Buffalo State
State University of New York

Environmental Health & Safety

Title: General Electrical Safety and Arc Flash Protection Program	
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I. INTRODUCTION AND POLICY FOR WORK ON ENERGIZED PARTS/EQUIPMENT

Electricity is a serious workplace hazard capable of causing both employee injury and property damage. It is the policy of Buffalo State College to protect employees, students and other personnel from potential electrical hazards. This will be accomplished through compliance with work practices described in this procedure along with effective application of engineering controls, administrative controls, and the use of Personal Protective Equipment (PPE).

The Electrical & Arc Flash safety Program is founded on the principle of avoiding energized work unless it is absolutely necessary. Energized ("Live") parts shall be de-energized in accordance with the BSC Policy and Procedure, "Lock Out/Tag Out for Energy Isolation," before an employee works on or near the part(s), unless at least one of the following circumstances apply:

* De-energizing introduces additional or increased hazards. Examples of additional or increased hazards would include deactivation of emergency alarms systems or shutdown of hazardous location ventilation systems.

* De-energizing is not possible due to the equipment design or operational limitations. Examples of this situation would include testing and troubleshooting of electrical circuits that can only be performed with the circuit energized.

* Live parts are operating less than 50 volts to ground and there is no increased exposure to electrical burns or to explosion due to electric arcs.

II. PURPOSE

The electrical and arc flash safety program has been established to:

* Ensure the safety of employees who may work on or near exposed electrical parts or equipment;

* Ensure that employees understand and comply with safety standards related to electrical safety; and

* Ensure that employees follow uniform practices during completion of electrical work.

III. SCOPE AND LIMITATIONS

This policy and procedure identifies the minimum protocols that shall be followed by BSC employees for conducting work on exposed live electrical parts or equipment. It specifies the protections for "electrical work" under 600 volts, which includes testing, troubleshooting, reading panel meters, operating switches, operating starters, and measuring voltage.

Any other work, such as work on parts or systems over 600 volts or work that is not testing, troubleshooting, reading panel meters, operating switches and starters, or measuring voltage, is not regulated by this policy and procedure, requires authorization from the EH&S Director and specialized worker protections.

Note that work on 600 volt class (or higher) Motor Control Centers (MCC), including insertion or removal of individual starter "buckets" or removal of bolted covers to expose bare, energized electrical conductors or parts, is *not* authorized by this policy and procedure. More detailed limitations are identified in Section VIII.

IV. APPLICABILITY, RESPONSIBILITIES AND AUTHORIZATIONS

4.1 Applicability

Adherence to this policy and procedure is mandatory for all BSC employees when working on or near exposed live electrical parts or equipment.

All BSC employees and non-BSC personnel, upon observing a machine or piece of equipment, which is locked out to perform servicing or maintenance, shall not attempt to start, energize, or use that machine or equipment.

BSC employees failing to follow this program are subject to disciplinary actions.

4.2 Authorization and Competency

Only an "Authorized" BSC employee may conduct work on exposed live electrical parts, but only when live work is necessary and de-energization can not be performed as specified in the criteria within Section I of this document. An "Authorized Employee" shall be a "Competent Person" and designated by management/supervisors to perform live electrical work. A "Competent Person" is authorized to take prompt corrective measures to eliminate unsafe conditions.

A person may "Authorized" and "Qualified Person" to perform live electrical work on certain equipment and "Qualified" but not authorized to perform live electrical work on other equipment based on the safety hazards and protection measures available. See the Definitions Section V and Training Section VI.

4.3 BSC Employee Responsibilities

A) BSC Managers shall:

i) Assist shops in implementing the provisions of this program;

ii) Designate or arrange for the necessary training of employees:

* whenever there is a change of job assignment;
* whenever a new hazard is introduced due to a change in machines, equipment, or process;
* whenever there is a change in energy control procedures; or
* whenever a periodic inspection reveals deficiencies in procedure implementation.

iii) Ensuring an adequate supply of safety equipment.

B) BSC EH&S Director shall:

i) Monitor applicable electrical and arc flash safety regulations;

ii) Maintain and promptly update this procedure accordingly to assure compliance with applicable regulations;

ii) Provide consultative advice to Department Heads and other affected personnel as necessary on correct implementation of the electrical safety procedures (for LO/TO, arc flash, etc) procedures; and

iv) Audit worker implementation of this policy and procedure;

v) Evaluate overall effectiveness of the Electrical/Arc Flash Safety Program on a periodic basis.

C) BSC Supervisors/Shop Foremen shall:

i) Determine the applicability of the Electrical/Arc Flash Safety Program to activities conducted within their respective areas;

ii) Be responsible for implementation of the Electrical/Arc Flash Safety Program within their areas;

iii) Ensure employees comply with all provisions of the Electrical/Arc Flash Safety program, including performing inspections and audits of employees performing live electrical work;

iv) Develop and maintain a list of all qualified employees in their area;

v) Ensure employees are provided with and use appropriate protective equipment.

D) BSC Employees shall:

i) Follow the work practices described in this document, including use of Personal Protective Equipment;

ii) Complete all required training for this program; and

iii) Immediately report any concerns on electrical safety, such as newly discovered electrical hazards/incidents, to their supervisor.

V. DEFINITIONS

The following terms are defined in order to allow for better understanding of this program.

Arc Rating: The maximum incident energy resistance demonstrated by a material (or layered system of materials) prior to "breaking open" or at the onset of a second degree burn. This rating is assigned to the electrical protective clothing and is normally expressed in calories per square centimeter (cal/cm^2).

Authorized Employee: An "Authorized Employee" is a "Competent Person" designated by management or supervisor to perform live electrical work. A person may be "Authorized" and "Qualified" to perform live work on one type of equipment and "qualified" but not authorized to perform live work on others. See definitions for "Qualified Person" and "Unqualified Person."

Competent Person: An individual by training and/or experience, of identifying existing and predictable hazards or working conditions in the work place.

Electrically safe work condition: A state in which the conductor or circuit part to be worked on or near has been disconnected from energized parts, Locked Out/Tagged Out in accordance with BSC's Lock Out Tag Out procedure, tested to ensure the absence of voltage, and grounded if determined necessary.

Energized: electrically connected to or having a source of voltage.

Exposed (as applied to live parts): Capable of being inadvertently touched or suitably guarded, isolated, or insulated.

(Arc) Flash Hazard Analysis: A study to investigate a worker's potential exposure to arc flash energy, conducted for the purpose of injury prevention and the determination of safe work practices and appropriate levels of PPE.

(Arc) Flash Protection Boundary: An approach limit at a distance from exposed live parts within which a person could receive a second degree burn if an electrical arc flash were to occur.

(Arc) Flash suit: A complete flame resistant clothing and equipments system that covers the entire body except for the hands and feet (typically includes pants, jacket (or coveralls), bee keeper style hood fitted with a face shield)

FR apparel: Flame resistant apparel, describes a broad category of clothing designed to protect employees from electric arc events during completion of energized (live) work tasks.

Incident Energy: The amount of energy impressed on a surface, a certain distance from the source, generate during an electrical arc event. One of the units used to measure incident energy is calories per square centimeter (cal/cm^2).

Limited Approach Boundary: An approach limit at a distance from an exposed live part within which a shock hazard exists.

Live Parts: Energized conductive components.

Prohibited Approach Boundary: An approach limit at a distance from an exposed live part within which work is considered the same as making contact with the live part.

PPE: an acronym for Personal Protective Equipment

Qualified Person (QP): For the purpose of arc flash protection, a QP is one who has skills and knowledge related to the construction and operation of the electrical equipment and installation and has received training on the hazards involved. A person

may be "Qualified" and "Authorized" to perform live work on one type of equipment and Qualified but not be authorized to perform live work on another type of equipment.

Restricted Approach Boundary: An approach limit at a distance from an exposed live part within which there is an increased risk of shock (due to electrical arc-over combined with inadvertent movement) to personnel working in close proximity to the live part.

Unqualified person: Any person who does not meet the definition of a "Qualified Person" for performing live electrical work. A person may be Qualified to perform live work on one type of equipment and Unqualified to perform live work on another type of equipment.

Working near (live parts): Any activity within a Limited Approach Boundary.

Working on (live parts): Coming in contact with live parts via tools, probes, tests equipment, hands, feet, or other body parts regardless of the level of PPE worn.

For example, if wearing gloves while testing a live circuit with a meter is considered "working on live parts."

VI. TRAINING

Employees who are exposed to an electrical hazard that is not reduced to a safe level by the equipment design/installation shall be trained.

The level of electrical safety training provided is dependent on whether the employee is classified as "Qualified Person" or "Unqualified Person."

A "Qualified Person" must be trained and knowledgeable in all of the following topics:

* Construction and operation of the equipment on which work is assigned;
* Skills and techniques necessary to distinguish exposed electrical parts from other parts of electrical equipment;
* Skills and techniques necessary to determine the nominal voltage of exposed electrical parts;
* The approach distances specified in this document and the corresponding voltages to which the Qualified Person will be exposed;
* The process necessary to determine the degree and extent of electrical hazards along with PPE and job planning necessary to perform the task safely.

A person can be considered "qualified" with respect to certain equipment and methods but "unqualified" for others.

An "Unqualified Person" shall be trained in inherent hazards of electricity and any related work practices that are necessary for their safety.

Each Supervisor and the EH&S Office shall maintain a record of electrical safety training provided to their employees along with a listing of all employees classified as "Qualified Persons."

VII. WORKING ON OR NEAR LIVE PARTS

7.1 Conditions for Live Work Authorization

There are two (2) aspects that must be addressed before a Qualified Person may be authorized to proceed to safely perform work on live parts.

Is the work necessary and authorizable?

The first criterion that limits live work is authorization and whether it is necessary to perform the work live rather than alternatively performing energy isolation (LO/TO). Refer to Section I for specific criteria to determining whether live work is necessary and thereby authorizable.

Is the hazard/risk rating within the protection available?

The hazard/risk and arc flash rating must be determined as some types of equipment/parts have a greater potential magnitude for an arc flash incident than others and require greater safety protection levels of PPE and tools. Some work is not authorized because the arc flash potential is too high for the protections available. The methods to determine the hazard/risk category for the task to be performed and the minimum PPE are identified in Section VIII.

7.2 Approach Boundaries to Energized Parts

Observing a safe approach distance from exposed energized parts is an effective way to maintain electrical safety. As the distance between the individual and the live parts increases, the potential for electrical injury decreases.

Shock Protection Boundaries:

Safe approach distances shall be determined for all tasks in which approaching personnel are exposed to live parts. Safe distances to fixed live parts can be determined by referring to Appendix B, "Approach Boundaries to Live Parts for Shock Protection." This appendix can be used to identify the Limited, Restricted and Prohibited Approach boundaries for various system voltages.

The following precautions and restrictions shall be followed when crossing the approach boundaries:

* Unqualified persons may only cross the Limited Approach Boundary and only when they are under the direct supervision of a qualified person;

* Qualified Persons may not cross or take any conductive object closer than the Restricted Approach Boundary unless one of the following conditions apply:

  - The Qualified Person is insulated or guarded from the live parts and no un-insulated part of the Qualified Persons body crosses the Prohibited Approach Boundary;

- The live parts are insulated from the Qualified Person and from any other conductive object at a different potential.

Crossing the Prohibited Approach Boundary is considered the same as making contact with energized parts. Qualified Persons may only cross this boundary when all of the following precautions have been taken:

* The Qualified Person has specific training to work on energized parts; and

* The Qualified Person uses PPE appropriate for working on energized parts and the PPE are appropriately rated for the voltage and energy level involved.

Flash Protection Boundary:

PPE shall be provided to and used by all employees working within the Flash Protection Boundary.

For systems that are 600 volts or less the Flash Protection Boundary shall be a *minimum* of four (4) feet. Flash Protection Boundary for systems over 600 volts shall be determined by engineering analysis.

7.3 Alerting Techniques and Barriers

Proper alerting techniques shall be used to prevent or limit access to the work area containing live parts as follows:

* Non-conductive barricades and safety signs shall be used;

* Barricades shall be placed no closer than the Limited Approach Boundary;

* If signs and barriers do not provide adequate protection, an attendant shall be assigned to warn and protect pedestrians. The primary duty of the attendant is to keep unqualified persons out of the work area where an electrical hazard exists. The attendant shall remain in the area as long as there is a potential exposure to electrical hazards;

7.4 Good Safe Work Practices Required

Good safe work practices must be followed at all times to reduce risks for arc flash and shock incidents when working on or near live parts. This includes and is not limited to the following practices:

* Work on exposed live part only when necessary and adequately protected;

* Switch remotely if possible;

* Use proper PPE and tools when working within Arc Flash Boundary;

* Inspect PPE and tools before each use;

* An air test must be performed on rubber insulating gloves before each use;
* Stand aside and away as much as possible during switching;
* Avoid leaning on or touching switchgear, metallic surfaces, and electrical equipment;
* No blind reaching into sight-impaired areas containing exposed live parts;
* No smoking or other ignition sources permitted within Flash Protection Boundary and Limited Approach Boundary;
* No flammables, such as solvents, gasoline, etc., permitted within the Flash Protection Boundary and Limited Approach Boundary;
* Fuse or fuse- holder handling equipment, insulated for short circuit voltage, shall be used to remove or install a fuse, if the fuse terminals are energized;
* Ropes and hand lines used near energized parts shall be non-conductive;
* Portable ladders used for electrical work shall have non-conductive side rails;
* Conductive articles of jewelry, and clothing (such as watchbands, bracelets, rings, key chains, necklaces, metalized aprons, cloth with conductive thread, metal frame glasses) shall not be worn where they present an electrical contact hazard with exposed energized parts;
* Conductive materials, tools and equipment that are in contact with any part of the employees body shall be handled in a manner that prevents accidental contact with live parts. Such materials and equipment include but are not limited to long, conductive objects, such a pipes, tubes, ducts, conductive hose, rope, metal lined rules and scales, steel tape measures, scaffold parts, chains and structural members;
* When an employee works in a confined space or enclosed space (such as a manhole or vault) that contains exposed energized parts, the employee shall obtain Confined Space Work Permit and use protective shields, barriers or insulating materials as necessary to avoid contact with these parts. Doors and hinged panels shall be secured to prevent them from swinging on employees
* Clean and maintain tools and PPE in proper condition.

VIII DETERMINATION OF HAZARD/RISK CATEGORY AND PPE REQUIREMENTS

In order to determine the minimum specific PPE requirements, the hazard/risk rating of the work task must be first determined. Once the hazard/risk is known, the appropriate level of PPE protection can be determined.

8.1 Hazard/Risk Classification and Voltage Ratings

There are three (3) options for determining the hazard/risk classification for the task to be performed:

A. Obtain hazard rating information from arc flash label on the equipment:

Arc flash labels on campus equipment identify: 1) The incident energy in Cal/cm2 and/or flash hazard rating (0, 1, 2 , 3, or 4), which is needed to determine the minimum coverall/suit and face shield PPE rating required to the work; 2) The glove hazard class or voltage, which is needed to identify the minimum glove rating. The labels on many pieces of equipment were based on an extensive study analysis of campus equipment (see below). Labels for electrical equipment with a facility are also maintained in pocket folders mounted on walls in the rooms in which the main switchgear is located;

B. Obtain hazard rating from the campus arc flash study report:

A study analysis of the campus electrical system was done to identify hazard ratings for campus equipment. The study report includes a table and drawings that provide hazard ratings (for PPE) for specific equipment. The report is maintained by and available from the Assistant Maintenance Director's office. A copy is also maintained by the EH&S Office in the Clinton Center

C. Obtain hazard rating from the NFPA 70E electrical code:

The NFPA Code Section 70E contains a matrix table (Table 130.7(C)) showing Hazard/Risk Category Classifications and equipment requirements for specific tasks to be performed on live equipment and voltage and amperage ratings of the equipment. A copy of the code is available for viewing at the EH&S Office.

To assist with this determination, Appendix C contains 1) A table summarizing Hazard/Risk Classifications for lower voltage panelboards/switchboards and more common work tasks on campus; and 2) Hazard/Risk classifications for more comprehensive listing of work tasks and parts/system voltages.

8.2 Minimum Level of PPE

Once the hazard ratings are obtained from Section 8.1, the next step is to compare the hazard ratings with the ratings for the PPE provided by BSC. This will identify the minimum PPE required when working within the Arc Flash boundary on exposed live parts or equipment to protect against thermal effects. The Hazard/Risk classifications and the associated required PPE are as follows:

Hazard/Risk Category 0 - For work that is rated at Hazard/Risk Category 0, the following minimum PPE equipment shall be worn when working within the Arc Flash boundary on live parts/equipment rated at 50 volts and greater:

* Non-melting/Untreated Natural Fiber (untreated cotton, wool, rayon, silk or blends of these) long sleeve shirt and long pants (or coveralls). Note: BSC provides coveralls with an Arc Thermal Performance Value of 12 cal/cm^2, which is protective up to Hazard/Risk Category 2;

* Safety glasses/goggles;

* Hearing protection; and

* Heavy duty leather gloves (as needed).

Hazard/Risk Category 1 and 2 - In addition to Hazard Category 0 PPE, some or all of the following are required for Hazard Category 1 and 2 work. See Table 7.2-1.

* Arc-rated coveralls. BSC provides coveralls with an Arc Thermal Performance Value of 12 cal./cm^2, which is protective up to Hazard/Risk Category 2;

* Arc-rated hood: 8 cal./cm2 minimum. BSC provided hood is rated at 10 cal/cm^2, protective up to Hazard/Risk Category 2;

* Class 00 Insulating Gloves: BSC provided gloves are rated at 500 volts, line-to-line.

* Leather shoes (as needed for Category 1, required for Category 2).

Note that Hazard/Risk Category 2 work on energized parts/equipment that exceeds 500 volts and requires insulated gloves is prohibited.

Hazard/Risk Category 3 and 4 – Standard issue arc flash rated PPE provided by BSC is not adequately protective Hazard/Risk Categories 3 or 4 work. *Therefore, Hazard/Category 3 and 4 work tasks by BSC personnel are prohibited unless the work is reviewed and approved by the EH&S Director and additional specialized administrative, engineered, or PPE protections are put in place.*

A comparison of these PPE ratings with the Hazard/Risk Categories for work tasks and equipment ratings, from NFPA 70E results in the following

TABLE 8.2-1
Minimum PPE Requirement for Hazard/Risk Classifications

Flash Hazard/ Risk Category	Minimum PPE Arc Rating, Cal/cm^2	Description of Minimum Required PPE	Additional PPE Requirements and Work Authorization Limitations
0	NR	* Non-melting/untreated natural fiber long sleeve shirt and long pants or coveralls; * Safety glasses/goggles; * Hearing protection; * Leather gloves (as needed); and Certain Class 0 tasks require rubber insulating gloves as specified in NFPA 70E.	* Work on live equipment/part that exceeds 500 volts is prohibited.
1	4	* Arc-rated long sleeve shirt and long pants or arc-rated coveralls; * Safety glasses/goggles; * Hearing protection; * Leather gloves; * Arc-rated hood/faceshield; * Hard hat; and * Leather work shoes (as needed).	* Insulating gloves may be required – see equipment label, NFPA 70E, Arc Flash study; * Work on live equipment/parts that exceed 500 volts is prohibited
2*	8	* Arc-rated long sleeve shirt and long pants or arc-rated coveralls; * Arc rated hood/faceshield * Safety glasses/goggles;	* Insulating gloves may be required – see equipment label, NFPA 70E, Arc Flash study,

		* Hearing protection; * Leather gloves; * BSC issued arc-rated hood rated; * Hard hat; and * Leather work shoes.	or Table; *** See note below.**
3	**25**	**Work prohibited (BSC personnel not authorized)**	**NA**
4	**40**	**Work prohibited (BSC personnel not authorized)**	**NA**

*** Note: work on energized parts/equipment that exceeds 500 volts and requires insulated gloves is prohibited.**

IX. INSPECTING AND MAINTAINING PPE AND TOOLS

PPE and insulating tools shall be inspected before each as follows:

* Rubber insulating gloves shall be air tested before each use;

* Insulating tools shall be visually inspected before each use and immediately after any incident that may have caused damage.
Equipment or tools found to have defects shall be removed from service until testing indicates it is acceptable for continued use.

Rubber gloves shall be tested by an accredited testing firm on the schedule specified in Appendix E.

X. RE-ENERGIZING CIRCUITS

After a circuit is de-energized by an automatic protective device (breaker), the circuit shall not be re-energized until it has been determined that equipment and circuit can be safely re-energized.

Repetitive manual reclosing of circuit breakers or re-energizing of circuits through replaced fuses is prohibited.

When it is determined that automatic operation of circuit protective device was caused by an overload rather than a fault condition, examination of the circuit or connected equipment is not required.

XI. CHANGING LIGHT BULBS

Changing lamps or bulbs requires that the individual be qualified and experienced in recognizing electrical hazards. The bulbs may be replaced by such individuals with the power on or turned off at the wall switch, whichever provides the individual with adequate lighting. The minimum protective equipment required for lamp and bulb changing is goggles or safety glasses with side shields and if possible, leather gloves.

If a lamp or bulb is physically broken, the circuit shall be de-energized and locked out in accordance with this procedure to remove the fragments and electrical connectors. Fixture washdown and lamp cleaning using water will require light fixtures to be locked out. In addition, any lamp or bulb replacements in electrically classified areas will require Lock Out.

Low voltage (30 volts or less) bulbs in control panels and graphics can be changed by anyone trained to do so.

XII. CONTRACTED WORK

All BSC contractors are required to comply with applicable Safety, Health and Environmental regulations, such as OSHA, EPA, NYS DEC, DOH and PESH. Safety programs used by BSC contractors on BSC jobsites must meet or exceed all applicable guidelines of this policy and procedure. The contractor may be required to submit copies of their Safety Program to the BSC Director of Environmental Health and Safety upon request.

XIII. PERIODIC COMPLIANCE VERIFICATION AND PROCEDURE REVIEW

In addition to supervisor/foreman inspections and audits of their employees, the EH&S Office Director, or their designees who are knowledgeable and familiar with the requirements of this procedure and OSHA regulations, will conduct and document audits/inspections periodically, based on the frequency that live work is performed. The results of the audit will be documented and shared with area/shop supervision in order to correct inadequacies/deviations in a timely manner.

The EH&S Director (or their designee) shall maintain this procedure and ensure any necessary modifications are promptly incorporated.

APPENDIX A

Standard Operating Procedure

It is the goal of SUNY Buffalo State College to control the arc flash hazard, which occurs during the maintenance of electrical building components throughout campus. Standard operating procedures will eliminate or control arc flash events to reduce the hazard to employees. To reduce the potential for arc flash occurrences, the following standard operating procedures will be applied:

1. De-energize all circuits before performing any maintenance on them.

2. Ensure that all possible sources of supply are found and open disconnecting devices for each source.

3. Apply Lockout/Tagout devices in accordance with the BSC Lockout/Tagout procedures.

4. Test voltage on each conductor to verify that it is de-energized.

5. Apply grounding devices where stored energy or induced voltage could exist or where de-energized conductors could contact live parts.

If it is necessary to work on energized equipment; the following procedures will be applied:

1. Establish boundaries keeping those not involved with the work ten feet away.

2. Use insulated tools rated for the voltages on which they will be used.

3. Consider using insulated floor mats.

4. Wear safety glasses.

5. Wear voltage rated gloves.

6. Wear hard-soled leather work shoes or dielectric overshoes.

7. Wear appropriate arc flash protection. See work sheet

PPE REQUIREMENTS FOR WORK TASKS ON ENERGIZED PARTS/EQUIPMENT
Worksheet

Description of Task	Equipment	Voltage	Hazard/Risk Category	Specific PPE To Be Worn

APPENDIX B

Approach Boundaries to Live Parts for Shock Protection

(All dimensions are distance from live part to employee)

Nominal System Voltage (phase to phase)	Limited Approach Boundary (fixed circuit parts)	Restricted Approach Boundary (includes inadvertent movement adder)	Prohibited Approach Boundary
Less than 50V	Not specified	Not specified	Not specified
50V to 300V	3 feet, 6 inches	Avoid contact	Avoid Contact
301V to 750V	3 feet, 6 inches	1 foot	1 inch
751V to 15 kV	5 feet	2 feet, 2 inches	7 inches
Over 15 kV or movable conductor:		See NFPA 70 E Table 130.2 (C)	

*** Limited Approach Boundary:** Distance from an exposed live part within which a shock hazard exists. An unqualified person may not cross this boundary unless they are continuously escorted by a qualified person.

* **Restricted Approach Boundary:** Distance from an exposed live part within which there is an increased risk of shock (due to electrical arc-over combined with inadvertent movement) for personnel working in close proximity to the live part. This boundary may only be crossed by a qualified person who is safely insulated or guarded from the live parts.

* **Prohibited Approach Boundary:** Distance from an exposed live part within which work is considered the same as making contact with the live part. This boundary may only be crossed by a qualified person who has specific training to work on energized parts; has obtained an approved Energized Electrical Work Permit; and uses PPE appropriate for working on energized parts which are rated for the voltage and energy level involved. (Note: A permit is not required for work related to testing, troubleshooting, and voltage measuring).

* **Flash Protection Boundary (not listed in table):** Distance from exposed live parts within which a person could receive a second-degree burn if an electrical arc flash were to occur. This boundary may only be crossed by a qualified person wearing the appropriate PPE. For systems that are 600 volts or less, the Flash Protection Boundary shall be a minimum of four fee unless a flash protection analysis (equipment label) indicates otherwise. An analysis must be performed to determine the Flash Protection Boundary for systems that are above 600 volts.

APPENDIX C

Hazard/Risk Category Classifications
SUMMARY TABLE
FOR LOWER VOLTAGE PANELBOARDS AND SWITCHBOARDS

Task (Assumes equipment is energized, and work is done within the Flash Protection Boundary)	Hazard/Risk Category	V-rated Gloves	V-rated Tools
Panelboards Rated 240 V and Below			
Circuit breaker (CB) or fused switch operation with covers on	0	N	N
CB or fused switch operation with covers off	0	N	N
Work on energized parts, including voltage testing	1	Y	Y
Remove/install CBs or fused Switches	1	Y	Y
Removal of bolted covers (to expose bare, energized parts)	1	N	N
Opening hinged covers (to expose bare, energized parts)	0	N	N
Panelboards or Switchboards Rated > 240 V and up to 600 V (with molded case or insulated case circuit breakers)			
CB or fused switch operation with covers on	0	N	N
CB or fused switch operation with covers off	1	N	N
Work on energized parts, including voltage testing	2 (*)	Y*	Y

PPE Requirements can be found in section VIII

Additional Information:

1. Y* means yes for work up to 500 volts (line to line). V-rated gloves, provided by BSC, are rated and tested for a maximum line-to-line voltage of 500 v.
2. V-rated Tools are tools that are rated and tested for the maximum line-to-line voltage upon which work will be done.
3. 2(*) means that a double-layer switching hood and hearing protection are required for this task in addition to the other Hazard/Risk Category requirements of Appendix E.
4. Y means Yes (required)
5. N means No (not required)

Notes:

* 25kA short circuit current available, 0.03 second (2 cycle) fault clearing time.minimum 18 inch working distance
* For < 10kZ short circuit current available, the hazard/risk category required may be reduced by one number.

APPENDIX C
Comprehensive Hazard/Risk Category Classification Matrix

Table 130.7(C)(15)(a) Hazard/Risk Category Classifications and Use of Rubber Insulating Gloves and Insulated and Insulating Hand Tools-Alternating Current Equipment (Formerly Table 130.7(C)(9)

Tasks Performed on Energized Equipment	Hazard/Risk Category	Rubber Insulating Gloves	Insulated and Insulating Hand Tools
Panelboards or other equipment rated 240 V and below Parameters: Maximum of 25 kA short circuit current available; maximum of 0.03 sec (2 cycle) fault clearing time; minimum 18 in. working distance Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 19 in.			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	0	N	N
Circuit breaker (CB) or fused switch operation with covers on	0	N	N
CB or fused switch operation with covers off	0	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	1	Y	Y
Remove/install CBs or fused switches	1	Y	Y
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	1	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	0	N	N
Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the panelboard	1	Y	Y
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 cycle) fault clearing time; minimum 18 in. working distance Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 30 in.			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	1	N	N
Circuit breaker (CB) or fused switch operation with covers on	0	N	N
CB or fused switch operation with covers off	1	Y	N
Work on energized electrical conductors and circuit parts, including voltage testing	2	Y	Y
Remove/install CBs or fused switches	2	Y	Y
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	1	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	0	N	N
Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the panelboard	2	Y	Y
600 V class motor control centers (MCCs) Parameters: Maximum of 65 kA short circuit current available; maximum of 0.03 sec (2 cycle) fault clearing time; minimum 18 in. working distance Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 53 in.			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	1	N	N

(continues)

APPENDIX C (Cont'd)
Comprehensive Hazard/Risk Category Classification Matrix

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

Tasks Performed on Energized Equipment	Hazard/Risk Category	Rubber Insulating Gloves	Insulated and Insulating Hand Tools
CB or fused switch or starter operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB or fused switch or starter operation with enclosure doors open	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2	Y	Y
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	0	Y	Y
Work on control circuits with energized electrical conductors and circuit parts >120 V, exposed	2	Y	Y
Application of temporary protective grounding equipment, after voltage test	2	Y	N
Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the motor control center	2	Y	Y
600 V class motor control centers (MCCs) Parameters: Maximum of 42 kA short circuit current available; maximum of 0.33 sec (20 cycle) fault clearing time; minimum 18 in. working distance Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 165 in.			
Insertion or removal of individual starter "buckets" from MCC	4	Y	N
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	1	N	N
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 cycle) fault clearing time; minimum 18 in. working distance Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 233 in.			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	2	N	N
CB or fused switch operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB or fused switch operation with enclosure doors open	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2	Y	Y
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	0	Y	Y
Work on control circuits with energized electrical conductors and circuit parts >120 V, exposed	2	Y	Y

APPENDIX C (Cont'd)
Comprehensive Hazard/Risk Category Classification Matrix

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

Tasks Performed on Energized Equipment	Hazard/Risk Category	Rubber Insulating Gloves	Insulated and Insulating Hand Tools
Insertion or removal (racking) of CBs from cubicles, doors open or closed	4	N	N
Application of temporary protective grounding equipment after voltage test	2	Y	N
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	2	N	N
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 cycle) fault clearing time; minimum 18 in. working distance (except as indicated) Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 53 in.			
Lighting or small power transformers (600 V, maximum)			
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	2	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2	Y	Y
Application of temporary protective grounding equipment, after voltage test	2	Y	N
Revenue meters (kW-hour, at primary voltage and current)—insertion or removal	2	Y	N
Cable trough or tray cover removal or installation	1	N	N
Miscellaneous equipment cover removal or installation	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2	Y	Y
Application of temporary protective grounding equipment, after voltage test	2	Y	N
Insertion or removal of plug-in devices into or from busways	2	Y	N
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 0.2 sec (12 cycle) fault clearing time; minimum 36 in. working distance Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 422 in.			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	3	N	N
Contactor operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
Contactor operation with enclosure doors open	2	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	4	Y	Y
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	0	Y	Y
Work on control circuits with energized electrical conductors and circuit parts >120 V, exposed	3	Y	Y

(continues)

APPENDIX C
Comprehensive Hazard/Risk Category Classification Matrix

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

Tasks Performed on Energized Equipment	Hazard/Risk Category	Rubber Insulating Gloves	Insulated and Insulating Hand Tools
Insertion or removal of CBs from cubicles with door open	4	N	N
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	2	Y	Y
Insertion or removal (racking) of ground and test device with door closed	0	N	N
Insertion or removal (racking) of voltage transformers on or off the bus door closed	0	N	N
Other equipment 1 kV through 38 kV Parameters: Maximum of 35 kA short circuit current available; maximum of up to 0.2 sec (12 cycle) fault clearing time; minimum 36 in. working distance Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 422 in.			
Metal-enclosed interrupter switchgear, fused or unfused			
Switch operation of arc-resistant-type construction, tested in accordance with IEEE C37.20.7, doors closed only	0	N	N
Switch operation, doors closed	2	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	4	Y	Y
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	3	N	N
Outdoor disconnect switch operation (hookstick operated)	3	Y	Y
Outdoor disconnect switch operation (gang-operated, from grade)	2	Y	N
Insulated cable examination, in manhole or other confined space	4	Y	N
Insulated cable examination, in open area	2	Y	N

Y = Yes (required). N: No (not required).

Notes:

(1) Rubber insulating gloves are gloves rated for the maximum line-to-line voltage upon which work will be done.

(2) Insulated and insulating hand tools are tools rated and tested for the maximum line-to-line voltage upon which work will be done, and are manufactured and tested in accordance with ASTM F 1505, *Standard Specification for Insulated and Insulating Hand Tools*.

(3) The use of "N" does not indicate that rubber insulating gloves and insulated and insulating hand tools are not required in all cases. Rubber insulating gloves and insulated and insulating hand tools may be required by 130.4, 130.8 (C) (7), and 130.8(D).

(4) For equipment protected by upstream current limiting fuses with arcing fault current in their current limiting range (½ cycle fault clearing time or less), the hazard/risk category required may be reduced by one number.

(5) For power systems up to 600 V the arc flash boundary was determined by using the following information: When 0.03 second trip time was used, that indicated MCC or panelboard equipment protected by a molded-case circuit breaker. Working distance used was 18 in. (455 mm). Arc gap used was 32 mm for switchgear and 25 mm for MCC and protective device type 0 for all. When 0.33 or 0.5 second trip time was used, that indicated a LVPCB (drawout circuit breaker) in switchgear. Working distance was 24 in. (610 mm). Arc gap used was 32 mm and protective device type 0 for all. All numbers were rounded up or down depending on closest multiple of 5.

(6) For power systems from 1 kV to 38 kV the arc flash boundary was determined by using the following information: No maximum values were given in the 2009 edition of NFPA 70E for short-circuit current or operating time. Two sets of equations were performed: 35 kA AIC and 0.2 second operating time and 26 kA AIC and 0.2 second operating time. 0.2 seconds was used by adding the typical maximum total clearing time of the circuit breaker to an estimated value for relay operation. This coincides with the IEEE 1584 values of 0.18 second operating time and 0.08 tripping time rounded off. A short-circuit current of 35 kA was used as a maximum (HRC-4 @ ~ 40 cal/cm^2) and 26 kA was used to compare the effects of lowering the short circuit current (HRC-4 @ ~ 30 cal/cm^2). Working distance used was 36 in. (909 mm), arc gap was 6 in. (455 mm), and protective device type 0 for all.

APPENDIX D

Personal Protective Equipment Matrix
Minimum PPE Requirement for Hazard/Risk Classifications

Work Hazard/ Risk Category	Minimum PPE Arc Rating, in Cal/cm^2	Description of Minimum Required PPE	Additional PPE Requirements and Work Authorization Limitations
0	NR	* Non-melting/untreated natural fiber long sleeve shirt and long pants or coveralls; * Safety glasses/goggles; * Hearing protection; *and* Certain Class 0 tasks require rubber insulating gloves as specified in NFPA 70E.	* Work on live equipment/part that exceeds 500 volts is prohibited.
1	4	* Arc-rated long sleeve shirt and long pants or arc-rated coveralls; * Safety glasses/goggles; * Hearing protection; * Leather gloves; * BSC issued arc-rated hood rated; * Hard hat; and * Leather work shoes (as needed).	* Insulating gloves may be required – see equipment label, NFPA 70E, Arc Flash study; * Work on live equipment/parts that exceed 500 volts is prohibited
2*	8	* Arc-rated long sleeve shirt and long pants or arc-rated coveralls; * Arc rated hood/faceshield * Safety glasses/goggles; * Hearing protection; * Leather gloves; * BSC issued arc-rated hood rated; * Hard hat; and * Leather work shoes.	* Insulating gloves may be required – see equipment label, NFPA 70E, Arc Flash study, or Table; *** See note below.**
3	**25**	**Work prohibited (BSC personnel not authorized)**	**NA**
4	**40**	**Work prohibited (BSC personnel not authorized)**	**NA**

*** Note work on energized parts/equipment that exceeds 500 volts and requires insulated gloves is prohibited.**

APPENDIX F

Inspection Schedule for Rubber Insulating Equipment

Type of Equipment	When to Test
Rubber insulating line hose	Upon indication that insulating value is suspect
Rubber insulating covers	Upon indication that insulating value is suspect
Rubber insulating blankets	Before first issue and every 12 months thereafter (*)
Rubber insulating sleeves	Before first issue and every 12 months thereafter (*)
Rubber insulating gloves	Before first issue and every 6 months thereafter (*)

(*) – If the insulating equipment has been electrically tested but not issued for service, it may not be placed into service unless it has been electrically tested within the previous 12 months.