SC Budget and Control Board **SAFETY PROGRAM**:

LOCKOUT TAGOUT - Control of Hazardous Energies & Safe Electrical Work Practices

(March 1995; Revised September 2011)

I. INTRODUCTION

Electricity and other energies are essential to modern life, at home and on the job. Some employees work with these energies directly, such as our Trades Specialists in the Facilities Management Section. Others, such as office administrative employees, work with it indirectly. Electricity has long been recognized as a serious workplace hazard, exposing employees to such dangers as electric shock, arc flash, burns, fires, and explosions. In 2001 for example, there were 7,600 electrical injuries and 432 work-related deaths with low-voltage electrocution as the fourth leading cause. Experts in electrical safety have traditionally looked toward the widely used National Fire Protection Association (NFPA) standards and the Occupational Safety and Health Administration (OSHA) standards for help in the practical safeguarding of persons from hazardous energies. However, besides electricity, there are other hazardous energy sources such as mechanical, pneumatic, fluids and gases, hydraulic, thermal, water under pressure, and gravity. Some of the problems of not properly controlling these hazardous energies include accidental start-ups resulting in disabling injuries and death. The OSHA-prescribed Lockout/Tagout (LOTO) procedure and safe work practices when used protect workers from the potentially dangerous effects of these hazardous energies.

II. PURPOSE

The purpose of this LOTO program is to prevent personnel injury by the unexpected energization, start-up, or release of a hazardous energy. The worker performing servicing or maintenance must be able to disable all power sources in such a way that only that worker can restore power. As required by the OSHA standard, the SC Budget and Control Board (BCB) establishes this program and procedures for affixing appropriate lockout and/or tagout apparatus to energy isolation devices so machinery or equipment is disabled thus preventing unexpected energization and start up of the machine or equipment, or release of stored energy.

III. OSHA REGULATORY REFERENCES

South Carolina operates its own federal OSHA-approved job safety and health program (covering both the private sector and State and local government employees) by incorporating by reference the federal OSHA regulations. The BCB is governed by these federal and state requirements.

1. South Carolina Code of Regulations, Department of Labor, Licensing and Regulation, Division of Labor, Chapter 71, Article 1 Occupational Safety and Health Regulations
2. Title 29, Code of Federal Regulations (CFR), Chapter 1910.147, The Control of Hazardous Energy, Lockout Tagout (29 CFR 1910.147)
3. 29 CFR 1910.269 Electrical Power Generation, Transmission and Distribution
4. 29 CFR Subpart S - Electrical, 1910.331-335 Electrical Safety-Related Work Practices
5. 29 CFR Subpart K - Electrical General, 1926.400-449
   NOTE: OSHA references *NFPA 70 - National Electrical Code* and *NFPA 70E - Electrical Safety Requirements for Employee Workplaces* as "how to guides" to comply with the above OSHA standards.

IV. POLICY

1. Employees that service and/or maintain various pieces of equipment or machinery face the potential for unexpected activation and/or energy release. In Those Circumstances **WHERE THE MACHINE OR EQUIPMENT CAN BE MADE SAFE** In Accordance With Procedure Established By This Program In Order To Perform Servicing Or Maintenance, The Machine Or Equipment ***MUST BE DE-ENERGIZED*, LOCKED OUT *and* TAGGED OUT,** Then Verified That The Equipment/Machinery Cannot Start Up Or Have An Inadvertent Release Of A Hazardous Energy. **NEARBY MACHINERY OR EQUIPMENT ALSO MUST BE DE-ENERGIZED, LOCKED AND TAGGED OUT** And Verified As Such To Prevent Inadvertent Exposure To Live Hazardous Energies. Exception: Work on live equipment is only allowed if the employer can show that de-energizing is not feasible and is only allowed after the supervisor and involved authorized employees complete a live work permit (see Section VIII Working On or Near Energized Equipment and Appendix D Live Work Permit).
2. All contract employees that are to perform servicing or maintenance in a BCB facility must also comply with this program or will be denied access to these areas.
3. All new equipment and machinery containing hazardous energies purchased must have an energy-isolating device incorporated into the design which will accept a lockout device.

V. SCOPE

1. OSHA standards for the control of hazardous energies establish minimum requirements for the lockout and tagout of energy sources that could cause injury to personnel. These standards cover:
    - How to perform a shutdown
    - How to isolate equipment
    - How to apply and remove lockout and tag warning devices
    - How to safely release stored energy to assure that a zero energy state exists
    - Training, audits, and record keeping
2. OSHA LOTO EXCEPTIONS:
    A. Plug and cord-connected electric equipment (e.g., portable hand or shop woodworking tools), when unplugged and the plug is under the exclusive control (in direct line-of-sight and within arm's length) of the employee performing the servicing and/or maintenance, are exempted from the prescribed LOTO procedure. Note: Plug lockout devices are recommended to control plug and cord-connected electrical equipment undergoing service or maintenance.
    B. Installation of connections or parts using welding or cutting on equipment pipelines, vessels or tanks under pressure (hot tap operations) is allowed only when continuous service is essential, shutdown is impractical and documented procedures and special equipment are used that provide effective employee protection. Note: Supervision must make a prior determination and document that employees are authorized for each specific hot tap operation. Such authorization must include the work location, work to be accomplished and special work procedures and protective equipment to be used. "Blanket" authorization for hot tap operations, i.e., for an indefinite time or for more than one job, is not allowed. See Welding (Hot Work) Program.

VI. RESPONSIBILITIES

1. By this program, the BCB establishes mandatory procedures for the control of hazardous energies through the de-energization of equipment or machinery and energy isolation using a lockout/tagout work practice. Hazardous energy sources in each building, equipment and machine is required to have control procedures for shutdown, equipment isolation, lockout/tagout application, release of stored energy, and verification of isolation.
2. Employee position descriptions state minimum knowledge, skills and abilities for each job. OSHA standards and BCB Training Policy require initial and recurring training for each position involving equipment servicing or maintenance operations needing the control of hazardous energies.
    A. Individual training requirements for these jobs include LOTO and Electrical Safety courses.
    B. Electrical Safety:
        (1) Employees shall be trained in and familiar with the safety-related work practices required by 29 CFR1910.331 through 1910.335 that pertain to their respective job assignments.

(2) Workers and their supervisors need to be trained in Electrical Safety if the workers are exposed to 50 volts or more to ground for a hazard to exist. Note: BCB employees do not work with high voltage (600 volts or more) but may be required to escort SCE&G or other personnel into restricted and locked high-voltage areas to maintain or repair electrical power generation or transmission systems.

(3) For the purposes of safe work practices with electrical systems, a person must have the following training in order to be considered a Qualified Person:
   a. The skills and techniques necessary to distinguish exposed live parts from other parts of electric equipment.
   b. The skills and techniques necessary to determine the nominal voltage of exposed live parts.
   c. The clearance (approach) distances specified in 1910.333(c) Table S-5 and the corresponding voltages to which the qualified person will be exposed.
   d. Qualified persons whose work on energized equipment involves either direct contact or contact by means of tools or materials must also be capable of working safely on energized circuits and shall be familiar with the proper use of special precautionary techniques, personal protective equipment, insulating and shielding materials, and insulated tools.

(4) The instruction and hands-on training received by authorized employees includes:
   a. Recognition of hazardous energies;
   b. Types and magnitudes of hazardous energies found in the workplace;
   c. When a Live Work Permit is required, the process to obtain the permit, and the BCB exception allowed for the Lighting Ballast Procedure;
   d. A hands-on demonstration of the means and methods of isolating and/or controlling various hazardous energies should include but are not limited to the following:
      1. Electrical -
         (a) Circuit Breaker – Examples:
            - 277/480/600 Volt - No Hole
            - Universal Multiple Breaker
            - Single Pole
         (b) Fuse
         (c) Wall Switch
         (d) Plug
      2. Mechanical:
         (a) Ball Valve
         (b) Gate Valve
         (c) Chain
      3. Safety Hasps (for situations involving more than one employee)
      4. Locks
      5. Tags
   e. The means of verification of effective energy control, and the purpose of the procedures to be used.
   f. Each employee must be able to demonstrate in a hands-on class, on-the-job training and during routine work practices the proper selection and application

of the appropriate LOTO devices for the specific tasks that exit in their work environment.

(5) Affected employees are to be instructed in the purpose and use of the energy control procedures.

(6) All other employees who may be affected by the energy control procedures are to be instructed about the procedure and the prohibition relating to attempts to restart or reenergize such machines or equipment.

(7) Certification of training: Transcripts of employee safety training will be maintained in a computer database maintained by the Safety staff.

(8) Retraining of authorized and affected employees is required:

a. Whenever there is a change in employee job assignments;

b. Whenever a new hazard is introduced due to a change in machines, equipment or process;

c. Whenever there is a change in the energy control procedures; or

d. Whenever a periodic inspection by the employer reveals inadequacies in the company procedures or in the knowledge of the employees.

C. The Job Safety (Hazard) Analysis (JSA / JHA) technique allows each team to look at their work process steps, identify hazards and implement controls. Each team is to conduct a JSA for each piece of equipment and machinery or work process where servicing or maintenance involves potentially hazardous energies. Each JSA is to identify and document the specific types of energy to be controlled, where isolation devices are located and how the hazardous energy is to be controlled for each piece of equipment and machinery.

(1) A survey of facilities, equipment and machinery is required to identify the location of all isolating devices.

(2) The supervisor is to inform subordinates of the physical and health hazards and control measures associated with the work.
Example: Material Safety Data Sheets for chemicals in a pipeline requiring service or maintenance should be discussed and made available to each worker prior to the work. In addition to the types of LOTO to be used, the supervisor should cover personal protective equipment, spill prevention and cleanup, first aid and emergency notification procedures.

D. The budgeting for and purchase of LOTO devices, locks, tags, etc. is each team's own responsibility.

3. Enforcing the program.

A. Workers will be observed to verify proper compliance with LOTO procedures. These verifications:

(1) Must be conducted at least annually.

(2) Must be conducted by an authorized person.

(3) Are to validate proper procedures being used by the workforce.

(4) May be implemented through random audits, inspections and/or planned visual observations.

B. Board Safety will ensure LOTO verification records for each identified energy control procedure is documented and maintained.

C. Deviations from or procedural inadequacies in implementing an energy control procedure are to be reported to the employee's supervisor for appropriate corrective actions.

VII. LOCKOUT/TAGOUT (LOTO) PROCEDURE

WARNING: ALL Equipment Or Parts Will Be Considered ENERGIZED Until All LOTO Steps Are Completed.

CAUTION: Placing a machine or piece of equipment in a safe work condition is in itself a potentially hazardous task.

1. **NOTIFY**: Before LOTO controls are applied, the Authorized Employee must tell all affected employees that servicing or maintenance is required on a machine or equipment and that the machine or equipment must be shut down and locked out and/or tagged out. Affected and other employees, as required, are to be informed not to attempt to operate the machine or equipment, or to remove the LOTO, and that they will be informed when the machine or equipment is returned to service.
2. **PREPARE FOR SHUTDOWN**: The Authorized Employee must know the type and strength of the energy, the hazards to be controlled, and the method(s) to control the energy/hazards.
   CAUTION: A single machine or piece of equipment can have more than one power source. Each power source isolation device must be identified. (A Job Safety Analysis for each machine or equipment should be done to indicate in writing the hazardous energy sources, where the normal operational controls are located, and what type and where lockout/tagout devices are to be applied.)
3. **SHUTDOWN**: Turn off the machine or equipment using the normal established procedure.
4. **ISOLATE**: Locate and de-activate all energy isolating devices so that the machine or equipment is isolated from all energy sources.
   CAUTION: A single machine or piece of equipment can have more than one power source. Each power source must be identified, shut down, and secured against inadvertent re-activation or release of energy.
5. **APPLY LOTO**: The Authorized Employee will apply locks or lockout devices with locks to each energy source (lockout devices hold the energy-isolating device in a safe, neutral or "Off" position. Tagout devices are a clear warning prohibiting operators and others from removing the lockout device and/or lock or attempting to restore power for equipment operation.)
   NOTE: Locks designated for LOTO are only to be used for controlling hazardous energies; other use is prohibited.
   A. **GROUP LOTO**: When more than one employee is servicing or maintaining the same machine or equipment, each employee is to apply his/her own lock. A safety hasp LOTO device or group lockout box is to be used when more than one employee needs to simultaneously work on the same machine or equipment (see Appendix B).
      (1) **SAFETY HASP**: This is a LOTO device that typically allows 6-8 employees to simultaneously apply their individual locks onto one disconnect. Each employee would have one lock for each and every point of disconnect for the equipment or

machinery. Example: A boiler has 10 points of isolation. A hasp would be used at each isolation point and each involved employee would need 10 locks. Therefore the LOTO need for three employees equals 10 hasps and 30 locks.

(2) **GROUP LOCKOUT BOX**:

a. **Individual LOTO using Group Lockout Box**: One designated employee applies a lock and tag to each disconnect according to a written procedure specifically for the equipment or machinery. (All employees involved in the maintenance or servicing are responsible for ensuring the written LOTO procedure for that equipment or machinery is followed and all energy sources are made safe.) The keys for each of those locks are then placed inside the Group Lockout Box which is then secured by one lock per each employee involved in the maintenance or servicing of that equipment or machinery. The box is kept on site. Example: The same boiler would require 10 locks (one for each disconnect point) plus one lock per involved employee applied to the lockout box. The LOTO need for three employees equals one lockout box with its prescribed locks and LOTO devices, and 3 locks, one for each employee – a total of 13 locks. A lockout box with multiple slots for each of the participating employees or a lockout box with one locking point where a safety hasp is used are appropriate for this LOTO method. Recommend making a Group Lockout Box for a specific piece of large equipment or machinery so that it contains all appropriate LOTO devices, locks and written LOTO procedures.

b. **One Controller for Group Lockout Box**: Each employee locks out their particular energy source then places their key into the group lockout box. The designated employee then secures the box with his/her lock until the job is complete and all group members are finished working in their areas. This method typically uses a lockout box with one locking point and each employee inserts their key(s) through a slot. Only the Controller has a key to open the lockout box for the employees to retrieve keys their individual locks.

B. **SHIFT CHANGE**: Some jobs require more than one work shift to complete. When conducting a shift change, the oncoming employee will apply his/her lock prior to the employee going off shift removing his/her lock. The oncoming employee will verify LOTO is properly implemented prior to beginning work.

6. **SAFE STORED ENERGY**: All potentially hazardous stored or residual energy shall be relieved, disconnected, restrained or rendered safe.
7. **VERIFY ISOLATION**: Prior to starting work on machines or equipment that have been locked out or tagged out, the Authorized Employee will verify that isolation and de-energization was accomplished.
   A. Check that no persons are exposed.
   B. Push the button or other operational controls or use test equipment to make certain the machine or equipment will not operate.
   C. Return operating controls to Neutral or the “Off” position after verification.
   D. Electrical: Use test equipment such as a voltage pen or voltmeter to determine that no electrical power is being stored or supplied to the machine or equipment.

NOTE: Voltage testing while completing LOTO is considered as working on live (energized) parts.

8. **TESTING OR REPOSITIONING EQUIPMENT (TEMPORARY RE-ENERGIZATION)**: If the machine or equipment has to be temporarily re-energized in order for a part of the machine to be repositioned, or if the equipment has to be tested as part of the servicing or maintenance, use the following procedure:
   A. Clear the machine or equipment of all tools, materials and non-essential items.
   B. Clear Affected Employees from the vicinity.
   C. Remove any LOTO devices required to reposition or test the machine or equipment.
   D. Energize the Energy Isolation Devices and Turn the machine or equipment on using normal procedures.
   E. Proceed with repositioning and/or testing.
   F. When repositioning and testing are completed, de-energize the equipment or machine in accordance with the previously described LOTO procedure (return to Step 3).
9. **RESTORING THE MACHINE OR EQUIPMENT TO SERVICE**:
   A. INSPECT:
      (1) Ensure nonessential items have been removed and that machine or equipment components are operationally intact.
      (2) Before LOTO devices are removed and energy is restored to the machine or equipment, Affected Employees must be told that LOTO controls are going to be removed. Ensure all employees have been safely positioned or removed from the area.
   B. REMOVE LOTO DEVICES:
      (1) Verify the operational controls are in Neutral or Off.
      (2) The Authorized Employee who installed the LOTO device will remove and account for all LOTO devices that were installed.
      CAUTION: If the Authorized Employee is for some reason not available, that employee's immediate supervisor can authorize removal of his/her LOTO devices. There will be two keys for each LOTO lock; the Authorized Employee will keep one key and the Authorized Employee's immediate supervisor will keep the other key. If the supervisor's key does not work, the supervisor may cut off the lock. The supervisor must ensure the absent employee is informed that the lock was removed before he/she resumes work at that facility.
   C. RE-ENERGIZE THE MACHINE OR EQUIPMENT.
   D. NOTIFY: Tell the affected employees that the servicing or maintenance is completed and the machine or equipment is ready for use.

VIII. WORKING ON OR NEAR ENERGIZED ("LIVE") EQUIPMENT:

With Careful Planning, **Work Can Almost Always Be Done With The Machine or Equipment DE-ENERGIZED**. Financial or customer comfort considerations are NOT adequate reasons to work on or near energized circuits, equipment or machinery.

NOTE: Only Qualified Persons may work on electric circuit parts or equipment that have not been de-energized.

1. **If an employee can be exposed to any hazardous live parts that must remain energized, additional measures other than LOTO must be used.** Protective measures such as **guarding, isolating** and/or **insulating** as well as the following **work practices** are to be used to protect employees against contact with energized circuit parts directly with any part of their body or indirectly through some other conductive object. Work on live equipment is only allowed if the employer can show that de-energizing is not feasible, such as:
   A. De-energizing introduces additional hazards, i.e., an interruption of an emergency alarm system.
   B. De-energizing increases the hazards involved in doing the job, i.e. shutting down the ventilating system in purging a hazardous atmosphere.
   C. De-energizing, by the nature of the equipment or installation, requires the shutdown of the whole operation.
2. Workers are prohibited from blindly reaching into areas with energized live parts.
3. Qualified employees should avoid contact with live equipment of 300 volts or less. Qualified employees should avoid live equipment of more than 300 volts by at least 1 foot minimum (See Table S-5, 29 CFR 1910.333(c), for the minimum approach distance for equipment of more than 750 volts).
   A. Conductive materials and equipment that are in contact with any part of an employee's body shall be handled in a manner that will prevent them from contacting exposed energized conductors or circuit parts. If an employee must handle long dimensional conductive objects (such as ducts and pipes) in areas with exposed live parts, the employer shall institute work practices (such as the use of insulation, guarding, and material handling techniques) which will minimize the hazard.
   B. Conductive articles of jewelry and clothing (such as watch bands, bracelets, rings, key chains, necklaces, cloth with conductive thread, or metal headgear) may not be worn if they might contact exposed energized parts.
4. ILLUMINATION: Employees may not enter spaces containing exposed energized parts, unless illumination is provided that enables the employees to perform the work safely. Where lack of illumination or an obstruction precludes observation of the work to be performed, employees may not perform tasks near exposed energized parts. Employees may not reach blindly into areas that may contain energized parts.
5. AERIAL LIFTS: When an unqualified person is working on the ground in the vicinity of overhead lines, or if 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 10 ft. is maintained. If the voltage is higher than 50kV, the clearance shall be increased 4 in. for every 10kV over 50kV.

6. CONFINED OR ENCLOSED WORK SPACES: When an employee works in a confined or enclosed space that contains exposed energized parts, the supervisor shall provide, and the employee shall use protective shields, protective barriers, or insulating materials as necessary to avoid inadvertent contact with these parts. Doors, hinged panels, and the like shall be secured to prevent their swinging into an employee and causing the employee to contact exposed energized parts.
7. PORTABLE LADDERS: Portable ladders shall have nonconductive side-rails if used where the employee or the ladder could contact exposed energized parts.
8. GENERAL PROTECTIVE EQUIPMENT AND TOOLS: When working near exposed energized conductors or circuit parts, each employee shall use insulated tools or handling equipment if the tools or handling equipment might make contact with such conductors or parts. If the insulating capability of insulated tools or handling equipment is subject to damage, the insulating material shall be protected. Fuse handling equipment, insulated for the circuit voltage, shall be used to remove or install fuses when the fuse terminals are energized. Protective shields, protective barriers, or insulating materials shall be used to protect each employee from shock, burns, or other electrically related injuries while that employee is working near exposed energized parts that might be accidentally contacted or where dangerous electric heating or arcing might occur. 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.

IX. **PERSONAL PROTECTION**

The employer must provide protective equipment to include personal protective equipment (PPE) to their employees who must work where there is a risk from potentially hazardous energies. The PPE must comply with ANSI standards appropriate for the hazard. BCB Safety will assist Team Leaders and/or their representatives conduct Job Safety Analysis of work processes, as required, to determine appropriate PPE. The required PPE for specific work processes will be documented in a PPE Assessment (see PPE, Safety Footwear and Safety Eyewear policies). Example: Employees shall wear nonconductive and fire-resistant PPE whenever there is a danger of injury from arc flash, electric shock or burns due to contact with exposed energized parts.

1. **GLOVES**: Gloves and sleeves come in various materials to provide hand and arm protection according to the hazard, i.e., chemical, thermal, and electrical.
2. **SAFETY FOOTWEAR** provides varying types of foot protection, i.e., chemical, electrical.
3. All **HARD HATS** in accordance with the ANSI Z89.1 standard meet or exceed either Type I or Type II impact requirements. In addition to type classifications, all hard hats are further classified as meeting Class G, Class E, or Class C electrical requirements.
   A. Type I hard hats are intended to reduce the force of impact resulting for a blow only to the top of the head.
   B. Type II hard hats are intended to reduce the force of impact resulting from a blow which may be received off center or to the top of the head.
   C. Class G – General (formerly Class A): Class G hard hats are intended to reduce the danger of contact exposure to low voltage conductors. Test samples are proof tested at 2200 volts (phase to ground). However, this voltage is not intended as an indication of the voltage at which the hard hat protects the wearer.
   D. Class E – Electrical (Formerly Class B): Class E hard hats are intended to reduce the danger of exposure to high voltage conductors. Test samples are proof-tested at 20,000 volts (phase to ground). However, this voltage is not intended as an indication of the voltage at which the helmet protects the wearer.
   E. Class C - Conductive: Class C hard hats are not intended to provide protection against contact with electrical conductors.
   CAUTION: Do not wear Class C hard hats when working on or near live electrical equipment.
4. **SAFETY EYEWEAR**: Employees shall wear protective equipment for the eyes or face wherever there is danger of injury to the eyes or face from electric arcs or flashes or from flying objects resulting from electrical explosion; grinding; welding; or chemical splashes are occurring or likely to occur.
5. **FIRE-RESISTANT CLOTHING**: Employees shall wear fire-resistant clothing, in the form of long-sleeve shirts and pants or coveralls, wherever there is danger of injury from electrical shock, arc flashes or blasts, i.e., whenever working within the 4 foot flash boundary for energized circuits of 50 to 600 volts. Most work done by FM employees is at but is not restricted to 240 volts or less. On occasion the FM Building Maintenance Supervisors may be exposed to 600 or more volts when escorting SCE&G power distribution personnel into high-voltage rooms. The various levels of risk require increased levels of flame-resistant clothing as follows:

   50 – 276 Volts: BCB employees who are exposed by working on electrical systems of 50 volts or more but less than 277 volts must wear personal protection equipment to include:

   - Fire Resistant (minimum Arc Rating of 8) Long Sleeve Shirt and Pants or Coverall
   - Safety Glasses

277 – 599 Volts: Due to the higher potential hazard of arc flash, equipment of 277 volts or more will be identified with Arc Flash Warning labels. BCB employees who are exposed by working on electrical systems of 277 volts or higher must wear personal protection equipment to include:

- Fire Resistant (minimum Arc Rating of 8) Long Sleeve Shirt and Pants or Coverall with non-synthetic (i.e., cotton) clothing underneath

  WARNING: Clothing made with synthetics (100% synthetic such as acetate, nylon, polyester, polypropylene, or rayon or in any blended combination with cotton) can melt when exposed to an arc flash, even under the FR outer garment, and cause severe burns

- Arc Flash Face Shield
- Safety Glasses
- Leather Gloves

NOTE: Facilities Management Trades Specialists are to be provided with FR coveralls with a minimum Arc Rating of 8.

600 Volts or Higher: Due to the higher potential hazard of arc flash, equipment of 277 volts or more will be identified with Arc Flash Warning labels. Entry is to be restricted (i.e., by key lock) to locations that have electrical systems of 600 volts or higher. Access to these areas requires the employee to see the Facilities Management Area Supervisor. BCB employees who are exposed by working on electrical systems of 600 volts or higher must wear personal protection equipment to include:

- Fire Resistant (minimum Arc Rating of 40) Long Sleeve Shirt and Pants or Coverall or Arc Flash Coat and Pants with non-synthetic (i.e., cotton) clothing underneath

  WARNING: Clothing made with synthetics (100% synthetic such as acetate, nylon, polyester, polypropylene, or rayon or in any blended combination with cotton) can melt when exposed to an arc flash, even under the FR outer garment, and cause severe burns

- Arc Flash Face Shield
- Safety Glasses
- Leather Gloves

6. **INSULATED TOOLS**: When working on 50 volts ac or more to ground, insulated tools must be used.
7. **INSULATING BLANKETS** can protect workers from low-voltage electrical hazards. 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.

X. **EMPLOYEE WARNINGS**:

Safety signs, safety symbols, or accident prevention tags shall be used where necessary to warn employees about hazards that may endanger them. Barricades shall be used in conjunction with safety signs where it is necessary to prevent or limit employee access to work areas exposing employees to hazardous energies. If signs and barricades do not provide sufficient warning and protection from hazards, an attendant shall be stationed to warn and protect employees.

XI. RESCUE PROCEDURES

If, despite every precaution, an electrocution or arc flash incident occurs and workers are injured, it is important that rescue and treatment are performed in a manner that does not risk further injury, either to the injured worker or others or to those conducting the rescue.

- Do not touch an injured worker who is in contact with a live circuit. Shut off the power. If this is impossible, use tools made of nonconductive material to attempt to dislodge the worker.
- Do not move an injured worker, as falls caused by an electric shock or arc blast may have caused spinal injury that could be made worse by moving.
- If worker is not breathing or lacks a pulse, CPR should be performed by a trained worker immediately.
- Remove burning clothing, unless it is melted to the worker's skin.
- Wash burns with cool, but not cold, water. Do not apply lotions or creams. Cover burns with a cool dry cloth.
- Seek medical assistance. In addition to burns, electrical accidents may cause internal injuries that are not immediately apparent.

APPENDIX A

TERMINOLOGY:

AFFECTED EMPLOYEE: Is someone whose job requires being in close vicinity to, operating or using a machine or equipment which is subject to servicing or maintenance under LOTO procedures. NOTE: Affected employees only need training to the point that they are aware of the LOTO program and how to recognize when LOTO is in effect.

APPROACH DISTANCES: Applies to work performed on exposed live parts (involving either direct contact or contact by means of tools or materials) or near enough to them for employees to be exposed to any hazard they present. Only qualified persons may work on electric circuit parts or equipment that has not been de-energized under the prescribed procedures.

29 CFR 1910.333 Table S-5 APPROACH DISTANCES
for Qualified Employees - Alternating Current

Voltage range (phase to phase)	Minimum approach distance
300V and less	Avoid contact
Over 300V, not over 750V	1 ft. 0 in. (30.5 cm)
Over 750V, not over 2kV	1 ft. 6 in. (46 cm)
Over 2kV, not over 15kV	2 ft. 0 in. (61 cm)
Over 15kV, not over 37kV	3 ft. 0 in. (91 cm)
Over 37kV, not over 87.5kV	3 ft. 6 in. (107 cm)
Over 87.5kV, not over 121kV	4 ft. 0 in. (122 cm)
Over 121kV, not over 140 kV	4 ft. 6 in. (137 cm)

ARC FLASH: Arc flash occurs when the phase conductors are shorted and ionizations of the air take place. An arc flash with 1000 amperes or more can cause substantial damage, fire or injury. The massive energy released in the fault rapidly vaporizes the metal conductors involved, blasting molten metal and expanding plasma outward with extreme force. In addition to the explosive blast of such a fault, destruction also arises from the intense radiant heat produced by the arc. The metal plasma arc produces tremendous amounts of light energy from far infrared to ultraviolet. Surfaces of nearby people and objects absorb this energy and are instantly heated to vaporizing temperatures up to 35,000°F. The best way to remove the hazards of an arc flash is to de-energize electrical equipment when interacting with it; however this in itself is an arc flash hazard.

ARC FLASH ANALYSIS: This is a study of your electrical distribution system to determine if hazards exist and their severity to show if a short circuit or equipment failure will result in a small spark or a life threatening explosion. The primary goal is to identify the hazards and then engineer them out of your system.

AUTHORIZED EMPLOYEE: Is a person who has been trained (see Qualified Person) and designated to perform servicing or maintenance on specified machinery or equipment to include applying lockout and/or tagout for the control of potentially hazardous energies. NOTE: An employee may be generally qualified and authorized to service and maintain Brand X equipment but not authorized to service and maintain Brand Z even though it is similar equipment.

CIRCUIT PROTECTION: Devices designed to automatically limit or shutoff electrical flow in event of a ground-fault, overload or short-circuit. Note: Current values exceeding the limits for which a wire was designed causes overheating resulting in the wire softening, damaging the insulation (melted, brittle or cracked) and exposing bare wires creating electrocution and/or fire hazards. Damage from overheating results from using too small of a cable or wire for the required load. To prevent an over-current or overloading from occurring, the proper size wire should be used for the load and a circuit protection device must be installed in the line with the circuit.

A. FUSE: An over-current protective device with a circuit opening fusible part that is heated and severed by the passage of over-current through it.
    1. Designed to melt and burn in two at a set current value, i.e. commonly 15/20/30 amps for households and 100/200 amps and greater for industrial
    2. Plug fuse screws into holder
    3. Cartridge fuse held by contacts
B. CIRCUIT BREAKER: an electromechanical switch inside is tripped open by heat generated due to the overloaded circuit; can be reset and reused over and over but a tripped circuit breaker is indicative of a defective circuit.
    1. (600 volts nominal or less). A device designed to open and close a circuit by non-automatic means and to open the circuit automatically on a predetermined over-current without injury to itself when properly applied within its rating.
    2. (Over 600 volts, nominal). A switching device capable of making, carrying, and breaking currents under normal circuit conditions, and also making, carrying for a specified time, and breaking currents under specified abnormal circuit conditions, such as those of short circuit.
C. GROUND-FAULT CIRCUIT INTERRUPTER (GFCI): A device whose function is to interrupt the electric circuit to the load when a fault current to ground exceeds some predetermined value that is less than that required to operate the over-current protective device of the supply circuit.
    1. Compares electric current output and return then can shut off power within as little as $1/40^{th}$ of a second when the two values differ by a set amount.
    2. Used in high-risk areas such as wet locations and construction sites. Only protects line to ground faults; does not provide complete protection.

DE-ENERGIZED: The equipment or machinery is turned off, disconnected from the supplying energy source(s), and is without residual or stored energy.

DIAGNOSTICS: Troubleshooting of live (energized) equipment using test instruments. Only qualified persons may perform testing work on live electric circuits or equipment. Test instruments and equipment and their accessories shall be rated for the circuits and equipment to which they will be connected and shall be designed for the environment in which they will be used. Test equipment must be verified as functional prior to troubleshooting.

DISCONNECTING MEANS: Is a device, or group of devices, or other means by which the conductors of a circuit can be disconnected from their source of energy.

ENERGIZED: Connected to an energy source or containing residual or stored energy.

ENERGY ISOLATING DEVICE: A mechanical device that physically prevents the transmission or release of energy. Examples: Manually operated circuit breaker, disconnect switch, line valve.

ENERGY (POWER) SOURCE: Any source of electrical, mechanical, hydraulic, pneumatic, chemical, thermal or other energy.

GUARDED: Covered, shielded, fenced, enclosed, or otherwise protected by means of height or suitable covers, casings, barriers, rails, screens, mats, or platforms to remove the likelihood of approach to a point of danger or contact by persons or objects.

GROUND: A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth, or to some conducting body that serves in place of the earth (offering a path of sufficiently low resistance and current carrying capacity to prevent dangerous voltage buildups). NOTE: Grounding is not a guarantee against shock, injury or death but will substantially reduce the possibility of such incidents.

A. Service or System Ground - one wire (the service entrance earth ground to which the system ground and neutral are connected) is the neutral or ground wire.
    1. The white or gray wire is grounded at the generator or transformer and again at the service entrance of the building
    2. Used to protect machines, tools and insulation against damage

B. Equipment Ground
    1. An additional ground from the tool or machine to the ground
    2. Used to protect the worker in the event a malfunction accidentally energizes the tool's metal frame

GROUP LOCKOUT / TAGOUT: Group LOTO allows authorized individual employees to be protected from hazardous energy when they are part of a group (two or more employees) performing covered servicing or maintenance. Group LOTO is the means by which each authorized employee performing the servicing and/or maintenance exercises his or her control over the associated hazardous energy by attaching his or her personal lock onto a group LOTO mechanism. It consists of personal LOTO devices, group LOTO devices/mechanisms, and equipment LOTO devices.

GROUP LOCKOUT / TAGOUT MECHANISM: Any device or mechanism that, when used as part of a group LOTO system, permits each individual employee to use his personal lock or lockout device with lock to physically secure energy isolating device(s) during the servicing or maintenance work. The use of group lockout hasps, lockboxes (containing keys or tabs from equipment locks or job tags) or similar group mechanisms, such as a master tag that procedurally controls equipment re-energization, are examples.

GUARDED: Covered, shielded, fenced, enclosed, or otherwise protected by means of height or suitable covers, casings, barriers, rails, screens, mats, or platforms to remove the likelihood of approach to a point of danger or contact by persons or objects.

GUARDING (ELECTRICAL): Locations containing exposed live parts must be marked with conspicuous warning signs forbidding unqualified persons from entering

A. Live parts of electrical equipment operating at 50 volts or more must be guarded against accidental contact by:
    1. Enclosure (room or vault) accessible only to qualified persons
    2. Permanent partitions or screens to exclude unqualified persons
    3. Located 8 feet or more off of the floor
    4. In electrical platform, balcony or gallery
B. Indoor electrical installations with live parts of electrical equipment operating at over 600 volts and open to unqualified persons must be:
    1. Made with metal-enclosed equipment
    2. Enclosed in a vault controlled by a lock

HOT TAP: A repair, maintenance or service procedure involving welding or cutting on a piece of equipment (pipelines, vessels or tanks) under pressure in order to install connections or parts.

HOT WORK: Electric or gas welding or cutting operations are considered “hot” work which requires a written permit with the authorized employee’s supervisor’s approval to conduct such work..

INSULATION: any material with a high resistance to electrical current (amperes near 0), i.e. glass, mica, rubber, plastic

A. Used to prevent shock, fires, short circuits and accidental contact with the current
B. Circuit conductors generally are required to have insulation (29 CFR 1910 Subpart S, Design Safety Standards for Electrical Systems)
    1. Should be suitable for the voltage and conditions such as temperature, moisture, oil, gasoline and corrosive fumes
    2. Conductors and cables should be marked by the manufacturer to show maximum voltage, American Wire Gage size, type letter of the insulation, and the manufacturer's name or trademark
    3. Insulation is color coded:
        a. Equipment/Frame Grounding conductors - continuous green or green with yellow stripes or non-insulated (bare) wire
        b. Grounded conductors (that complete a circuit) - white or natural gray
        c. Ungrounded conductors ("hot" wires) - any other color; most often red or black

LIVE EQUIPMENT: Equipment or machinery being powered by one or more energy sources. Controls are typically electrical powered while other energy sources can power other parts of the machine or equipment. Work on live equipment is only allowed if the employer can show that de-energizing is not feasible.

1. De-energizing introduces additional hazards, i.e., an interruption of emergency alarm system.

2. De-energizing increases the hazards involved in doing the job, i.e. shutting down the ventilating system in purging a hazardous atmosphere.
3. De-energizing, by the nature of the equipment or installation, requires the shutdown of the whole operation. Where electrical equipment and circuits can't be de-energized before they are to be worked on or near:
    a. Only qualified persons are allowed.
    b. Sufficient illumination is required.
    c. Other safety-related work practices must be employed to protect the worker from contact.
4. Workers are prohibited from blindly reaching into areas with energized live parts.
5. If there is less than 50 volts and no increased exposure to electrical burns or explosion due to arcing.

LIVE WORK: Working on equipment or machinery which is not de-energized and made safe, i.e., LOTO is not implemented, is considered “live” work which requires a written permit with the authorized employee’s supervisor’s approval to conduct such work.

LOCKOUT/TAGOUT (LOTO): A work practice (see procedure) to de-energize equipment, apply a lockout device on each energy isolating device (its disconnection), and tagout of the equipment to ensure the equipment being controlled cannot be operated before servicing, maintaining or making repairs. Where the machine or equipment can be de-energized and LOTO used in order to safely perform the servicing or maintenance, de-energization and LOTO will be performed.

LOCKOUT DEVICE: An apparatus that holds an energy-isolating device in a safe position. These devices shall be substantial enough to prevent removal without the use of excessive force or unusual techniques. Examples: Locks (keyed locks are preferred to combination locks because the individual retains sole control), bolted slip blinds, blank flanges, pins, chains, wedges, valve clamps. Each device shall indicate the identity of the employee applying it. The employee should be identified by name, employee number or assigned code. The device is not to be removed without the permission of the Authorized Employee, and it is not to be bypassed, ignored or defeated. Only the supervisor can authorize the removal of a LOTO device in an emergency where the Authorized Employee is not available and the Authorized Employee is informed before his/her return to work of the removal.

MAY - A discretionary right, privilege, or power is conferred by the word "may."

MAY NOT - If a right, privilege, or power is abridged or if an obligation to abstain from acting is imposed, the word "may" is used with a restrictive "not" or "only."

OVERCURRENT: Any current in excess of the rated current of equipment or the capacity (in amperes) of a conductor. It may result from overload, short circuit, or ground fault. A current in excess of rating may be accommodated by certain equipment and conductors for a given set of conditions. Hence the rules for over-current protection are specific for particular situations.

OVERLOAD: Operation of equipment in excess of normal full-load rating or of a conductor in excess of rated capacity (in amperes) which, when it persists for a sufficient length of time, would

cause damage or dangerous overheating. A fault, such as a short circuit or ground fault, is not an overload.

PERMIT: A written authorization from a supervisor designating what job is to be done, which employees are involved, the location, hazards that are involved, what procedures and/or equipment are required to protect the employees, any other tools and/or procedures relevant to accomplishing the task, and rescue recovery operations. Permits will be limited to specified start and finish dates and times. Example: Permits for confined space entry, welding or working on energized systems.

QUALIFIED PERSON: A designated and trained employee familiar with the construction and operation of the equipment and the hazards involved. Example: A qualified electrician is an employee who has had training in avoiding the electrical hazards of working on or near exposed energized parts. (For BCB this includes premises wiring, wiring for connection to supply, and optical fiber cable. Power generation, transmission, and distribution installations; communications installations; and installations in vehicles, which are covered by other standards, are not performed by BCB employees.)

A. "Qualified" depends on the workplace, i.e., it is likely for an employee to be considered "qualified" with regard to certain equipment in the workplace, but "unqualified" as to other equipment. Example: An employee may be qualified to work on a motor in a mechanical room but not qualified to work on the same type motor in a permit required confined space until completing confined space training requirements.
B. An unqualified employee who is undergoing on-the-job training and who has demonstrated an ability to perform duties safely at his/her level of training, and who is under the direct supervision of a qualified person, is considered to be a qualified person up to the level of his/her training.

SAFETY HASP: When more than one employee is servicing/maintaining a machine or equipment, each employee is to apply his/her own lock. A safety hasp is a group LOTO device that allows the lock for each involved employee to be applied simultaneously. A safety hasp is also typically used when a shift change of personnel is expected so positive control can be maintained at all times (the on-coming employee applies his/her lock prior to the off-going employee removing his/her lock).

SERVICING / MAINTENANCE: Workplace activities such as constructing, installing, setting up, adjusting, inspecting, modifying, maintaining, repairing, lubricating, cleaning, or unjamming machines or equipment; and/or making adjustments or tool changes.

SHALL or WILL: Mandatory

SHALL NOT - is a prohibited activity.

SHOCK (ELECTRICAL): the physiological effect, severe injury or death that occur when an electric current passes through the body.

A. A person becomes a part of the electrical circuit when he/she comes in contact with:
    1. Both wires of electrical circuit
    2. One wire of the electrical circuit and the ground
    3. Metallic part that is "hot" (in contact with an energized wire) and in contact with the ground, i.e. due to a break in the insulation

B. Severity of shock is affected by:
    1. Amount of current flow (amperes)
    2. The path through the body
    3. Length of time the body is in the circuit
    4. Current frequency
    5. Phase of heart cycle
    6. Person's general health

C. Effects of Electric Current in the Human Body:
    1. *The body is a conductor*. A voltage difference causes a current flow. Current will flow through the body when a voltage difference is present between two points on the body.
    EXAMPLE: The earth has zero (0) voltage so a person (conductor) placed between a power line and the earth would conduct current.
    2. The following two charts show the resistance in ohms that were determined in actual tests from passing 110 volts through various body paths (Volts / Ohms = Current).

TYPICAL BODY RESISTENCE

BODY PATH	RESISTANCE	CURRENT (milli-amps)
Ear to Ear	100	1,100 mA (110/100)
Head to Foot	500	220 mA
Dry Skin	350,000	0.3 mA
Wet Skin	1,000	110 mA

Note: *AS LITTLE AS 27 VOLTS CAN BE FATAL.*

CURRENT	REACTION
1 mA	Faint Tingle
5 mA	Slight Shock; Strong Involuntary Reactions but Can Let Go
9 - 30 mA	Painful Shock; Lost Muscular Control
50 - 150 mA	Respiratory Arrest; ***POSSIBLE DEATH !***
1000 - 4300 mA	Heart Fibrillation; DEATH LIKELY
10,000 mA	Cardiac Arrest, Severe Burns; DEATH PROBABLE

    3. POSSIBLE RESULTS OF ELECTROCUTION:
        a. *CARDIOPULMONARY* problems. The most dangerous path is through the chest and heart (from one arm to the opposite leg) as that can stop cardiopulmonary (heart and/or lung) functions.

b. *BURNS*: All three types of burn can occur simultaneously resulting in internal hemorrhages, tissue/nerve/muscle destruction, and/or broken bones.
    (1) Electrical burn - current flows through tissues or bones resulting in one of the most serious of injuries.
    (2) Arc or Flash burn - person near to arc or explosion with high temperatures.
    (3) Thermal contact burn - skin contacts hot surface.
c. *SECONDARY INJURIES* from falls, cuts, explosions, fires. TAGOUT: The placement of a tagout device on an energy-isolating device IAW standard procedure.

SHOULD / SHOULD NOT – a recommended (but not mandatory) practice.

TAGOUT DEVICE: A prominent warning, such as a tag and a means of attachment, securely fastened to an energy-isolating device to indicate the energy isolating device and equipment being controlled may not be operated until the tagout device is removed. Examples of Tagout warning: DO NOT START, DO NOT OPERATE, DO NOT OPEN, DO NOT CLOSE, or DO NOT ENERGIZE. Tagout devices and their means of attachment shall be substantial enough to prevent inadvertent or accidental removal. Each tagout device shall indicate the identity of the employee applying it. The employee should be identified by name, employee number or assigned code. The tagout device is not to be removed without authorization of the responsible person, and it is never to be bypassed, ignored or defeated. Where the machine or equipment can be de-energized but lockout is not feasible to perform the servicing or maintenance, de-energization and tagout will be performed.
CAUTION: Tags may evoke a false sense of security. Tagout devices do not provide the physical restraint of a lockout device. Where the machine or equipment can be de-energized and lockout/tagout used to perform the servicing or maintenance, de-energization and lockout/tagout will be performed.

APPENDIX B

LOCKOUT / TAGOUT DEVICES

MINIMUM REQUIREMENTS

LOTO Locks shall be:

1. Instantly identifiable as equipment to be used specifically for Lockout/Tagout, i.e., color-coded by team, and shall not be used for any other purpose
2. Individually keyed. There are to be only two keys per lock with one key in the employee's possession and the other key under the supervisor's control.
3. Substantial enough to prevent removal without the use of excessive force or unusual techniques (removal, i.e., by use of bolt cutters, is only allowed by supervisor direction when the employee is not available).
4. Capable of withstanding the environment to which they are exposed.

Example:

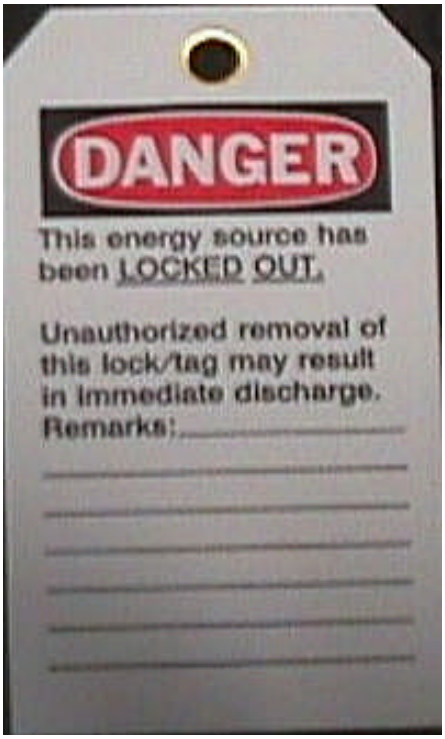
Lock

LOTO TAGS shall be:

1. Instantly identifiable as warnings for lockout/tagout purposes. A message shall warn of a hazardous condition if the machine or equipment is energized with words such as, "Do Not Operate," "This energy source has been locked out," and "This lock/tag may only be removed by (space for employee's name)." The authorized worker that attaches a tagout should include his/her name, Team name, and expected completion date on the tag.
2. Used whenever a lock is applied to control a hazardous energy.
3. Constructed so as to resist the effects of exposure to weather conditions, wet and damp locations or corrosive environments.
4. Attached to the lock directly or with a tie substantial enough to prevent inadvertent or accidental removal.
5. Replaced when the tag becomes damaged or not readable.

Example:

Tag - Front



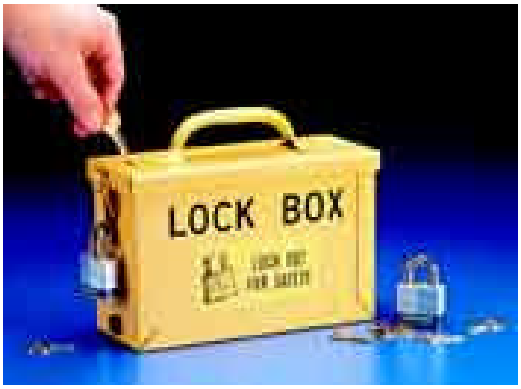
Tag – Back

Group LOTO is used when more than one person is expected to simultaneously work on the same equipment/machine or there is to be a shift change.

Group Lockout Hasp

Group LOTO using Hasp

Group LOTO Box for Multiple Locks



Group LOTO Box with One Controller

LOTO DEVICES - LOTO devices are available for various situations. Contact your Supervisor, Board Safety or a local safety equipment vendor to determine the appropriate device for specific equipment.
Note: Recommend using LOTO devices specifically designed to fit the size and type of equipment; universal LOTO devices do not work as well. Examples:

ISOLATION DEVICE	LOCKOUT DEVICE	LOTO APPLIED
 Ball Valve	 Lockout for Ball Valve	 Ball Valve: LOTO applied
 Gate Valve	 Lockout for Gate Valve	 Gate Valve: LOTO applied
 Fuse Block	 Lockout for Fuse Block	 Fuse Block: LOTO applied

Wall Switch

Light Switch

Clamp-On 120/277V Circuit Breaker

Universal Multi-Pole Circuit Breaker

Single Pole Circuit Breaker

Universal Ball/Gate/Butterfly Valve

Plug

APPENDIX C

ARC FLASH PROTECTION

OSHA requires employers to protect employees from "recognized hazards" (General Duty Clause) and that steps must be taken specifically to address electrical hazards (29 CFR 1910.335 (a)). Among the recognized electrical hazards present in the workplace are arc flash and shock. To summarize: OSHA currently requires your facility to protect employees from arc flash and shock. However, OSHA regulations themselves do not provide enough detailed information to accomplish this. NFPA 70E is crucial because it provides a bridge between OSHA's requirement to protect against these dangers and actual compliance with that rule. OSHA itself defers to 70E in a Standard Interpretation Letter dated November 14, 2006: "OSHA recommends that employers consult consensus standards such as NFPA 70E-2004 to identify safety measures that can be used to comply with or supplement the requirements of OSHA's standards for preventing or protecting against arc flash hazards."

The primary method of protecting employees from arc flash as spelled out in 70E is de-energizing live parts prior to working on or near them using proper lockout-tagout procedures. However, because the employee is still exposed during shutdown and verification, this policy does nothing to remove the need to protect against arc flash. Until you have verified that the circuit is de-energized, it must be treated as energized and the appropriate Personal Protective Equipment (PPE) must be used to protect against arc flash. NFPA 70E describes two methods of doing that: a thorough arc flash hazard analysis in which dangers are identified and recommendations are made to mitigate them, and a set of tables to determine what PPE personnel should wear when performing electrical work.

The tables are task-based and divided into eight equipment- and voltage-specific sections. In each section several tasks are listed that might be performed on that piece of equipment. This procedure may seem simple enough, but using a tables-only approach to protection from electrical hazards overlooks the critical flaw in the tables' creation: The authors have never visited your facility. As a result, there are enormous gaps in the protective qualities of the tables. A task you perform or a piece of equipment you use may not be covered in the tables and, most glaringly, the tables are based on a predetermined available short circuit current and clearing time. Your facilities may have variances from either of these, which will introduce huge inaccuracies in the selection of PPE. The tables may be a good place to begin the process of protecting against electrical hazards, but will leave you woefully short if they are the only length to which you go to keep your people safe. The tables are not perfect, but they at least provide some measure of protection. Use the tables until you can have a thorough arc flash analysis performed at your facility, with recommendations for mitigating hazards.

The best way to keep employees safe from shock and arc flash, other than de-energizing, is through an arc flash analysis. The analysis must obtain accurate, up-to-date information on the facility's electrical system by actually visiting the facility. This is absolutely critical, as often drawings or blueprints of a system will become dangerously outdated with even slight renovations or additions to the physical building. Next, the data collected in phase one is utilized to evaluate the power system using NFPA 70E and IEEE 1584. It is imperative this is performed by a licensed professional engineer using highly sophisticated software. The calculations made

by the engineer and the software will show where in your facility the hazards exist. Then ways for mitigating the existing hazards are recommended. Most adjustments to eliminate or greatly reduce hazards can be performed with little or no cost at all - replacing fuses or adjusting circuit breakers. More expensive and time-consuming modifications include breaker replacement or having entire panels upgraded.

The last step is to have one or more qualified and highly skilled persons that work on electrical equipment train our employees in these existing dangers, how to stay safe and making them better at what they do.

PROTECTIVE (FLAME RESISTANT) CLOTHING

The intense energy and very short duration of an electric arc flash represents a very unique exposure. Everyday work clothes made from regular cotton or poly/cotton fabrics, regardless of weight, can be readily ignited at some exposure level and will continue to burn adding to the extent of injury sustained from the arc alone. NFPA70E now requires employees to wear flame resistant (FR) protective clothing that meets the requirements of ASTM F1506 wherever there is possible exposure to an electric arc flash. It requires employers to perform a flash hazard analysis to determine the flash protection boundary distance. The various levels of risk require increased levels of flame-resistant clothing as follows:

50 – 276 Volts: BCB employees who are exposed by working on electrical systems of 50 volts or more but less than 277 volts must wear personal protection equipment to include:

- Fire Resistant (minimum Arc Rating of 8) Long Sleeve Shirt and Pants or Coverall
- Safety Glasses

277 – 599 Volts: Due to the higher potential hazard of arc flash, equipment of 277 volts or more will be identified with Arc Flash Warning labels. BCB employees who are exposed by working on electrical systems of 277 volts or higher must wear personal protection equipment to include:

- Fire Resistant (minimum Arc Rating of 8) Long Sleeve Shirt and Pants or Coverall with non-synthetic (i.e., cotton) clothing underneath

  WARNING: Clothing made with synthetics (100% synthetic such as acetate, nylon, polyester, polypropylene, or rayon or in any blended combination with cotton) can melt when exposed to an arc flash, even under the FR outer garment, and cause severe burns

- Arc Flash Face Shield
- Safety Glasses
- Leather Gloves

NOTE: FM Trades Specialists are to be provided with FR coveralls with a minimum Arc Rating of 8.

600 Volts or Higher: Due to the higher potential hazard of arc flash, equipment of 277 volts or more will be identified with Arc Flash Warning labels. Entry is to be restricted (i.e., by key lock) to locations that have electrical systems of 600 volts or higher. Access to these areas requires the employee to see the Facilities Management Area Supervisor. BCB employees who are exposed by working on electrical systems of 600 volts or higher must wear personal protection equipment to include:

- Fire Resistant (minimum Arc Rating of 40) Long Sleeve Shirt and Pants or Coverall or Arc Flash Coat and Pants with non-synthetic (i.e., cotton) clothing underneath

  WARNING: Clothing made with synthetics (100% synthetic such as acetate, nylon, polyester, polypropylene, or rayon or in any blended combination with cotton) can melt when exposed to an arc flash, even under the FR outer garment, and cause severe burns

- Arc Flash Face Shield
- Safety Glasses
- Leather Gloves

QUESTIONS: Contact –

- Robert Huff, FM Building Maintenance Supervisor (Electrician), 734-3407, or
- Bernie Lee, BCB Safety, 737-2315

Hazard Risk Categories (HRC) for Clothing Description with Minimum Arc Cal Rating

The standard is designed to protect employees working inside these flash protection boundaries by requiring protective clothing for the corresponding Hazard/Risk Category (HRC) that has an Arc Thermal Protective Value (ATPV in calories per square centimeter - Cal/cm^2) of at least the value listed in the "Protective Clothing Characteristics" section of the standard. Garments which meet the requirements of ASTM F1506 comply with OSHA standard with regard to garments not contributing to burn severity.

HRC level is determined by the minimum amount of (calories per square centimeter - Cal/cm^2) a treated garment must pass through with a 50% probability of a 2nd or 3rd degree burn occurring, thus the protective level of the treated clothing. The higher the ATPV, the higher the HRC level attained, the greater the protection.

Hazard Risk Category	PROTECTIVE CLOTHING CHARACTERISTICS Table 130.7(C)(11)	Minimum ATPV Rating of PPE cal/cm^2
O	Non-melting flammable materials 4.5 oz.	N/A
1	FR shirt and FR pants; Or FR coveralls; Single base layer of FR protection	4
2	FR under garments (undershirt, underwear), FR shirt, and FR pants; FR under garments, FR coveralls; 2 or more layers of FR protection	8
3	FR under garments (undershirt, underwear), FR shirt, FR jacket, FR pants, and FR coveralls; 2-3 or more layers of FR protection; FR long-sleeve shirt and FR pants and FR coverall and FR jacket and FR pants or total FR clothing system with hood	25
4	FR under garments (undershirt, underwear), FR shirt, FR jacket/coat, FR pants, and FR coveralls; FR under garments (undershirt, underwear), FR shirt, FR pants, multi-layer flash suit; 3-4 or more layers of FR protection, FR long-sleeve shirt and FR pants or FR coverall and FR jacket and FR pants or total FR clothing system with hood (2 or 3)	40

CAUTION: When there is an arc flash hazard, never wear clothing made from synthetic materials, such as acetate, nylon, polyester, polypropylene, or rayon – alone or combined with natural fibers such as cotton. Such clothing is dangerous because it can burn and melt into your skin.

NFPA 70E Requirements

The National Fire Protection Association (NFPA) published the latest edition of the NFPA 70E Standard (Standard for Electrical Safety Requirements for Employee Workplaces) in 2004. The revised version requires employees to wear flame resistant (FR) protective clothing that meets the requirements of ASTM F1506 wherever there is possible exposure to an electric arc flash. It requires employers to perform a flash hazard analysis to determine the flash protection boundary distance. The standard is designed to protect employees working inside these flash protection boundaries by requiring protective clothing for corresponding Hazard/Risk Category that has an arc thermal performance value (ATPV) of at least the value listed in the "Protective Clothing Characteristics" section of the standard (see table above). The vast majority of major companies in the U.S. have some employees who work on or near energized electrical conductors or circuit parts. In addition, the Department of Energy has required that federal and contractor employees comply with NFPA 70E and the 2002 National Electric Code (NEC) references the NFPA 70E standard. Finally, OSHA considers the NFPA 70E standard a "recognized industry practice."

When incident energy exceeds ATVP - 40 (cal/cm^2) at the working distance, greater emphasis than normal should be placed on de-energizing before working on or near the exposed electrical conductors or circuit parts.

3 Ways to Analyze the Arc Flash Hazard

A Flash Hazard Analysis will determine the flash protection boundary and the personal protective equipment that people within the flash protection boundary should use. There are three ways provided within NFPA 70E to perform a Flash Hazard Analysis to determine the required performance level of protective clothing for the corresponding Hazard Risk Category, which are highlighted below.

1. **Detailed Flash Hazard Analysis**

There are multiple tools available to the industry to help perform a Flash Hazard Analysis on energized equipment. Where it has been determined that a person will be working within the flash protection boundary, the Flash Hazard Analysis shall determine, and the employer shall document, the incident energy exposure of the worker (in calories per square centimeter). The determination of the incident energy can be performed using multiple tools:

- NFPA 70E Equations (Examples given in 70E; Annex D)
- IEEE 1584

After the incident energy has been determined and documented, the proper fabric for the protective clothing can be selected.

2. **NFPA 70E Hazard/Risk Category Classifications or Job Task Matrix**

The second way to perform a hazard risk assessment is using the Hazard/Risk Category Classifications of Job Task Matrix provided in NFPA 70E. Below are excerpts of the most common job tasks and the corresponding Hazard Risk Category:

TABLE 130.7(C)(9)(A) *See back cover for complete table*

Task (Assumes equipment is energized, and work is done within the Flash protection boundary) (Sample Job Tasks)	Hazard/Risk Category	V-rated Gloves	V-rated Tools
Panel Boards Rated 240 V and Below—Notes 1 and 3			
Work on energized parts, including voltage testing	1	Y	Y
Remove/install CBs or fused switches	1	Y	Y
Panel boards or Switchboards Rates>240 V and up to 600 V (with molded case or Insulated case circuit breakers)—Notes 1 and 3			
Work on energized parts, including voltage testing	2*	Y	Y
600 V Class Switchgear (with power circuit breakers or fused switches)—Notes 5 and 6			
Opening hinged covers (to expose bare, energized parts)	2	N	N
Metal Clad Switchgear, 1 kV and above			
CB or fused switch operation with enclosure doors closed	2	N	N
Insertion/removal (racking) of CBs from cubicles, doors open	4	N	N
Opening hinged covers (to expose bare, energized parts)	3	N	N
Other Equipment 1 kV and above			
Work on energized parts, including voltage testing	4	Y	Y

3. **Annex H Simplified; Two Category, Flame-Resistant (Fr) Clothing Approach**

The use of table H.1 is suggested as a simplified approach to ensure adequate PPE for electrical workers within facilities with large and diverse electrical systems. The clothing listed fulfills the minimum FR clothing requirements of the NFPA 70E Table 130.7 (C) (10) and (11).

TABLE H.1 SIMPLIFIED, TWO-CATEGORY, FLAME-RESISTANT CLOTHING SYSTEM

CLOTHING*	APPLICABLE TASKS
Everyday Work Clothing ATPV 8 Note: INDURA® Ultra Soft® Style 301 7 oz. = 8.7 INDURA® Ultra Soft® Style 451 9oz. = 12.4	All Hazard/Risk Category 1 and 2 tasks listed in Table 130.7 (C) (10). On systems operating at less than 1,000 volts, these tasks include work on All equipment, ***except*** insertion/removal of low-voltage motor starter "buckets,"; insertion/removal of power circuit breakers from switchgear cubicles or removal of bolted covers from switchgear. On systems operating at 1,000 volts or greater, tasks also include the operation of switching devices *with equipment enclosure doors closed.*
Electrical "Switching" Clothing ATPV 40 Note: INDURA® Ultra Soft two-layer options available >40	All Hazard/Risk Category 3 and 4 tasks listed in Table 130.7 (C)(10). On operating systems operating at 1,000 volts or greater, these tasks include work on exposed live parts of all equipment. On systems of less than 1,000 volts, tasks include insertion/removal of low voltage motor starter MCC "buckets," insertion/removal of power circuit breakers and removal of bolted covers from switchgear.

The information in this appendix is condensed from NFPA 70E which should be consulted for complete information.

Arc Flash Warning Labels

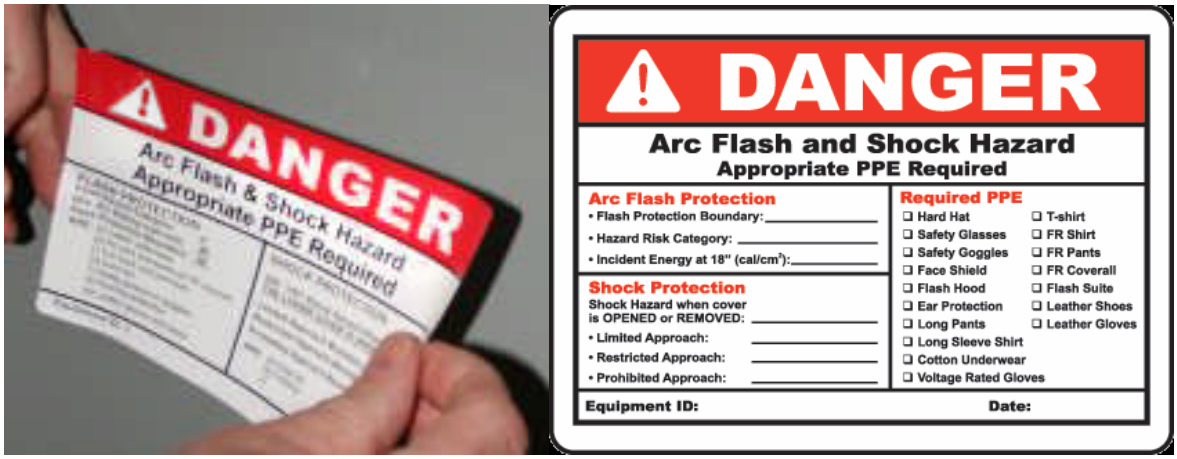
Arc flash warning labels on hazardous equipment are required by the NFPA 70 - the National Electric Code, Section 110.16 and by NFPA 70E - Electrical Safety Requirements for Employee Workplaces. The following requirements apply:

- All hazardous equipment installed or modified after 2002 is required to carry a warning label. NEC 110.16 specifically mentions "switchboards, panel boards, industrial control panels and motor control centers that ... are likely to require examination, adjustment, servicing, or maintenance while energized."
- Equipment must be marked in the field, rather than by the equipment manufacturer or installer. Arc flash hazard varies depending on actual operating conditions, including up-current protective devices and voltage. Labeling is the responsibility of the BCB FM Building Maintenance and Building Systems Teams.
- Labels must be placed and sized so as to be visible to personnel before beginning inspection or maintenance.

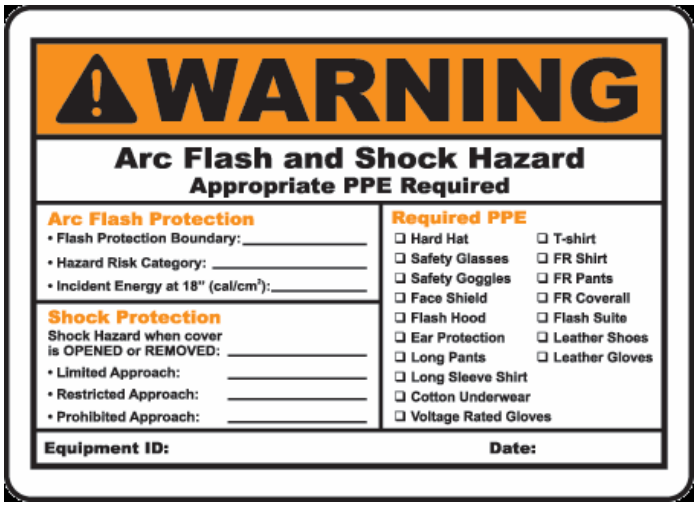
- NFPA 70E (2009) requires that:
    - Arc flash labels contain one of two specific pieces of information: available incident energy or required level of PPE as determined by an arc flash hazard analysis for each piece of equipment.
    - All arc flash analysis shall be reviewed at least every five years to account for changes in the electrical distribution system. This may require a change in the arc flash label but if not the date of the most recent arc flash analysis should be updated on each label.

The NFPA recommends for arc flash label design to follow ANSI Z535.4-1998 which offers two options:

- The word “DANGER” in white letters on a red background, especially where the incident energy is above 40 cal/cm^2.



- The word “WARNING” in black letters on an orange background where a hazard could cause death or serious injury.



Other appropriate information may include assumed working distance; flash protection boundary; and limited, restricted, and prohibited approach boundaries. It is important to strike a balance in providing information. Too little information can leave workers unaware of risks, while too much may make labels confusing or hard to read.

APPENDIX D

ENERGIZED ELECTRICAL WORK PERMIT

The Completed Permit Is To Be Kept At The Job Site Until The Job Is Done

1. LIVE WORK TASKING

Work Location: _____ Work Order Number: _____
(Building Name, Room Number)

Start Date: _____ Time: _____

Equipment To Be Shut Down**:** _____

___ Until Work Is Completed ___ Temporarily While Barriers Are Placed

Description Of Planned Work Activities Including Involved Components: _____
_____
_____ Voltage: _____ V

2. PERSONNEL ASSIGNED TO PERFORM THE LIVE WORK

Qualified Electrician(s): _____

Qualified Electrician Certified In CPR-1ST Aid-AED: _____

Assistant/Attendant(s) (Un-Qualified): _____

3. JUSTIFICATION FOR THE LIVE WORK

The Work Cannot Be Delayed To Allow The Equipment To Be Shutdown and De-Energized For Maintenance. Work On Energized Electrical Equipment Is Justified Because The Equipment Shutdown And De-Energizing:

Creates an:

__ Increased Hazard (specify): _____

__ Additional Hazard (specify): _____

Is infeasible due to:

__ Equipment Design (specify): _____

__ Operational Limitations (specify): _____

4. METHODS TO RESTRICT UNAUTHORIZED PERSONS FROM THE WORK AREA

__ Signs / Tags __ Barricades __ Attendants

5. HAZARD ANALYSIS (To be completed by the Qualified Electrician(s) and Supervisor)

Work will be conducted within the following Approach Boundaries:

FLASH PROTECTION BOUNDARY – 4 ft 0 in for systems 600 volts or less or
Calculated: ___ ft ___ in

Select **VOLTAGE**	**LIMITED** (**Movable** Conductor)	**LIMITED** (**Fixed** Circuit Part)	**RESTRICTED**	**PROHIBITED**
50 – 300 v	10 ft	3 ft 6 in	Avoid Contact	Avoid Contact
301-750 v	10 ft	3 ft 6 in	1 ft	1 in

Hazard Risk Category	1	2	3	4
Required Fire Resistant Clothing ATPV Rating (in cal/cm^2)	4	8	25	40

__ Voltage-rated gloves
__ Safety glasses
__ Hearing Protection
__ Leather gloves
__ Rubber sleeves
__ Hard Hat-Class G / E
__ Hard Hat FR liner*

__ Short-sleeve shirt (natural fiber)
__ Long-sleeve shirt (natural fiber)
__ Long pants (natural fiber)
__ Long-sleeve FR shirt*
__ Long FR pants*
__ FR coveralls*
__ Under layers that do not melt

__ Multi-layer FR flash suit jacket*
__ Multi-layer FR flash suit pants*
__ Arc-rated face shield*
__ Flash suit hood*
__ FR jacket/rainwear*

*- Arc Thermal Protective Value (ATPV)

__ Communications
__ Conductive jewelry / items removed
__ Fire Extinguisher

__ Dielectric/rubber insulating mat
__ Voltage test equipment of compatible rating and checked

__ Adequate/additional lighting
__ Voltage-rated insulated tools
__ Non-conductive portable Ladder

6. OTHER SAFE WORK PRACTICES (description; attach sheet, as required): _____
_____
_____

7. ENERGIZED ELECTRICAL WORK REVIEW

Equipment Will Be De-Energized And Isolated To The Extent Feasible. I Agree The Remaining Energized Electrical Work As Described Above Can Be Done Safely.

QUALIFIED ELECTRICIANS: _____ Date: _____
(Assigned To Work Task) (Name)
_____ Date: _____

I Verify That Energized Electrical Work Preparations Have Been Completed And The Assigned Employees Have Been Briefed With Detailed Procedures And Are Properly Equipped.

SUPERVISOR: _____ Date: _____
(Name)

Send Copy to BCB Safety; Copy kept by Supervisor; Copy kept at work site until job completed

8. WORK COMPLETION End Date: _____Time: _____

Send completed form to: JP Gouffray, FM Energy-Environmental (To be kept on file for 1 year) as of 3 March 2011

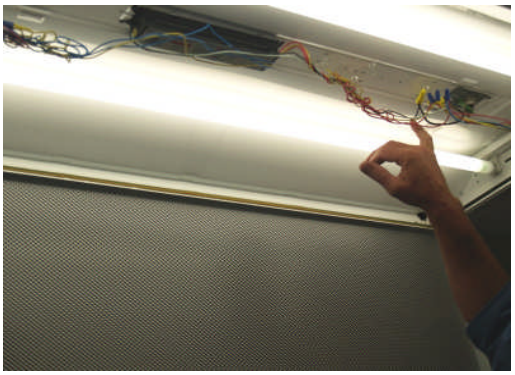
APPENDIX E

LOCKOUT-TAGOUT

For All Lighting Ballasts

To Be Posted in Electrical Equipment Supply Rooms - **DO NOT REMOVE**

POC: Jean-Paul Gouffray, 737-8038, cell 223-1004 as of 9/30/2010



"Removing Light Fixture from Service - LIVE-WIRE"		
CAUTION: 10 Foot Ladder or Higher - Two People Required		
No.	**Energy Source / Location**	**Procedure** *(New Ballast To Include Installation Of Quick Connect/Disconnect Power Plug)*
1	Fixture	Open or remove lens or light fixture cover.
2	Fixture	Remove lamp(s) and ballast cover.
3	Electricity	Inspect wiring for proper working length and that the wires are not damaged or frayed.
4	Electricity	If improper length or damaged wire is present or any other unsafe conditions are found: Proper Lock Out - Tag Out procedures must be conducted. See other side of this page Lock Out - Tag Out "Removing Light Fixture from Service" procedure.
5	Electricity	If conditions are safe proceed with voltage meter to identify the hot wire.
6	Electricity	Disconnect hot wire first (colored wire) and isolate.
7	Electricity	Disconnect neutral second (white wire) and isolate.
8	Fixture	Remove ballast and/or repair fixture.
		"Restoring Light Fixture to Service"
9	Fixture	Install new ballast.
10	Fixture	Correctly wire-in quick connect/disconnect power plug on load side neutral 1st and hotwire 2nd.
11	Fixture	Correctly wire-in quick connect/disconnect power plug on line side neutral 1st and hotwire 2nd. Safely tuck wires up.
12	Fixture	Install ballast cover and lamp(s).
13	Fixture	Install lens or light fixture cover.

Page 1 of 2

"Removing Light Fixture from Service"		
No.	**Energy Source / Location**	**Procedure**
1	Electricity	Disconnect power at ALL 'switch(es)' (as shown above) and install lockout/tag-out device(s).
2	Electricity	If the number of switches is unknown, disconnect power of the designated light fixture(s) at the labeled Breaker Panel, and install lockout/tag-out device(s).
3	Light Fixture	Ensure that the light fixture(s) are disconnected from the energy source(s) by first checking that no personnel are exposed, then verify the isolation of the light fixture(s) by testing the switch or other normal operating control(s) or by testing to make certain the light fixture(s) will not operate.
		The equipment is now locked out.
4		Install 2-Wire or 3-Wire Quick Connect/Disconnect to new fixture.
"Restoring Light Fixture to Service"		
		When the servicing or maintenance is completed and the light fixture is ready to return to normal operating condition, the following steps shall be taken.
5		Check the light fixture and the immediate area around the light fixture to ensure that nonessential items have been removed and that the light fixture components are operationally intact.
6		Check the work area to ensure that all maintenance personnel have been safely positioned or removed from the area.
7		Remove the lockout/tag-out device(s) and re-energize the light fixture(s) and return lighting to regular service.
8		Notify affected employees that the servicing or maintenance is completed and the lighting is ready for use.