR) Arc-rated arc flash suit jacket (AR) Arc-rated arc flash suit pants (AR) Arc-rated arc flash suit hood Arc-rated gloves (see Note 1) Arc-rated jacket, parka, rainwear, or hard hat liner (AN)</p> <p>Protective Equipment Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather footwear</p>

AN: as needed (optional). AR: as required. SR: selection required.

Notes:

(1) Arc rating is defined in Article 100.

(2) Face shields are to have wrap-around guarding to protect not only the face but also the forehead, ears, and neck, or, alternatively, an arc-rated arc flash suit hood is required to be worn.

(3) If rubber insulating gloves with leather protectors are used, additional leather or arc-rated gloves are not required. The combination of rubber insulating gloves with leather protectors satisfies the arc flash protection requirement.

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Revisions

11/11/2010 – Section 11: Changed Part II, Line 6 (*If no, return to requestor*) to (*If no, contact supervisor*).

8/27/2015 – updated to conform to NFPA 70E 2015 Edition changes.

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