AIRFIELD LIGHTING CIRCUIT ELECTRICAL SAFETY PROGRAM

Airfield lighting at the Duluth International Airport presents a unique electrical hazard that requires specialized knowledge of series circuits, as opposed to the more common parallel circuits on which most electricians are trained. Once trained on series circuits, qualified electricians are more capable of performing their tasks with tolerable levels of risk. To obtain and maintain this level of tolerability, however, a detailed airfield lighting electrical safety program (separate from any general electrical safety program) must be developed, implemented, and maintained so that new employees and contract electricians can work on or near the airfield lighting circuits with minimal risk of injury. The program should be updated when new hazards are introduced so that experienced electricians (in addition to new and contract electricians) will have a resource from which to gather information.

The existing electrical safety program has served the Duluth International Airport in numerous ways, but given the unique nature of airfield lighting circuits (ungrounded circuits; sophisticated, remotely-controlled constant current regulators with 3,000 volts on taxiways and 5,000 volts on runways), a specific program designed for airfield lighting is warranted. Along with such a program, a new role should be established, that of electrical safety manager (ESM). The ESM will be responsible for overseeing the development and maintenance of the airfield lighting electrical safety program.

This program is the first draft of such an airfield electrical safety program. The goals of this program are as follows:

**Airport Electrical Safety Goals**

1. Place all electrical circuits in an *electrically safe work condition* prior to any work on or near them.

2. When it is not possible to place a circuit in an *electrically safe work condition* prior to working on or near the circuit, provide additional safeguards (such as voltage-rated gloves and blankets) so that an equivalent level of protection is provided.

3. Provide meaningful electrical safety training for airfield maintenance employees, including contractors, newly-hired DAA maintenance employees, and experienced/qualified electricians (when new tasks/hazards are introduced).

4. Provide guidance for airfield maintenance in the specific safe work practices associated with airfield lighting systems.

5. Provide guidance regarding the proper personal protective equipment (PPE) to wear for various airfield lighting electrical tasks.

6. To minimize airfield lighting down-time due to safety-related incidents

7. To ensure that the best airfield lighting safety practices are incorporated into the Duluth Airport Authority’s electrical safety program to keep pace with the ever-increasing aviation knowledge base, thus facilitating the airport’s response to the rapid growth and change in the aviation industry.

These are obtainable goals, but it is critical that airport upper management concur with them lest they not be embraced at all levels of the organization.
This electrical safety program has the following components:

Section I: Scope & Philosophy
Section II: Personal Responsibility
Section III: Electrical hazards and other definitions
Section IV: Creating an *Electrically Safe Work Condition*, including Lockout Program (Control of Hazardous Energy)
Section V: Approaching Live Parts (Hazard Boundaries & Limits of Approach)
Section VI: Energized Electrical Work Permit Program
Section VII: Personal Protective Equipment
Section VIII: Contractors and Vendors
Section IX: Identification of Hazardous Tasks and Jobs
Section X: Procedures
Section XI: Program Administration
Section XII: Training
Section XIII: Budget
Section XIV: Audit and Recordkeeping
Appendix A: Annual Observation of LOTO
Appendix B: Airfield Bulb Training
SECTION I: SCOPE and PHILOSOPHY

The basic philosophy on which this program is based is that all airfield electrical work must be performed with electrical circuits and systems in an electrically safe work condition. This means that the circuits are de-energized, locked out, tested dead, and in some cases, grounded. Although there will be some circumstances when this is not possible, those circumstances should be minimized, performed only when:

A. De-energizing the circuit introduces additional hazards or,

B. De-energizing is infeasible due to equipment design or operational limitations (such as the hazard that would be introduced to an aircraft on approach if the lighting system was inoperable).

In cases when a circuit or system will be worked on while energized, the airfield foreman must be aware of and approve the work (this is typically done via a work-permit system, although a permit is not required for tasks done routinely).

This airfield lighting electrical safety program must be read and understood by all maintenance employees at the Duluth Airport Authority who are or may be exposed to the airfield lighting circuits. Compliance with this program is a condition of employment. This includes electricians, contractors, vendors, servicing personnel, and employees other than electricians who may be exposed to the dangers of the airfield lighting circuits in the course of their normal work. Portions of the program will apply to airfield tower personnel, who must understand that their actions may endanger airfield electricians doing repairs on lighting circuits.

This program should also be read and understood by others who, although not directly exposed to the hazards of airfield lighting circuits, have a need to know about the associated hazards.

The Duluth Airport Authority’s Safety Director is responsible for administering this program, although significant assistance will be provided by the SRE supervisory staff.
SECTION II: PERSONAL RESPONSIBILITY

- Each employee must take responsibility for working safely on or around electrical equipment. If you do not understand the job or task, ask your supervisor for a job briefing.

- If you are designated as a qualified electrician (see definition below), you must know how to execute the emergency procedures to release someone from a live circuit and to perform first aid/CPR.

- For all electrical work, particularly energized-electrical work, HAVE A PLAN to perform the work safely. Anticipate unexpected events.

- Use the following safety-related work practices at all times:
  
  o Never break a live series circuit, as the voltage will rapidly increase, possibly up to 10,000V. Short circuits through YOU are the result. There is no overcurrent protection.
  
  o Never handle cables or transformers in light base cans while there is current present. Cables or connectors can have cracked insulation that is not visible.
  
  o Never enter a manhole containing exposed energized conductors without donning the proper protective equipment.
  
  o Never handle cables or
  
  It should always be assumed that a circuit is energized until proven otherwise.

- Employees must be aware that de-energizing an electrical conductor or circuit part and making it safe to work on is, in itself, a potentially hazardous task.

- Do not work on electrical circuits or systems unless they are in an electrically safe work condition (de-energized, locked out, tested dead). Exceptions are permitted as allowed in this program.

- If an electrical circuit or system is not in an electrically safe work condition, additional precautions must be taken (e.g. voltage-rated gloves, blankets, mats).

- If a circuit is locked out, your lock should be on the lockout device.

- Only qualified electricians can perform high voltage work (>600V), and must always work with another qualified electrician.

- No bare-hand contact is to be made with exposed energized electrical conductors or circuit parts above 50 volts.

- Know what constitutes a confined space. A confined space is defined as follows:
  
  o Is large enough and so configured that an employee can bodily enter and perform assigned work; and
  
  o Has limited or restricted means for entry or exit (for example, tanks, vessels, silos, storage bins, hoppers, vaults, and pits); and
  
  o Is not designed for continuous employee occupancy. (from OSHA 1910.146)
SECTION III: ELECTRICAL HAZARDS and other DEFINITIONS

**Electrically Safe Work Condition:**
A state in which the conductor or circuit part to be worked on or near has been disconnected from energized part, locked/tagged in accordance with established standards, tested to ensure the absence of voltage, and grounded if determined necessary. Achieving an *electrically safe work condition* is the underlying principle of all electrical work. Performing work when a circuit is not rendered safe should be done only when necessary.

**Hazards**
The hazards associated with the airport lighting system, while unique, remain the same when discussing how they will injure and kill. Electrical hazards are:

- **Electric shock** – the primary hazard

- **Arc flash** and **arc blast** – typically hazardous only when working on the 480V side of the CCR or on any other non-series circuit, such as motor control centers, switchgear, and electrical distribution panels

- **Fire**

**Electric Shock**
To eliminate the hazards of electric shock, we need to know:

- The source of the hazard
- How the exposure could occur
- How severe the shock would be to the human body
- What action is necessary

**Mitigating the Exposure to Electric Shock**

- Can the circuit be de-energized?
- If not, what must be done to minimize the hazard?
- What personal protective equipment (PPE) will minimize the exposure?
**Arc Flash**

Arc flash is not as likely to occur on the low current series lighting circuits, but can occur on other non-lighting circuits on the airfield. This is because on non-lighting circuits, fault currents can increase significantly before over-current protective devices operate (in series lighting circuits, no such increase in current should occur, since the constant current regulator will maintain the current at its prescribed current).

**Arc flash** is defined as follows:

*When an electric current passes through air between ungrounded conductors or between ungrounded conductors and grounded conductors, the temperatures can reach 35,000°F. Exposure to these extreme temperatures both burns the skin directly and causes ignition of clothing, which adds to the burn injury. The majority of hospital admissions due to electrical accidents are from arc-flash burns, not from shocks. Each year more than 2,000 people are admitted to burn centers with severe arc-flash burns. Arc-flashes can and do kill at distances of 10’.* – Annex K, NFPA 70E

**Arc Blast**

Arc blast is not as likely to occur on the low current series lighting circuits, but can occur on other non-lighting circuits on the airfield. This is because on non-lighting circuits, fault currents can increase significantly before over-current protective devices operate (in series lighting circuits, no such increase in current should occur, since the constant current regulator will maintain the current at its prescribed current).

**Arc blast** is defined as follows:

*An arc blast occurs when the tremendous temperatures of the arc cause the explosive expansion of both the surrounding air and the metal in the arc path. For example, copper expands by a factor of 67,000 times when it turns from a solid to a vapor. The danger associated with this expansion is one of high pressures, sound, and shrapnel. The high pressures can easily exceed hundreds or even thousands of pounds per square foot, knocking workers off ladders, rupturing eardrums, and collapsing lungs. The noise can exceed 160 dB. Finally, material and molten metal is expelled away from the arc at speeds exceeding 700 mph, fast enough for the shrapnel to penetrate the body.* – Annex K, NFPA 70E

**Fire**

Electrical systems are a significant source of fire. This electrical safety program will not address this hazard directly, since fire hazards are broadly addressed in other sections of airport safety policies

**Qualified Electrician**

One who has the knowledge and skills related to the construction and operation of the electrical equipment and installations and has received safety training on the hazards involved.
<table>
<thead>
<tr>
<th><strong>Limited Approach Boundary</strong></th>
<th>An approach limit at a distance from an exposed live part within which a shock hazard exists</th>
</tr>
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<tbody>
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<td><strong>Restricted Approach Boundary</strong></td>
<td>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, for personnel working in close proximity to the live part.</td>
</tr>
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<td><strong>Prohibited Approach Boundary</strong></td>
<td>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.</td>
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<td><strong>Flash Protection Boundary</strong></td>
<td>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.</td>
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**Confined Space**

i. Is large enough and so configured that an employee can bodily enter and perform assigned work; and  
ii. Has limited or restricted means for entry or exit (for example, tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry.); and  
iii. Is not designed for continuous employee occupancy. (from OSHA 1910.146)
SECTION IV: ESTABLISHING AN ELECTRICALLY SAFE WORK CONDITION INCLUDING LOCKOUT PROGRAM (Control of Hazardous Energy)

The underlying principle in all airfield electrical work, whether on airfield lighting circuits or any other system greater than 50 volts, is to place the system in an electrically safe work condition. This means de-energizing the system through a physical disconnect switch (as opposed to an electronic switch, push button switches, selector switches, or other shutdown means that does not physically separate the electrical supply from the part or circuit you will be working on); locking the circuit out; testing the circuit dead (de-energized), and; grounding the circuit, where appropriate.

The steps in achieving an electrically safe work condition are as follows:

1. Determine all possible sources of electrical supply to the equipment or circuit on which you will be working. Check applicable up-to-date drawings, diagrams, and ID tags.

2. After properly interrupting the load current, open the disconnecting device(s) for each source identified in Step 1 above.

3. Wherever possible, visually verify that all blades of the disconnecting devices are fully open or that drawout-type circuit breakers are withdrawn to the fully disconnected position.

4. Apply lockout devices in accordance with the lockout program below.

5. Use voltage and current detection equipment to test each phase conductor or circuit to verify they are de-energized. Only a true RMS clamp-on ammeter should be used to test a series lighting circuit dead (voltage detection devices can read zero on such circuits). Voltage testing (or current testing) is, in itself, a hazardous activity. You should test the circuit dead after lunch, at the start of a new shift, or any time conditions change so that energy may be present on the circuit. Each and every time you test for the presence of hazardous energy:
   a. Test the meter on a known energized source
   b. Test the locked out circuit for zero energy
   c. Verify the function of the meter again on the known energized source

6. Safeguard the circuit against induced voltages. Airfield lighting circuits are subject to such induced voltages. Use local procedures to protect yourself against such voltages. When grounding is appropriate, use grounding wires with ample capacity, such as in cases where the circuit on which you are working could contact other exposed energized conductors.
**Lockout Program and Procedure**

A system cannot be considered in an *electrically safe work condition* unless it is locked out. The steps below must be used to ensure that the circuit on which you are working is not only de-energized but will *remain de-energized* until you remove your lock or otherwise relinquish control of the circuit.

Circuit lockout implies that whoever is working on the circuit has *his or own lock* on the power supply disconnecting means. You should never work under the protection of someone else’s lock. If numerous employees are working on a circuit, multi-lock hasps or group lock boxes are available so that each employee can put his own lock on the circuit.

Employees other than electricians, such as contractors and other trades, should be included in the lockout. Only qualified persons, however, trained in the lockout program as well as any specific lockout procedures may apply a lockout.

Locks used in the lockout program must be uniquely identified and must be used for system lockout only. The lock must be linked to a particular employee or group lockbox. Keyed or combination locks are allowable, provided the key or combination is in the control of the person whom the lock is protecting.

**Machine- or System-Specific Lockout Procedures**

Each task, circuit, or system having one of the following characteristics requires its own, unique lockout procedure:

a. Multiple energy sources  
b. Multiple disconnecting means  
c. Multiple crews or crafts working on the equipment  
d. Multiple locations  
e. Unique or unusual shutdown or re-start sequences  
f. A job or task that continues for more than one week

The procedures must inform the qualified person how and through what disconnecting means the energy sources can be identified, including drawings; how energy sources can be isolated; sources of stored/residual energy; must identify who might be exposed; who is in charge;
Steps to Perform in a Lockout

1. Determine if this will be an individual employee control lockout, a simple lockout, or a complex lockout.
   a. Individual Employee Control Lockout Procedure – Permitted for a single employee when equipment with exposed conductors and circuit parts is de-energized for minor maintenance, servicing, adjusting, cleaning, inspection, and similar low-hazard activities. A lock need not be placed on the disconnecting means, provided the disconnecting means is adjacent to the conductor or equipment being worked on and is clearly visible to the employee working on it. The work cannot extend beyond one shift. Machine or equipment specific lockout procedures are not required for this type of lockout.
   b. Simple Lockout Procedure – All lockouts not considered an individual employee control lockout or a complex lockout are simple lockouts. A simple lockout involves one or more qualified employees (trained in the lockout program) locking out one set of conductors. Machine or equipment specific lockout procedures are not required for this type of lockout.
   c. Complex Lockout Procedure
      i. Requires that a single qualified person be in charge of all energy sources and their lockout status as well as all personnel working under the protection of the lockout. The means of accounting for all personnel must be identified.
      ii. Requires a written procedure which identifies the person in charge. The written procedure must identify how the circuit is verified dead (de-energized).
      iii. A complex lockout procedure is required when:
          g. There are multiple energy sources
          h. Multiple disconnecting means
          i. Multiple crews or crafts
          j. Multiple locations
          k. Particular shutdown or re-start sequences
          l. A job or task that continues for more than one week

2. Record the Circuit or items to be locked out on the dry erase board in the vault office including all info asked for on the board. Fill out a LOTO log sheet and post on the CCR for the duration of the work and then file on the LOTO binder.

3. Determine how each source of energy is to be physically controlled. A specific lockout procedure is required for any gear that has more than one energy source, can regain energy after lockout, or cannot be locked out with one device. Refer to the specific lockout procedure. If the procedure has not been audited in the last year, review it with a knowledgeable person.

4. Open the disconnect switches or other disengaging means. Place the lockout device on the disconnecting means (e.g. circuit breaker/disconnect switch covers; rackout circuit breakers and bag them in lockable bags).

5. Place your lock and identifying tag on the locking device
6. Remove any stored voltage or other energy (e.g. capacitors, steam pressure, residual heat, springs, gravity, chemical energy)

7. Verify that all energy has been removed with the appropriate test equipment. For airport series lighting circuits, only a true RMS ammeter should be used to test for the absence of current.

8. Using the normal starting means, attempt to start the equipment to verify that no energy is available on the circuit.

9. Work on the circuit as necessary. Check for the presence of hazardous voltages at frequent intervals, particularly after lunch, at the start of a new shift, or whenever you suspect energy on the circuit.

10. **Shift Changes**: At no time should a locked out circuit have its protective locks removed. Shift changes should be planned so that before one or more of the off-going shift’s locks are removed, someone (the supervisor is best) from the oncoming shift should place his lock on the disconnecting means.

11. **Never** remove someone’s lock until it can be confirmed that they are not somewhere on the airfield subject to injury. If another’s lock is removed, ensure they are notified before they return to work.
SECTION V: APPROACHING LIVE PARTS (HAZARD BOUNDARIES & LIMITS OF APPROACH)

All live parts greater than 50 volts must be placed in an electrically safe work condition before work on or around them can be done. There are exceptions, however, if it can be demonstrated by electrical supervision or airport management that de-energizing the circuit:

1. Introduces additional or increased hazards, or;
2. Is infeasible due to equipment design or operational limitations.

For example, if de-energizing a circuit places aircraft on approach or on the ground in danger, airport management or electrical supervision may decide that the risks of working on a circuit energized are worthwhile. Another example demonstrating when it may be acceptable to allow energized work is when a circuit must be tested when it is running, including voltage testing on live circuits. Note that it should be airport management or electrical supervision that makes such a determination, and an energized electrical work permit should be obtained!

Boundaries around energized electrical parts and circuits should be established:

1) When working near exposed energized electrical parts. This includes work that is done close enough to energized electrical circuits or conductors such that a person who is not knowledgeable about such circuits could be injured if he or she inadvertently touched or came near the circuit. This could include the general public, other employees on the airfield, other electricians, or contractors. Such work will not require an energized electrical work permit if the employees involved will not be crossing the limited approach boundary, which is, at a minimum, 3’6” from the energized part. If at any time employees who are not classified as qualified electricians will be crossing the limited approach boundary, an energized electrical work permit (see next section) must be pulled from electrical supervision, and the job must be overseen by a qualified electrician, even if no electrical work is to be done. A better alternative to this is to de-energize the circuit, but if this is not possible, boundaries must be established, a permit pulled, and a qualified electrician enlisted to oversee the job. At no time is an unqualified person permitted beyond the limited approach boundary without a qualified electrician escorting him! Unqualified persons are never permitted beyond the restricted approach boundary!

2) Boundaries must also be established when purposely working on or near exposed energized electrical parts. This includes all work, whether by a qualified electrician or not, done inside the restricted approach boundary (see definitions below). All work of this type also requires an energized electrical work permit (with some exceptions as noted in the next section). Unqualified persons are never permitted beyond the restricted approach boundary!
The boundaries established in the table below should be adhered to when working on or near exposed energized electrical conductors. The table is taken from NFPA 70E, Standard for Electrical Safety in the Workplace (2004) (the NFPA table goes up to values of 800 kV and should be consulted if needed for higher voltages).

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Limited Approach Boundary</th>
<th>Restricted Approach Boundary</th>
<th>Prohibited Approach Boundary</th>
<th>Arc Flash Protection Boundary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 50</td>
<td>Not specified</td>
<td>Not specified</td>
<td>Not specified</td>
<td>See Flash Protection Boundary definition below</td>
</tr>
<tr>
<td>50 to 300</td>
<td>3’6”</td>
<td>Avoid contact</td>
<td>Avoid contact</td>
<td></td>
</tr>
<tr>
<td>301 to 750</td>
<td>3’6”</td>
<td>1’0”</td>
<td>0’1”</td>
<td></td>
</tr>
<tr>
<td>751 to 15 kV</td>
<td>5’0”</td>
<td>2’2”</td>
<td>0’7”</td>
<td></td>
</tr>
<tr>
<td>15.1 kV to 36 kV</td>
<td>6’0”</td>
<td>2’7”</td>
<td>0’10”</td>
<td></td>
</tr>
</tbody>
</table>

**Table Notes**
1) The *limited approach boundary* increases to 10’ if the part being worked on can move (for example, energized rotors, wires, and other conductors that can be blown or pushed into an employee.

**Limited Approach Boundary**
An approach limit at a distance from an exposed live part within which a shock hazard exists. Persons who are not classified as *qualified electricians* may not breach this boundary without:
1) being briefed by a *qualified electrician* about the hazards of the space;
2) an escort by a *qualified electrician*, and;
3) wearing the appropriate flash protection equipment if an arc flash hazard exists.

**Restricted Approach Boundary**
Only *qualified electricians* may breach this boundary, and only when insulated or guarded from the energized part. The electrician must not only be qualified generally, but specifically qualified to do the task at hand. No conductive tools or parts may be brought closer than this boundary unless the electrician is insulated or guarded from shock. This boundary is 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, for personnel working in close proximity to the live part.

**Prohibited Approach Boundary**
Crossing this boundary is considered the same as making contact with the live part. An electrical shock is probable simply by crossing this boundary without insulation or other protective measures.

**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. The arc flash hazard while working on series airfield lighting circuits powered by a constant current regulator is minimal, since there is little bolted fault current available. For other airfield work, such as work done on the 480V supply to the constant current regulators and other non-lighting circuits, there is a significant arc flash/arc blast hazard. For voltages < 600 volts, the arc flash boundary will be at least four (4’) feet (this is based on circuit interruption clearing time of 6 cycles (0.1 second) and
the available bolted fault current of 50,000 A – other clearing times will require a flash hazard analysis in accordance with NFPA 70E, section 130.3).

Observing a safe approach distance from exposed energized electrical conductors or circuit parts is an effective means of maintaining electrical safety. As the distance between a person and the exposed energized conductors or circuit parts decreases, the potential for electrical accident increases.

Unqualified persons can ensure their safety when they maintain the distances specified in the Limited Approach Boundary of table above. They must increase the distance if they are carrying long parts or tools (for example, if carrying a 1’ pipe wrench, a plumber who happens to be working near a 120V exposed circuit should maintain a Limited Approach Boundary of 4’6” (3’6” + 1’ (wrench) = 4’6”).

Note that if this is a lighting circuit, there is no significant arc flash hazard. If this is any other type of non-lighting circuit, however, there is a possibility of arc flash, so that the arc flash boundary of 4’ should be observed. Within 4’ of such a circuit, all employees should be wearing flash protection gear.
SECTION VI: ENERGIZED ELECTRICAL WORK PERMIT PROGRAM

When Must an Energized Electrical Work Permit be Pulled?

All live parts greater than 50 volts must be placed in an electrically safe work condition before work on or around them can be done. There are exceptions, however, if it can be demonstrated by electrical supervision or airport management that de-energizing the circuit:

1. Introduces additional or increased hazards, or;
2. Is infeasible due to equipment design or operational limitations.

For example, if de-energizing a circuit places aircraft on approach or on the ground in danger, airport management or electrician supervision may decide that the risks of working on a circuit energized are worthwhile. Note that it should be management or supervision that makes such a determination, and an energized electrical work permit should be obtained!

Exceptions to Work Permit

Work performed on or near live parts by qualified electricians for testing, troubleshooting, voltage measuring, and similar tasks may be permitted without a permit, provided appropriate safe work practices and personal protective equipment is used. Note that it should be management or supervision that allows such exceptions. These exceptions should never be allowed unless additional precautions are taken, such as using insulated gloves and other protective gear.

Initiating an Energized Electrical Work Permit

1. Unless a task has been pre-approved as one that is allowed to be done energized without a permit, complete an Energized Electrical Work Permit form, items 1-11. Use the Job Briefing and Planning Checklist below to assist you. On some occasions, you may need input from someone outside the electrical maintenance group to complete items 1-3, since it is they who are telling you that the equipment or circuit cannot be de-energized.
2. Once complete, have the form approved by the Airside Manager.
3. If approved, establish the shock and flash protection boundaries, keeping in mind that they must be sturdy enough to keep unqualified people away. Unqualified people usually do not know what live bussing, cable, and circuits look like.
4. In addition to the shock hazards, remember the arc flash/arc blast hazards! This usually calls for arc flash clothing and protective gear whenever you are within 4’ of an energized circuit < 600V. See the Personal Protective Equipment chapter of the electrical safety program for the right protective gear to wear.
5. Perform the work as outlined on the form, but plan for the unexpected.
6. After the work is complete, notify the supervisor who authorized the work.
ENERGIZED ELECTRICAL WORK PERMIT

PART I: To be completed by the requestor (may or may not be an electrician)  
Job/Work Order Number: ____________

1. Description of circuit/equipment/job location:
________________________________________________________________________________________________

2. Description of work to be done:
________________________________________________________________________________________________

3. Justification of why the circuit/equipment cannot be de-energized or the work deferred until the next scheduled outage: ______________________________________
________________________________________________________________________________________________

Requestor – Print Requestor - Sign Date

PART II:  TO BE COMPLETED BY THE QUALIFIED ELECTRICIAN DOING THE WORK

4. Detailed procedure to be used in performing the above detailed work:
________________________________________________________________________________________________

5. Description of the safe work practices to be employed:
________________________________________________________________________________________________

6. Determine boundary distances: limited approach; restricted approach; prohibited approach; flash:
________________________________________________________________________________________________

7. Is there an arc flash/arc blast hazard (there is no arc flash/blast hazard if the work will be done on constant current circuits; if work is done on any other circuit, including the 480V side of the CCR, there is dangerous arc flash/arc blast current available)
________________________________________________________________________________________________

8. Personal protective equipment to be used:
________________________________________________________________________________________________

9. Means employed to restrict the access of unqualified persons from the work area:
________________________________________________________________________________________________

10. Did you complete a job briefing (when and with whom)? _________________________________________________

11. Do you agree that this work can be performed safely (if not, return to requester)? ______________________________
_____________________________________________________________________________

Electrically Qualified Person – Print Sign Date

PART III: APPROVALS TO PERFORM THE WORK WHILE HOT (ENERGIZED)

Airside Manager – Print Sign Date
Job Briefing and Planning Checklist

Identify
- Hazards
- Voltage levels
- Skills required
- Any secondary voltage sources?
- Any unusual work conditions
- Number of people needed to do the job
- Shock protection boundaries
- Is this series lighting, powered by a CCR? If so, no significant arc flash hazard
- If this is not an airfield lighting circuit, an arc flash/arc blast hazard is available

Ask
- Can the equipment be de-energized?
- Are backfeeds to the circuit possible?

Check
- Job Plans
- Single-line diagrams, as-builts, vendor diagrams
- Status board
- Safety procedures
- Vendor information/tech manual

Know
- What the job is
- Who else needs to know
- Who is in charge

Think
- About the unexpected…what if…?
- Lock-tag-test-try
- Test for voltage or current first
- Use the right tools and equipment, including protective gear
- Install and remove grounds, when required
- Install barriers and boundaries

Prepare for an emergency
- Is the standby person CPR trained?
- Is the required emergency equipment available?
- Where is the nearest telephone or communication equipment?
- Where is the fire alarm and fire extinguisher?
- Is confined space rescue available?
- What is the exact work location?
- How is the equipment shut off in an emergency?
SECTION VII: PERSONAL PROTECTIVE EQUIPMENT

General Principles

- Fire-resistant (FR) safety eyewear is required at all times

- Protective equipment is worn to protect against two major categories of electrical injury:
  
  o Electrical shock – insulating gloves, mats, blankets. The primary feature of this protective equipment is that it insulates the wearer from electric shock
  o Arc flash and arc blast – usually clothing, coveralls, hoods, etc., designed to withstand the arc flash and blast. The primary feature of this protective equipment is that it insulates the wearer from the high-energy electrical plasma, the heat, and to a lesser extent, the blast of a high-energy bolted fault. **It is critically important to protect the head, neck, and chest.**

- You must wear rubber insulating gloves where there is danger of hand and arm injury from electric shock due to contact with live parts. Gloves are categorized as follows:
  
  o Class 00 up to 500V
  o Class 0 up to 1,000V
  o Class 1 up to 7,500V
  o Class 2 up to 17,000V
  o Class 3 up to 26,500V
  o Class 4 up to 36,000V

- Insulated tools
  
  o Insulated tools rated for the task being done must be used whenever working within the restricted approach boundary.
  o Note that the restricted approach boundary must be increased by the length of tools, parts, and materials used. For example, if a two foot long pipe wrench is needed in the work zone, the restricted approach boundary must be increased by two feet.
  o Fuse or fuse holding equipment must be insulated for the circuit voltages being worked on.
  o Ropes and cables must be non-conductive
  o Ladders must be non-conductive

- All protective equipment should be inspected before use. Do not used damaged gear or gear contaminated with oil or grease.

- Flame resistant clothing must be worn whenever there is a chance for arc flash or arc blast. Arc flash and arc blast, although unlikely to occur when working on lighting circuits, are frequent occurrences on other circuits, including simple 120V, 480V, and 277V circuits. Do not wear clothing that does not meet the FR requirements in the Table 2 below.

- Fibers that can melt, such as acetate, nylon, polyester, polypropylene, and spandex, shall never be worn against the skin (exception: small amounts of elastic used on underwear or socks is permitted). Fibers that can melt will greatly increase any burn injury incurred in an arc flash incident.
- When head, neck, face, and chin protection are required, ensure that the equipment is worn correctly. It is very common for electricians to leave their hoods up and their neck protection undone.

- When flame resistant (FR) clothing is worn to protect an employee, it shall cover all ignitable clothing and shall allow for movement and visibility.

- Tight-fitting clothing should be avoided. Loose-fitting clothing provides additional insulation because of air spaces.

- **Flash Suits** – required for some high hazard tasks (see Hazard/Risk Categories 3 and 4 in Table 1 below)
  - Must be easy to put on and remove
  - The entire flash suit, including the hood’s face shield, must have an arc rating that is suitable for potential arc flash exposure of the task (see arc rating data in Table 3 below)

- Face shields must have an arc rating exposure suitable for the potential arc flash exposure of the task (see arc rating data in Table 3 below)

- Any outer garments such as rainwear or jackets must also be made of FR material

- Insulated soles on shoes should never be used as the sole protection against electrical shock.
Personal Protective Equipment When Working Within the Flash Protection Boundary

When inside the flash protection boundary, only fire resistant clothing and equipment can protect employees from arc flash and arc blast. Arc flash and arc blast hazards are a significant hazard for electrical work done on the airfield, including on the 480V supply side of constant current regulators, in circuit breaker panels, in switchgear, in motor control centers, and in numerous other places on the airfield. Arc flash and arc blast cause severe injuries to the head, neck, and chest area. Arc flash and arc blast occur when bolted faults generate thousands of amps, vaporizing the conductors making contact. These short-term, high current events happen very quickly, before the overcurrent protective devices operate.

For equipment and circuits less than 600V, the flash protection boundary should be established no closer than four (4’) feet from the exposed energized part (this is based on circuit interruption clearing time of 6 cycles (0.1 second) and the available bolted fault current of 50,000 A – other clearing times will require a flash hazard analysis in accordance with NFPA 70E, section 130.3). Arc flash/arc blast boundaries do not need to be established on or around constant current airfield lighting tasks, since there is no significant bolted fault current to cause such an increase in energy.

Section X below contains common procedures done on the airfield in which arc flash and arc blast are a hazard. In each of those procedures, the protective equipment required to assist in surviving arc blast and arc flash are provided. Some other common tasks, their Hazard/Risk Categories, and their associated protective systems are listed below. First find the task you wish to do and the Hazard/Risk Category associated with it. Then determine what protective system matches the Hazard/Risk Category. Note that this is to protect you only against arc flash and arc blast. Insulated gloves and tools should be used to prevent against shock whenever working on or near the equipment. You will note that constant current airfield lighting work is not included because during normal constant current regulator (CCR) operation, dangerous bolted fault currents will not develop. By definition, arc flash and arc blast occur when bolted fault currents in the kA range develop. Since CCR’s maintain constant current, even in ground fault conditions, arc flash and arc blast are not expected to occur in most situations.

TABLE 1

<table>
<thead>
<tr>
<th>Task (assumes equipment is energized and work is done within the flash protection boundary)</th>
<th>Hazard/Risk Category</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panelboards rated 240V and below</strong></td>
<td></td>
</tr>
<tr>
<td>Circuit breaker (CB) or fused switch</td>
<td>0</td>
</tr>
<tr>
<td>Opening hinged covers (to expose bare, energized parts)</td>
<td>0</td>
</tr>
<tr>
<td>Work on energized parts, including voltage testing</td>
<td>1</td>
</tr>
<tr>
<td>Remove/install circuit breakers or fused switches</td>
<td>1</td>
</tr>
<tr>
<td>Removal of bolted covers (to expose bare, energized parts)</td>
<td>1</td>
</tr>
<tr>
<td><strong>Panelboards or Switchboards Rated &gt; 240V and up to 600V</strong></td>
<td></td>
</tr>
<tr>
<td>CB or fused switch operation with covers on</td>
<td>0</td>
</tr>
<tr>
<td>CB or fused switch operation with covers off</td>
<td>1</td>
</tr>
<tr>
<td>Work on energized parts, including voltage testing</td>
<td>2*</td>
</tr>
<tr>
<td><strong>600V Class Motor Control Centers (MCC)</strong></td>
<td></td>
</tr>
<tr>
<td>CB or fused switch or starter operation with enclosure doors closed</td>
<td>0</td>
</tr>
<tr>
<td>Reading a panel meter while operating a meter switch</td>
<td>0</td>
</tr>
<tr>
<td>CB or fused switch or starter operation with enclosure doors open</td>
<td>1</td>
</tr>
</tbody>
</table>
### Task

(assumes equipment is energized and work is done within the flash protection boundary)

<table>
<thead>
<tr>
<th>Task</th>
<th>Hazard/ Risk Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work on energized parts, including voltage testing</td>
<td>2*</td>
</tr>
<tr>
<td>Work on control circuits with energized parts 120V or below, exposed</td>
<td>0</td>
</tr>
<tr>
<td>Work on control circuits with energized parts &gt; 120V, exposed</td>
<td>2*</td>
</tr>
<tr>
<td>Insertion or removal of individual starter “buckets” from MCC</td>
<td>3</td>
</tr>
<tr>
<td>Application of safety grounds, after voltage test</td>
<td>2*</td>
</tr>
<tr>
<td>Removal of bolted covers (to expose bare, energized parts)</td>
<td>2*</td>
</tr>
<tr>
<td>Opening hinged covers (to expose bare, energized parts)</td>
<td>1</td>
</tr>
</tbody>
</table>

### 600V Class Switchgear (with power circuit breakers or fused switches)

<table>
<thead>
<tr>
<th>Task</th>
<th>Hazard/ Risk Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>CB or fused switch operation with enclosure doors closed</td>
<td>0</td>
</tr>
<tr>
<td>Reading a panel meter while operating a meter switch</td>
<td>0</td>
</tr>
<tr>
<td>CB or fused switch or starter operation with enclosure doors open</td>
<td>1</td>
</tr>
<tr>
<td>Work on energized parts, including voltage testing</td>
<td>2*</td>
</tr>
<tr>
<td>Work on control circuits with energized parts 120V or below, exposed</td>
<td>0</td>
</tr>
<tr>
<td>Work on control circuits with energized parts &gt; 120V, exposed</td>
<td>2*</td>
</tr>
<tr>
<td>Insertion or removal (racking) of CBs from cubicles, doors open</td>
<td>3</td>
</tr>
<tr>
<td>Insertion or removal (racking) of CBs from cubicles, doors closed</td>
<td>2</td>
</tr>
<tr>
<td>Application of safety grounds, after voltage test</td>
<td>2*</td>
</tr>
<tr>
<td>Removal of bolted covers (to expose bare, energized parts)</td>
<td>3</td>
</tr>
<tr>
<td>Opening hinged covers (to expose bare, energized parts)</td>
<td>2</td>
</tr>
</tbody>
</table>

### Other 600V Class Equipment (277V through 600V)

<table>
<thead>
<tr>
<th>Task</th>
<th>Hazard/ Risk Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Removal of bolted covers (to expose bare, energized parts)</td>
<td>2*</td>
</tr>
<tr>
<td>Opening hinged covers (to expose bare, energized parts)</td>
<td>1</td>
</tr>
<tr>
<td>Work on energized parts, including voltage testing</td>
<td>2*</td>
</tr>
<tr>
<td>Application of safety grounds, after voltage test</td>
<td>2*</td>
</tr>
<tr>
<td>Cable trough or tray cover removal or installation</td>
<td>1</td>
</tr>
<tr>
<td>Miscellaneous equipment cover removal or installation</td>
<td>1</td>
</tr>
<tr>
<td>Insertion or removal</td>
<td>2*</td>
</tr>
</tbody>
</table>

### Motor Starters - NEMA E2 (fused contactor): 2.3 kV through 7.2 kV

<table>
<thead>
<tr>
<th>Task</th>
<th>Hazard/ Risk Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contactor operation with enclosure doors closed</td>
<td>0</td>
</tr>
<tr>
<td>Reading a panel meter while operating a meter switch</td>
<td>0</td>
</tr>
<tr>
<td>Contactor operation with enclosure doors open</td>
<td>2*</td>
</tr>
<tr>
<td>Work on energized parts, including voltage testing</td>
<td>3</td>
</tr>
<tr>
<td>Work on control circuits with energized parts 120V or below, exposed</td>
<td>0</td>
</tr>
<tr>
<td>Work on control circuits with energized parts &gt; 120V, exposed</td>
<td>3</td>
</tr>
<tr>
<td>Insertion or removal (racking) of starters from cubicles, doors open</td>
<td>3</td>
</tr>
<tr>
<td>Insertion or removal (racking) of starters from cubicles, doors closed</td>
<td>2</td>
</tr>
<tr>
<td>Application of safety grounds, after voltage test</td>
<td>3</td>
</tr>
<tr>
<td>Removal of bolted covers (to expose bare, energized parts)</td>
<td>4</td>
</tr>
<tr>
<td>Opening hinged covers (to expose bare, energized parts)</td>
<td>3</td>
</tr>
</tbody>
</table>

### Metal Clad Switchgear, 1 kV and above

<table>
<thead>
<tr>
<th>Task</th>
<th>Hazard/ Risk Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>CB or fused switch or starter operation with enclosure doors closed</td>
<td>2</td>
</tr>
<tr>
<td>Reading a panel meter while operating a meter switch</td>
<td>0</td>
</tr>
<tr>
<td>Task</td>
<td>Hazard/Risk Category</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>(assumes equipment is energized and work is done within the flash protection boundary)</td>
<td></td>
</tr>
<tr>
<td>CB or fused switch or starter operation with enclosure doors open</td>
<td>4</td>
</tr>
<tr>
<td>Work on energized parts, including voltage testing</td>
<td>4</td>
</tr>
<tr>
<td>Work on control circuits with energized parts 120V or below, exposed</td>
<td>2</td>
</tr>
<tr>
<td>Work on control circuits with energized parts &gt; 120V, exposed</td>
<td>4</td>
</tr>
<tr>
<td>Insertion or removal (racking) of starters from cubicles, doors open</td>
<td>4</td>
</tr>
<tr>
<td>Insertion or removal (racking) of starters from cubicles, doors closed</td>
<td>2</td>
</tr>
<tr>
<td>Application of safety grounds, after voltage test</td>
<td>4</td>
</tr>
<tr>
<td>Removal of bolted covers (to expose bare, energized parts)</td>
<td>4</td>
</tr>
<tr>
<td>Opening hinged covers (to expose bare, energized parts)</td>
<td>3</td>
</tr>
<tr>
<td>Opening voltage transformer or control power transformer compartments</td>
<td>4</td>
</tr>
</tbody>
</table>

### Other Equipment 1 kV and Above

<table>
<thead>
<tr>
<th>Task</th>
<th>Hazard/Risk Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switch operation, doors closed</td>
<td>2</td>
</tr>
<tr>
<td>Work on energized parts, including voltage testing</td>
<td>4</td>
</tr>
<tr>
<td>Removal of bolted covers (to expose bare, energized parts)</td>
<td>4</td>
</tr>
<tr>
<td>Opening hinged covers (to expose bare, energized parts)</td>
<td>3</td>
</tr>
<tr>
<td>Outdoor disconnect switch operation (hookswitch operated)</td>
<td>3</td>
</tr>
<tr>
<td>Outdoor disconnect switch operation (gang-operated, from grade)</td>
<td>2</td>
</tr>
<tr>
<td>Insulated cable examination, in manhole or other confined space</td>
<td>4</td>
</tr>
<tr>
<td>Insulated cable examination, in open area</td>
<td>2</td>
</tr>
</tbody>
</table>

*This table is derived from NFPA70E, Table 130.7(C)(9)(a)*

**Notes**

2* - means that a double-layer switching hood and hearing protection are required for this task in addition to the other Hazard/Risk Category 2 requirements
TABLE 2

<table>
<thead>
<tr>
<th>Protective Clothing and Equipment</th>
<th>Protective Systems for Hazard/Risk Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-melting or untreated natural fiber</td>
<td>0</td>
</tr>
<tr>
<td>a. T-shirt (short sleeve)</td>
<td>X</td>
</tr>
<tr>
<td>b. Shirt (long sleeve)</td>
<td>X</td>
</tr>
<tr>
<td>c. Pants (long)</td>
<td>X</td>
</tr>
</tbody>
</table>

Fire Resistant (FR) Clothing

| a. Long-sleeve shirt | X | X | X<sup>9</sup> | X |
| b. Pants | X<sup>4</sup> | X<sup>6</sup> | X<sup>9</sup> | X |
| c. Coverall | 5 | 7 | X | 5 |

Fire Resistant (FR) Protective Equipment

| a. Flash suit jacket (multilayer) | X |
| b. Flash suit pants (multilayer) | X |
| c. Hard hat | X | X | X | X |
| d. Eye protection (safety glasses or safety goggles) | X | X | X | X | X |
| e. Face and head area protection | 1. Arc-rated face shield or flash suit hood | X<sup>8</sup> |
| 2. Flash suit hood | X | X |
| 3. Hearing protection (ear canal inserts) | X<sup>8</sup> | X | X |
| f. Leather gloves (note 2) | X | X | X |
| g. Leather work shoes | X | X | X |

Notes (table derived from NFPA 70E Table 130.7(C)(10))

2. Leather gloves must be worn in some cases, even if insulated voltage-rated gloves are not worn underneath
4. Regular weight untreated denim cotton blue jeans are acceptable in lieu of FR pants. The FR pants used for Hazard/Risk Category 1 shall have a minimum arc rating of 4
5. If desired, use FR coveralls instead of FR shirt and pants
6. If the FR pants have a minimum arc rating of 8, long pants of non-melting or untreated natural fiber are not required beneath the FR pants
7. If desired, use FR coveralls with a minimum arc rating of 4 over non-melting or untreated natural fiber pants and T-shirt
8. A faceshield with a minimum arc rating of 8, with wrap-around guarding to protect not only the face, but also the forehead, ears, and neck (or alternatively, a flash suit hood) is required
9. Alternate is to use two sets of FR coveralls (the minimum with an arc rating of 4 and outer coverall with a minimum arc rating of 5) over non-melting or untreated natural fiber clothing, instead of FR coveralls over FR shirt and FR pants over non-melting or untreated natural fiber clothing
### TABLE 3

<table>
<thead>
<tr>
<th>Hazard/Risk Category</th>
<th>Clothing Description (typical number of clothing layers given in parentheses)</th>
<th>Required Minimum Arc Rating of the Personal Protective Equipment cal/cm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Non-melting, flammable materials (i.e. untreated cotton, wool, rayon, or silk, or blends of these materials) with a fabric weight at least 4.5 oz/yd² (1 layer)</td>
<td>n/a</td>
</tr>
<tr>
<td>1</td>
<td>FR shirt and FR pants or FR coverall (1 layer)</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Cotton underwear – conventional short sleeve and brief/shorts, plus FR shirt and FR pants (1 or 2 layers)</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>Cotton underwear plus FR shirt and FR pants plus FR coverall, or cotton underwear plus two FR coveralls (2 or 3 layers)</td>
<td>25</td>
</tr>
<tr>
<td>4</td>
<td>Cotton underwear plus FR shirt and FR pants plus multilayer flash suit (3 or more)</td>
<td>40</td>
</tr>
</tbody>
</table>

This table is from NFPA 70E, table 130.7(C)(11)

- clothing, tools, barricades
- vault safety boards (see long list in other document)
SECTION VIII:  CONTRACTORS and VENDORS

All contractors and vendors performing electrical work, on the airfield, must review this procedure and confirm that their policies and procedures are at least as stringent. Contractors will be given a copy of this program via email for their review in advance of the projected start date. No electrical work will be authorized to commence without the contents of this section being adhered to.

Upon completion of review, by all employees working on the airfield or in the electrical vault, the contractor must provide a letter of compliance. The contents of the letter will include the following:

A. Assurance that all employees who will work on the airfield or in electrical vault have read and understand the procedures outlined in this program.

B. Assurance that all employees will comply with the procedures explained in this program.

C. Any request to deviate from the policies and procedures in this program will be done in writing to the DAA Safety Manager explaining the need to deviate and control measures that will be put in place to ensure a safe operation.

SECTION IX:  IDENTIFICATION OF HAZARDOUS TASKS AND JOBS

This section lists jobs and tasks on the airfield that present significant electrical hazards.

A. Placing a Circuit in an *Electrically Safe Work Condition* and Testing for the Presence of Hazardous Energy, including Circuit *Lockout*

B. Hot Re-Lamping

C. Re-Lamping with Circuits De-Energized

D. Constant Current Regulator (CCR) Maintenance with CCR Energized

E. Electrical Work in 30’ Pit

F. Ground Fault Detection Using the CCR

G. Jumping Circuits

H. Continuity Testing of Series Lighting Circuits

I. Manual Meggering® of Series Lighting Circuits

J. Output Voltage Measurements on CCR

K. Work at Heights from Bucket Truck

L. Switching Leads from One CCR to Another

In the following section, procedures are written for each of these tasks
SECTION X: PROCEDURES

A. Placing a Circuit in an Electrically Safe Work Condition and Testing for the Presence of Hazardous Energy, including Circuit Lockout

Purpose

One of the most common causes of airfield lighting injuries is failing to test a circuit for energy before breaking the circuit. Every time a circuit is broken, it should be tested for the presence of hazardous energy. In a series lighting circuit, testing is a straightforward process, but it is unique and therefore presents hazards to inexperienced electricians and contractors. Series circuits can register zero or near-zero levels of voltage on sections of the circuit, so that the only sure way to verify the presence of hazardous energy is via the use of a true RMS ammeter.

Most airfield lighting maintenance tasks, including series circuits and other more traditional electrical machinery and distribution systems, should be performed under the protection of a circuit lockout. A lockout is one element in placing an electrical system in an 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 in accordance with the DAA lockout program, tested to ensure the absence of voltage, and grounded if determined necessary).

If a circuit cannot be worked in an electrically safe work condition, then an Energized Electrical Work Permit must be pulled (see Section VI).

Qualifications and Number of Employees to be Involved: Qualified electricians only – a minimum of two.

Hazards

1) 5 kV shock hazard should an electrician begin working on an airfield lighting circuit after mistakenly testing for the presence of energy by using a voltage testing device instead of a true RMS clamp-on ammeter or by otherwise not properly testing for the presence of hazardous energy.

2) 5 kV shock hazard to SRE employees and contract electricians from incomplete execution of circuit lockout

Limits of Approach:

Limited Approach Boundary: 5’0”
Restricted Approach Boundary: 2’2” for 5 kV circuits
Prohibited Approach Boundary: 0’7” for 5 kV circuits

Flash Protection Boundary: Typically 4’ for voltages under 600V, but not applicable for lighting circuits, since constant current at 6-20 amps does not generate significant bolted fault current)

Safe Work Practices:

1. Never remove or override a lockout without positively verifying the whereabouts of all crew members, including contract personnel.
2. The electrician performing the work must have received specific training on how to perform the tasks, including the machine- or circuit-specific shutdown, lockout, and testing for the presence of current tasks.

3. A second, qualified electrician who is trained in emergency procedures must be standing by for any work on systems greater than 600V.

4. No one other than a qualified electrician is permitted within the limited approach boundary (5’), which exists until the circuit is verified dead (de-energized). If an unqualified person needs to come within the limited approach boundary, he or she should be advised of the hazards and continuously escorted by a qualified person. At no time should the unqualified person be allowed within the restricted approach boundary (2’2” for 5 kV circuits).

5. No un-insulated body parts are permitted past the restricted approach boundary (2’2” for 5 kV circuits).

6. No un-insulated tools or materials (e.g. replacement parts) that are in contact with an un-insulated part of the electrician’s body are permitted within the restricted approach boundary (2’2” for 5 kV).

7. If it is possible for you to contact exposed energized parts before you verify that the circuit is dead (de-energized), wear voltage-rated insulated gloves and other insulating materials when inside the restricted approach boundary (2’2” for 5 kV). For protection up to 7.5 kV, Class 1 gloves should be worn. Insulating gloves should be covered with leather outer-gloves.

8. DANGER: Do not use a voltage meter as the primary means of testing a series lighting circuit for the presence of hazardous energy! A true RMS clamp-on ammeter must be used. A series lighting circuit may indicate low and zero volts at numerous points in the circuit, even though the full electrical energy of the circuit is present.

9. All tools used prior to the circuit being verified dead (de-energized) must be insulated.

10. At no time should an electrician reach blindly into a can or other enclosure that may contain energized equipment.

11. If working in confined or enclosed spaces such as manholes or vaults, ensure there are no other exposed energized conductors in the vicinity.

12. Never work under a contractor’s lockout procedure unless you have verified the lockout yourself and have placed your lock on the lockout devices.

**Personal Protective Equipment Needed**

1. Voltage-rated gloves with leather protective covers if exposed to energized conductors prior to testing the circuit dead (de-energized).
2. Fire-resistant safety glasses
3. Non-melting/untreated natural fiber t-shirt (long sleeve)
4. Non-melting/untreated natural fiber long pants

**Insulating Tools and Equipment:** All tools should be insulated if, prior to verifying the circuit dead, they are exposed to energized electrical conductors.

**Special Precautionary Techniques:** Beware of stored energy in capacitors in REIL’s and beacons. Beware of secondary sources of voltage such as control voltage.

**Electrical Diagrams:** In many cases, multiple sources of electrical power are available in a circuit, including stored energy in capacitors (REILs and beacons), control voltage (typically 120 VAC or 48 VDC), and induced voltages from other circuits. For complex systems, it is
critical that accurate as-built drawings be consulted when placing a circuit in an *electrically safe work condition*.

**Equipment Details:** Electricians should be trained on the equipment they will be placing in an *electrically safe work condition*.

**Other Reference Documents or Materials:** none

**Steps to Take When Placing a Circuit in an Electrically Safe Work Condition, including Locking it Out**

1. Plan your work and work your plan. Expect the unexpected

2. De-energize the circuit using the normal shutdown procedure. To qualify as an *electrically safe work condition*, a physical disconnect mean must be used. Electronic circuitry cannot be used as a lockout means. Circuit breakers, disconnect switches, and pulled fuses are examples of disconnecting means that provide a physical break of the electrical circuitry.

3. Use accurate technical manuals or as-built drawings to de-energize machinery or circuits. Even simple machines and circuits may have multiple sources of energy such as control voltage and capacitors. Verify that the system will not have stored energy once shut down, such as charged capacitors, compressed springs, fluids under pressure, etc.

4. Protect against induced voltages (*how is this achieved on the airfield?*)

5. Some circuits require that stored or residual energy be dissipated. For example, capacitors must be discharged, springs disconnected, and flywheels allowed to coast to a stop. Using the procedure recommended by the manufacturer of the equipment or in accordance with other best practices, discharge the stored energy.

6. Place your lock and tag that identifies you on the disconnecting device (energy isolating device). In many cases, numerous locks and locking devices may be required to isolate all power sources.

7. If this is a group project, each person working on the system or equipment should place his or her lock and identifying tag on a group hasp or in a group lock box. Do not work under the protection of another’s lock.

8. Always do the three steps below when using your test equipment on a circuit:
   a. Test your meter on a known source to verify that it is functioning properly.
   b. Test your meter on the circuit on which you will be working. **THIS IS A HAZARDOUS STEP!** You must not assume that the circuit is dead. Disconnect switches and circuit breakers can and do fail, leaving hazardous energy on the circuit.
   c. After testing the circuit dead, re-test your meter on the known source again to verify that it is working.
9. If the circuit can be re-energized inadvertently via contact with adjacent circuits (such as falling wires) or via induced voltages, connect grounding rods or cables to the circuit being worked on (or otherwise protect the circuit) so that no potential can be created between you and the circuit).

10. Perform the work on the circuit. If you are leaving the site and must remove your lock, someone should place his or her lock and identifying tag on the lockout devices before you remove yours to ensure the continuity of the lockout.

11. Prior to clearing the lockout, verify that all personnel (including contractors) are clear of any danger.

12. Remove the locks and tags from the energy isolating devices.

13. Restart the system in accordance with the manufacturer’s instructions, verify that the system is operating within allowable specifications.
B. **Hot Re-Lamping**

**Purpose**

Re-lamping airfield lights while the system is energized is a frequent cause of injury and death on airfields around the world. Additionally, physical damage to the fixtures occurs when they are re-lamped while energized. Hot re-lamping is usually done when the need to correct a lighting deficiency is urgent.

If de-energizing a lighting system will endanger an aircraft on approach or on the ground, or if it is operationally unsafe or infeasible to de-energize a lighting circuit, it may be worked on energized (*hot re-lamping*). The hazards discussed here also include the simple cleaning tasks on glass lenses, since the use of cleaning fluids will greatly increase the electrical shock hazard as body resistance will be lowered. If a lighting circuit will be worked in an energized state, additional precautions should be used to compensate for the increased risk.

Because the re-lamping is done without having the system in an *electrically safe work condition*, the practice should be eliminated, if possible, or at least minimized.

**Qualifications and Number of Employees to be Involved:** Qualified electricians only with specific training in this procedure – a minimum of two electricians due to work on energized circuits

**Hazards:**

Secondary shock hazards up to 200V and primary-to-secondary short circuits, exposing electricians to voltages as follows:

1. On taxiways – 3 kV, with up to 6 kV if an electrician mistakenly attempts to break an energized circuit
2. On runways – 5 kV, with up to 10 kV if an electrician mistakenly attempts to break an energized circuit.

**Limits of Approach:**

- Limited Approach Boundary: 5’0”
- Restricted Approach Boundary: 2’2”
- Prohibited Approach Boundary: 0’7”
- Flash Protection Boundary: Not applicable (constant current at 6-20 amps – no significant bolted fault current)

**Safe Work Practices:**

1. Prior to starting the work, a determination must be made as to why this re-lamping procedure must be done with the circuit energized. A supervisor should make the determination that the task must be done while energized.
2. An energized electrical work permit should be issued, time permitting
3. The electrician performing the work must have received specific training on how to perform the hot re-lamping task
4. A second, qualified electrician who is trained in emergency procedures must be standing by
5. No one other than a qualified electrician is permitted within the *limited approach boundary* (5’). If an unqualified person needs to come within the *limited approach boundary*, he or she should be advised of the hazards and continuously escorted by a qualified person.
time should the unqualified person be allowed within the restricted approach boundary (2’2”).

6. No un-insulated body parts are permitted past the restricted approach boundary (2’2”).

7. No un-insulated tools or materials (e.g. replacement parts) that are in contact with an un-insulated part of the electrician’s body are permitted within the restricted approach boundary (2’2”).

8. Class 1 voltage-rated gloves (for protection up to 7.5 kV) must be worn when inside the restricted approach boundary (2’2”). These insulating gloves should be covered with leather outer-gloves.

9. The secondary side of the lamp should be tested to verify that a primary-to-secondary short does not exist. A VOM or DMM capable of testing up to the maximum expected voltage (3 kV on taxiways, 5 kV on runways) must be used.

10. All tools must be insulated.

11. At no time should an electrician reach blindly into a can or other enclosure that may contain energized equipment.

12. No energized electrical work may be done without proper illumination.

13. No conductive jewelry or clothing may be worn

14. If working in confined or enclosed spaces such as manholes or vaults, ensure there are no other exposed energized conductors in the vicinity.

**Personal Protective Equipment Needed**

1. Class 1 voltage-rated gloves (for protection up to 7.5 kV) with leather protective covers;
2. Fire-resistant safety glasses
3. Non-melting/untreated natural fiber t-shirt (long sleeve)
4. Non-melting/untreated natural fiber long pants

**Insulating Tools and Equipment:** All tools should be insulated

**Special Precautionary Techniques:** None

**Electrical Diagrams:** If time permits, refer to available hardcopy or computer-based as-builts or blueprints, if necessary.

**Equipment Details:** The lamp is typically a 200V bulb, but is powered via a lighting transformer whose primary can be 5 kV.

**Other Reference Documents or Materials:** none

**Steps to Take When Doing Hot Re-Lamping**

1. Plan your work and work your plan. Expect the unexpected

2. Determine why the lamp needs to be replaced while energized and communicate this reason to your supervisor.
3. Obtain an Energized Electrical Work Permit (see Section VI). If there is not enough time to pull a permit, verbally review the steps of the permit with the supervisor, obtaining verbal approvals and confirmations on each step.

4. Proceed to the lamp that must be replaced. You must be a qualified electrician and must have received training in this procedure.

5. You must be accompanied by another qualified electrician.

6. Prior to breaching the restricted approach boundary (2’ 2”), inspect your Class 1 insulated gloves and put them on (do not use the gloves if they are ripped or damaged). Cover the gloves with leather outer gloves.

7. Repair the lamp, remaining aware of the possibility of the high voltage hazards associated with primary to secondary shorts.

8. Do not remove your gloves until you are finished working inside the restricted approach boundary.
C. Re-lamping Circuits while De-Energized but with CCR NOT Locked Out

Purpose

Re-lamping airfield lights is typically done without the power supply (the constant current regulator (CCR)) locked out due to the infeasibility of such a lockout. It is infeasible because for most re-lamping tasks, electricians on the airfield would need to lock out the CCR in the vault and then drive long distances to the airfield to do the re-lamping. The electrician would then need to drive back to the vault, clear the lockout, and drive back to the lamp to ensure that it is working.

By definition, performing work on electrical circuits without a system lockout means that the circuit is NOT in an electrically safe work condition. As such, significant hazards remain with this task. Therefore, additional precautions must be taken to provide a level of protection equivalent to an electrically safe work condition. An electrician who does not maintain control of the circuit on which he works by placing his or her own lock on the CCR disconnect is placing himself at additional risk.

Note: Although it is rarely possible to do re-lamping tasks with the circuit in an electrically safe work condition (that is, with the CCR locked out by the electrician doing the re-lamping), it remains the preferred method of doing re-lamping tasks. When re-lamping is done with the circuit in an electrically safe work condition, this procedure need not be followed. Only the procedure to place the circuit in an electrically safe work condition need be followed.

Qualifications and Number of Employees to be Involved

1. Qualified electricians only – a minimum of two - with specific training on this procedure.
2. If a tower employee will be overseeing the CCR while an electrician is working on the circuit it supplies, the tower employee must be trained on this procedure.

Hazards

Secondary shock hazards up to 200V and primary-to-secondary short circuits, exposing electricians to voltages as follows:
1. On taxiways – 3 kV, with up to 6 kV if an electrician mistakenly attempts to break an energized circuit
2. On runways – 5 kV, with up to 10 kV if an electrician mistakenly attempts to break an energized circuit.

Limits of Approach:

- Limited Approach Boundary: 5’0”
- Restricted Approach Boundary: 2’2”
- Prohibited Approach Boundary: 0’7”
- Flash Protection Boundary: Not applicable (constant current at 6-20 amps – no significant bolted fault current)
Safe Work Practices:

1. Because you will not have direct control over the power source of the lighting circuit on which you will be working, you must complete this task as quickly and safely as possible. Planning is essential.
2. Establish radio contact with the person overseeing the CCR in the vault or tower. A headset or other hands-free device should be used. Radio communications should be constant.
3. If the CCR cannot be locked out, it is preferable to do re-lamping tasks by de-energizing the CCR from the vault, as opposed to the tower. Tower personnel are not trained electricians and may have numerous other airfield tasks to consider including aircraft on approach and on the ground.
4. A second, qualified electrician who is trained in emergency procedures is standing by during the re-lamping task.
5. No one other than a qualified electrician is permitted within the limited approach boundary (5’). If an unqualified person needs to come within the limited approach boundary, he or she should be advised of the hazards and continuously escorted by a qualified person. At no time should the unqualified person be allowed within the restricted approach boundary (2’2”).
6. No un-insulated body parts are permitted past the restricted approach boundary (2’2”).
7. No un-insulated tools or materials (e.g. replacement parts) that are in contact with an un-insulated part of the electrician’s body are permitted within the restricted approach boundary (2’2”).
8. Class 1 voltage-rated gloves (for protection up to 7.5 kV) must be worn when inside the restricted approach boundary (2’2”). These insulating gloves should be covered with leather outer-gloves.
9. The secondary side of the lamp should be tested to verify that a primary-to-secondary short does not exist. A VOM or DMM capable of testing up to the maximum expected voltage (3 kV on taxiways, 5 kV on runways) must be used.
10. All tools must be insulated.
11. At no time should an electrician reach blindly into a can or other enclosure that may contain energized equipment.
12. No energized electrical work may be done without proper illumination.
13. No conductive jewelry or clothing may be worn
14. If working in confined or enclosed spaces such as manholes or vaults, ensure there are no other exposed energized conductors in the vicinity.

Personal Protective Equipment Needed

1. Class 1 voltage-rated gloves (for protection up to 7.5 kV) with leather protective covers;
2. Fire-resistant safety glasses
3. Non-melting/untreated natural fiber t-shirt (long sleeve)
4. Non-melting/untreated natural fiber long pants
**Insulating Tools and Equipment:** All tools should be insulated

**Special Precautionary Techniques**

1. If the CCR cannot be locked out, it is preferable to do re-lamping tasks by de-energizing the CCR from the vault, as opposed to the tower. Tower personnel are not trained electricians and may have numerous airfield tasks to consider.
2. Establish hands-free radio communications with the vault or tower so that constant contact can be maintained during the procedure.

**Electrical Diagrams:** If time permits, refer to available hardcopy or computer-based as-builts or blueprints, if necessary.

**Equipment Details:** The lamp is typically a 200V bulb, but is powered via a lighting transformer whose primary can be 5 kV.

**Other Reference Documents or Materials:** none

**Steps to Take When Doing Re-Lamping of De-Energized Circuits without CCR Lockout**

1. Plan your work and work your plan. Expect the unexpected.

2. This procedure should only be done if it is infeasible to lock out the constant current regulator (CCR). If possible, do the re-lamping tasks by de-energizing the CCR and locking it out with your own lock. If this is not feasible, continue with the steps below.

3. Establish radio contact with the person overseeing the shutdown of the CCR in the vault or tower (using another trained, qualified electrician in the vault is preferable to using tower personnel). A headset or other hands-free device should be used. Radio communications should be constant.

4. Proceed to the lamp that must be replaced. You must be a qualified electrician and must have received training in this procedure.

5. You must be accompanied by another qualified electrician.

6. Prior to breaching the restricted approach boundary (2’2”), inspect your Class 1 insulated gloves and put them on (do not use the gloves if they are ripped or damaged). Cover the gloves with leather outer gloves.

7. Test the circuit for the presence of current using a true RMS ammeter. If no current is detected, proceed with the re-lamping task. Be aware that because the CCR is not locked out, power could inadvertently be turned on at any time. Test the circuit for the presence of current each time you return to the task after walking away from it.
8. Repair the lamp, remaining aware of the possibility of the high voltage hazards associated with primary to secondary shorts.

9. When repair is complete, step outside the restricted approach boundary and ask the tower or vault to energize the circuit. Visually confirm that the lamp is lit.

10. Ask the tower or vault to de-energize the CCR

11. Do not remove your gloves until you are finished working inside the restricted approach boundary.

12. When outside the restricted approach boundary, inform the vault or tower that it is safe to re-energize the circuit. Visually verify that the lamp
D. Constant Current Regulator Maintenance with CCR Energized

**Purpose**

Basic maintenance on constant current regulators (CCR) presents 480 volt, 120 volt, and 48 VDC shock, arc flash, and arc blast hazards.

For most maintenance tasks, the CCR cabinet remains completely closed with no exposed electrical conductors. Calibration is typically done from control panels on or around the outside of the CCR. This procedure does not apply to those tasks if they are done with the CCR in an *electrically safe work condition*.

There are some tasks, however, that expose electricians to energized conductors inside the CCR cabinet. This procedure applies to those tasks that are done on or around CCR’s when energized conductors are exposed.

The procedure for output voltage measurement tests on the CCR is a separate procedure. See item J later in this section.

**Qualifications and Number of Employees to be Involved:** Qualified electricians only with specific training in CCR maintenance

**Hazards:**

1) 480 VAC shock hazard from supply voltage in CCR
2) 120 VAC and 48 VDC shock hazard from control voltage
3) Arc flash and arc blast hazards

**Limits of Approach:**

<table>
<thead>
<tr>
<th></th>
<th>480 VAC</th>
<th>120 VAC/48 VDC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limited Approach Boundary</td>
<td>5’</td>
<td>3’6”</td>
</tr>
<tr>
<td>Restricted Approach Boundary</td>
<td>1’</td>
<td>Avoid contact</td>
</tr>
<tr>
<td>Prohibited Approach Boundary</td>
<td>0’1”</td>
<td>Avoid contact</td>
</tr>
<tr>
<td>Flash Protection Boundary</td>
<td>4’</td>
<td>4’</td>
</tr>
</tbody>
</table>
Safe Work Practices:

1. Prior to starting the work, a determination must be made as to why this re-lamping procedure must be done with the circuit energized. A supervisor should make the determination that the task must be done while energized.

2. An energized electrical work permit should be issued, time permitting.

3. The electrician performing the work must have received specific training on how to perform the hot re-lamping task.

4. A second, qualified electrician who is trained in emergency procedures must be standing by.

5. Exposed energized conductors are hazardous during even the simplest procedures, such as opening cabinet doors and voltage testing. Personal protective equipment must be worn as noted in the table below.

6. No one other than a qualified electrician is permitted within the limited approach boundary (5'). If an unqualified person needs to come within the limited approach boundary, he or she should be advised of the hazards and continuously escorted by a qualified person. At no time should the unqualified person be allowed within the flash protection boundary (4').

7. Do not cross the flash protection boundary without wearing the protective equipment as noted in the table below.

8. No un-insulated body parts are permitted past the restricted approach boundaries.

9. No un-insulated tools or materials (e.g. replacement parts) that are in contact with an un-insulated part of the electrician’s body are permitted within the restricted approach boundaries.

10. Class 00 voltage-rated gloves (for protection up to 500V) must be worn when inside the restricted approach boundary (1'). These insulating gloves should be covered with leather outer-gloves.

11. All tools must be insulated when working on energized electrical equipment.

12. At no time should an electrician reach blindly into a can or other enclosure that may contain energized equipment.

13. No energized electrical work may be done without proper illumination.

14. No conductive jewelry or clothing may be worn.

15. If working in confined or enclosed spaces such as manholes or vaults, ensure there are no other exposed energized conductors in the vicinity.

Personal Protective Equipment Needed
The table below addresses the hazards of working on the live supply side of a CCR, where there are high bolted fault currents available (as opposed to low fault currents available on the lighting side of the airfield lighting system). With high bolted fault currents come arc blast and arc flash hazards necessitating the use of personal protective equipment to protect electricians. Note that even some simple tasks such as opening cabinets to expose live conductors are hazardous. For these simple tasks, dangerous arc flash/arc blast potential exists, so that arc flash protective equipment must be worn.

For exposure to the voltages and conditions below, wear the protective equipment outline in the column below:

<table>
<thead>
<tr>
<th>120 VAC/48 VDC</th>
<th>480 VAC</th>
<th>480 VAC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Note 1:</strong> assumes no exposure to the live 480 V circuit</td>
<td>- Removal of bolted covers&lt;br&gt;- Work on energized parts&lt;br&gt;- Applying grounds&lt;br&gt;- Insert/remove parts, equip</td>
<td>- Removal of hinged covers&lt;br&gt;- Cable trough/tray removal or installation&lt;br&gt;- Equipment cover removal or installation</td>
</tr>
<tr>
<td>3. FR pants (if arc flash rating of FR pants &gt; 8, long pants need not be worn below FR pants)</td>
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<td>4. FR coveralls can replace FR pants and shirt (as long as arc rating is &gt; 4)</td>
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</tr>
<tr>
<td>5. FR hard hat</td>
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</tr>
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<td>6. FR safety glasses</td>
<td>6. FR safety glasses or goggles</td>
<td>6. FR safety glasses</td>
</tr>
<tr>
<td>7. Arc rated face shield or flash hood (minimum arc rating of 8)</td>
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</tr>
</tbody>
</table>

**Insulating Tools and Equipment:** All tools should be insulated

**Special Precautionary Techniques:** There are numerous CCR types on the airfield, so refer to the specific CCR tech manual for guidance

**Electrical Diagrams:** Refer to the CCR technical manual to ensure that all energy sources are properly considered.

**Equipment Details:** There are numerous CCR types on the airfield, so refer to the specific CCR tech manual for guidance

**Other Reference Documents or Materials:** none

**Steps to Take When Performing Maintenance on an Energized CCR**
1. Plan your work and work your plan. Expect the unexpected

2. Determine why the CCR needs to be maintained while energized and communicate this reason to your supervisor. This procedure should only be done if it is infeasible to lock out the constant current regulator (CCR). If possible, do the maintenance tasks by de-energizing the CCR and locking it out with your own lock. If this is not feasible, continue with the steps below.

3. Obtain an Energized Electrical Work Permit (see Section VI). If there is not enough time to pull a permit, verbally review the steps of the permit with the supervisor, obtaining verbal approvals and confirmations on each step.

4. Proceed to the CCR to be worked on. You must be a qualified electrician and must have received training in this procedure.

5. You must be accompanied by another qualified electrician if the work is done while the CCR is energized.

6. Prior to breaching the flash protection boundary (4’), don the flash protective equipment as noted in the table above. Simply opening CCR panels to expose 480V conductors presents an arc flash/arc blast hazard. Note that for some of the 480 V exposures, a flash hood and hearing protection is required in addition to other fire resistant gear. Arc flash protective equipment, including FR coveralls, an FR hardhat, ear canal hearing protection, and an FR arc-rated face shield or flash hood with a minimum arc flash rating of 8 (see the table above), should be provided in each of the vaults.

7. Prior to breaching the restricted approach boundary (1’), inspect your Class 00 insulated gloves and put them on (do not use the gloves if they are ripped or damaged). Cover the gloves with leather outer gloves.

8. Repair/maintain the CCR in accordance with the manufacturer’s instructions.
   a. When performing the short circuit test across the leads, the CCR must be placed in an electrically safe work condition before removing the leads and hooking up the short circuit wiring.
   b. When performing the open circuit test, the CCR must be placed in an electrically safe work condition before removing the CCR leads.

9. Do not remove your gloves until you are finished working inside the restricted approach boundary.

10. Do not remove the arc flash protective gear until all energized conductors are covered by the CCR cabinet.
E. Electrical Work in 30’ Pit  NOT APPLICABLE AT THIS TIME

**Purpose**

Some necessary electrical work is done in a 30’ pit on the airfield, including pulling wire and installing circuits and equipment.

**Qualifications and Number of Employees to be Involved:** Only electricians who have had specific training related to electrical tasks in this 30’ pit, including confined space entry training.

**Hazards:** Confined spaces; energized electrical work in a confined space.

Confined space hazards. A confined space is defined as follows:

i. Is large enough and so configured that an employee can bodily enter and perform assigned work; and

ii. Has limited or restricted means for entry or exit (for example, tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry.); and

iii. Is not designed for continuous employee occupancy. (from OSHA 1910.146)

**Limits of Approach:**

Limited Approach Boundary: 5’0”
Restricted Approach Boundary: 2’2”
Prohibited Approach Boundary: 0’7”
Flash Protection Boundary: 4’ - If tasks consist only of constant current circuitry, arc flash personnel protective equipment may not be necessary.

**Safe Work Practices:**

1. Prior to starting the work, a determination must be made as to why any work must be done with the circuit energized. Circuits to be considered include those circuits to be worked on as well as adjacent circuits to which an electrician might be exposed. A supervisor should make the determination that the task must be done while energized.

2. An energized electrical work permit should be issued, time permitting.

3. Refer to the ______________ AIRPORT/______________ Airport Confined Space Entry Procedure. A hazardous gas detector (sniffer) should be placed into the pit prior to entry. Readings should be logged until they are stable and within allowable limits. Ventilation should be provided into the pit during the electrical maintenance tasks. Sniffer readings should be taken continuously and logged at regular intervals to ensure that the sniffer is continuing to function. , but the sniffer is not left behind while work is being done. Ventilation is available during the task, but if the gas detector does not remain in the space, a hazard may develop while the work is being done.
4. No one other than a qualified electrician is permitted within the limited approach boundary (5’). If an unqualified person needs to come within the limited approach boundary, he or she should be advised of the hazards and continuously escorted by a qualified person. At no time should the unqualified person be allowed within the flash protection boundary (4’).

5. Do not cross the flash protection boundary without wearing arc flash protective equipment. Such equipment will not be necessary if only airfield lighting circuits are in the pit.

6. No un-insulated body parts are permitted past the restricted approach boundaries.

7. No un-insulated tools or materials (e.g. replacement parts) that are in contact with an un-insulated part of the electrician’s body are permitted within the restricted approach boundaries.

8. Voltage-rated gloves must be worn when inside the restricted approach boundary (1’). And when working on energized electrical equipment. Insulating gloves should be covered with leather outer-gloves.

9. All tools must be insulated when working on energized electrical equipment.

10. At no time should an electrician reach blindly into a can or other enclosure that may contain energized equipment.

11. No energized electrical work may be done without proper illumination.

12. No conductive jewelry or clothing may be worn

**Personal Protective Equipment Needed**

The table below addresses the hazards of working near energized electrical circuits with potentially high fault currents (as opposed to low fault currents available on the lighting side of the airfield lighting system). With high bolted fault currents come arc blast and arc flash hazards necessitating the use of personal protective equipment to protect electricians. **Note that even some simple tasks such as opening cabinets to expose live conductors are hazardous.** For these simple tasks, **dangerous** arc flash/arc blast potential exists, so that arc flash protective equipment must be worn.

For exposure to the voltages and conditions below, wear the protective equipment outline in the column below:
120 VAC/48 VDC

<table>
<thead>
<tr>
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</tr>
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<tbody>
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<tr>
<td>5. FR hard hat</td>
</tr>
<tr>
<td>6. FR safety glasses</td>
</tr>
</tbody>
</table>

480 VAC

- Removal of bolted covers
- Work on energized parts
- Applying grounds
- Insert/remove parts, equip

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<td>8. Hearing protection (in ear canal)</td>
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480 VAC

- Removal of hinged covers
- Cable trough/tray removal or installation
- Equipment cover removal or installation

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</tbody>
</table>

**Insulating Tools and Equipment:** All tools should be insulated when working on or near energized conductors.

**Special Precautionary Techniques:** In addition to electrical precautions, adhere to confined space precautions

**Electrical Diagrams:** Refer to as-built drawings

**Equipment Details:** None

**Other Reference Documents or Materials:** Constant current regulator technical manual
Steps to Take When Working in the 30’ Pit

1. Plan your work and work your plan. Expect the unexpected

2. If energized electrical work is being considered, determine why the circuit needs to be worked on while energized and communicate this reason to your supervisor. This procedure should only be done if it is infeasible to lock out the circuit. If possible, do the maintenance tasks by de-energizing the circuit and locking it out with your own lock. If lockout is not feasible, continue with the steps below.

3. Obtain an Energized Electrical Work Permit (see Section __ below). If there is not enough time to pull a permit, verbally review the steps of the permit with the supervisor, obtaining verbal approvals and confirmations on each step. You must be accompanied by another qualified electrician if the work is done while in the pit is energized

4. Prior to breaching the flash protection boundary (4’), don the flash protective equipment as noted in the table above. Simply opening CCR panels to expose 480V conductors Obtain a Confined Space Entry Permit (see the __________________ AIRPORT/__________________ Airport Confined Space Entry Program).
   a. Calibrate the air testing equipment prior to dropping it into the pit
   b. Obtain air quality readings from the readouts on the sniffer. When acceptable, proceed into the space. If acceptable readings cannot be obtained, introduce ventilation until acceptable readings are obtained. Once acceptable air readings are obtained, enter the pit.
   c. The sniffer should continuously monitor the space and alarm if and when the air quality deteriorates. EXIT THE PIT IMMEDIATELY UPON HEARING A SNIFER ALARM OR IF YOU FEEL FAINT OR NAUSEOUS!
   d. Ensure that the rescue and buddy system procedures are in place

5. Presents an arc flash/arc blast hazard. Note that for some of the 480 V exposures, a flash hood and hearing protection is required in addition to other fire resistant gear. Arc flash protective equipment, including FR coveralls, an FR hardhat, ear canal hearing protection, and an FR arc-rated face shield or flash hood with a minimum arc flash rating of 8, should be provided.

6. Prior to breaching the restricted approach boundaries, inspect your insulated gloves and put them on (do not use the gloves if they are ripped or damaged). Cover the gloves with leather outer gloves.

7. Perform the required electrical maintenance tasks in the pit.

8. Do not remove your gloves until you are finished working inside the restricted approach boundary.

9. Do not remove the arc flash protective gear until all energized conductors are covered by the CCR cabinet.

10. Exit the pit immediately upon finishing the tasks.
F. Ground Fault Detection Using the CCR

Purpose

In some cases when the situation is urgent, the constant current regulator (CCR) is used to locate single ground faults. This presents a hazard to employees in the vault and on the airfield who are trying to locate the ground faults visually. Because there are safer methods by which to locate ground faults, using the CCR to locate them should be avoided as much as possible. Ground faults should be located by less hazardous techniques such as via the automated Megger® test system or by using volt-ohm-milliammeters (VOM) or digital multimeters (DMM). If one of these tests indicates the presence of a ground, but the ground fault cannot be found by inspecting the circuit visually, the ground can be located by using the CCR and a test setup.

Qualifications and Number of Employees to be Involved:

1. Qualified electricians– a minimum of two in the vault - with specific training on this procedure.

2. Electricians on the airfield to observe specific sets of lights during the test

Hazards:

1) 5 kV shock hazard in the vault due to the CCR output being grounded (via a 45 Watt isolation transformer and light fixture). Electricians must stay away from the immediate vicinity of the grounded lamp setup.

2) 5 kV shock hazard in the field should electricians locate the open circuit and begin working on it before the CCR is de-energized from the vault.

Limits of Approach:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Limited Approach Boundary:</td>
<td>5’0”</td>
</tr>
<tr>
<td>Restricted Approach Boundary:</td>
<td>2’2”</td>
</tr>
<tr>
<td>Prohibited Approach Boundary:</td>
<td>0’7”</td>
</tr>
<tr>
<td>Flash Protection Boundary:</td>
<td>Not applicable (constant current at 6-20 amps – no significant bolted fault current)</td>
</tr>
</tbody>
</table>
Safe Work Practices:

1. Determine whether it is possible to locate ground faults using one of the safer methods employing a Megger®, volt-ohm-milliammeter (VOM), or digital multimeter (DMM). If not, proceed with the steps below.

2. A second, qualified electrician who is trained in emergency procedures is standing by in the vault during the test.

3. No one other than a qualified electrician is permitted within the limited approach boundary (5’). If an unqualified person needs to come within the limited approach boundary, he or she should be advised of the hazards and continuously escorted by a qualified person. At no time should the unqualified person be allowed within the restricted approach boundary (2’2”).

4. No un-insulated body parts are permitted past the restricted approach boundary (2’2”).

5. No un-insulated tools or materials (e.g. replacement parts) that are in contact with an un-insulated part of the electrician’s body are permitted within the restricted approach boundary (2’2”).

6. Class 1 voltage-rated gloves (for protection up to 7.5 kV) must be worn when inside the restricted approach boundary (2’2”). These insulating gloves should be covered with leather outer-gloves.

7. All tools must be insulated.

8. At no time should an electrician reach blindly into a can or other enclosure that may contain energized equipment.

9. No energized electrical work may be done without proper illumination.

10. No conductive jewelry or clothing may be worn

11. If working in confined or enclosed spaces such as manholes or vaults, ensure there are no other exposed energized conductors in the vicinity.

Personal Protective Equipment Needed

1) Non-melting/untreated natural fiber t-shirt (long sleeve)
2) Non-melting/untreated natural fiber long pants
3) Fire resistant (FR) safety glasses
**Insulating Tools and Equipment:** All tools should be insulated

**Special Precautionary Techniques**

1. An electrician will need to work on the airfield itself to detect grounds by observing whether or not lights are on or off. This electrician must not attempt to conduct repairs on the circuit without first placing the circuit in an electrically safe work condition. Refer to the procedures for Hot Re-Lamping and Re-Lamping with Circuits De-Energized above.

**Electrical Diagrams:** If available, a basic diagram depicting the lighting circuit being tested will assist with ground fault location.

**Equipment Details:** The lamp is typically a 200V bulb, but is powered via a lighting transformer whose primary can be 5 kV.

**Other Reference Documents or Materials:** Constant current regulator technical manual

**Steps to Take When Doing Re-Lamping of De-Energized Circuits without CCR Lockout**

1. Plan your work and work your plan. Expect the unexpected.

2. Determine whether it is possible to locate ground faults using one of the safer methods employing a Megger®, volt-ohm-milliammeter (VOM), or digital multimeter (DMM). If not, proceed with the steps below.

3. Obtain permission to use the energized CCR to locate ground faults.

4. There must be two qualified electricians in the vault during this procedure.

5. Before rigging the test setup, place the CCR in an electrically safe work condition. Typically, a 45 watt isolation transformer and light fixture are connected between one of the regulator outputs and ground.

6. Clear the lockout and stand well clear of the test setup. If the test lamp lights, there is at least one ground fault on the circuit.

7. With the regulator energized, electricians on the airfield can locate the ground fault by observing the pattern of lamps that are lit or not lit. This test may be done numerous times to locate multiple ground faults. The test setup should be switched from one CCR output lead to another to verify that multiple ground faults do not exist.

8. Once the ground faults are located in the field, place the CCR in an electrically safe work condition prior to repairing the grounded equipment.

9. Once the circuit is in an electrically safe work condition, repair the ground by checking the cable, connector kits, splices, etc.
When repairs are complete and field electricians are clear of the equipment, re-test the circuit using steps 3-8 above. Specific training should be provided for grounded output test used to locate ground faults. Electricians should be advised of the need to stay away from the grounded test setup in the vault, since the CCR may generate high voltages as it attempts to overcome the resistance of any high resistance faults.
F. Jumpering Circuits

**Purpose**

Airfield lighting must sometimes be re-aligned using jumpers. The task requires both knowledge of the specific airfield circuits being jumpered, as well as a familiarity with the hazards of series circuits to avoid incidents related to improper disconnection of a series lighting circuit.

**Qualifications and Number of Employees to be Involved:**

Qualified electricians only – a minimum of two whenever working with voltages greater than 600V - with specific training on this procedure.

**Hazards:**

1) 5 kV shock hazard from disconnecting the wrong airfield lighting cable
2) 5 kV shock hazard while working with splices and other non-standard connections
3) Shock and arc flash/blast hazards while working in vaults (vaults contain numerous and varied circuit types, including lighting and non-lighting circuits).
4) Confined space hazards
   a. Confined space hazards – Airfield spaces through which jumpering is done may need to be classified as *permit-required confined spaces*. A confined space is defined as follows:
      i. Is large enough and so configured that an employee can bodily enter and perform assigned work; and
      ii. Has limited or restricted means for entry or exit (for example, tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry.); and
      iii. Is not designed for continuous employee occupancy. (from OSHA 1910.146)

**Limits of Approach:**

- **Limited Approach Boundary:** 5'0" (may increase if circuit voltages encountered > 72.5 kV)
- **Restricted Approach Boundary:** 2'2" (may increase if other circuit voltages encountered > 15 kV)
- **Prohibited Approach Boundary:** 0'7" (may increase if other circuit voltages encountered > 15 kV)
- **Flash Protection Boundary:** Not applicable if only series circuits are encountered. If other non-lighting circuits exist in manholes, pits, or vaults, flash protection boundaries will be necessary. The voltage levels of the non-lighting circuits and the alignment of the space in which the jumpering is done will dictate the flash protection equipment required.
Safe Work Practices:

1. If spaces where the jumpering is to be done are classified as confined spaces, do not enter until the atmosphere in the space is tested clean. Refer to the DAA Confined Space Entry Program.

2. A second, qualified electrician who is trained in emergency procedures is standing by during all tasks.

3. Use only approved connector kits, splices, and glues.

4. No one other than a qualified electrician is permitted within the limited approach boundary (5’). If an unqualified person needs to come within the limited approach boundary, he or she should be advised of the hazards and continuously escorted by a qualified person. At no time should the unqualified person be allowed within the restricted approach boundary (2’2").

5. No un-insulated body parts are permitted past the restricted approach boundary (2’2").

6. No un-insulated tools or materials (e.g. replacement parts) that are in contact with an un-insulated part of the electrician’s body are permitted within the restricted approach boundary (2’2").

7. Class 1 voltage-rated gloves (for protection up to 7.5 kV) must be worn when inside the restricted approach boundary (2’2"). These insulating gloves should be covered with leather outer-gloves.

8. All tools must be insulated when working on or near energized parts. No un-insulated tools inside the restricted approach boundary.

9. At no time should an electrician reach blindly into a can or other enclosure that may contain energized equipment.

10. No energized electrical work may be done without proper illumination.

11. No conductive jewelry or clothing may be worn.

12. If working in confined or enclosed spaces such as manholes or vaults, ensure there are no other exposed energized conductors in the vicinity.
**Personal Protective Equipment Needed**

Depends on the flash hazards present in the manholes, vaults, and other spaces in which the jumpering is done. For example, if non-lighting cables carrying more than 1 kV must be handled, flash suits will be required. If any of the pits/manholes/vaults contain any exposed circuitry or bussing, flash protection will be required. At a minimum:

1) Non-melting/untreated natural fiber t-shirt (long sleeve)
2) Non-melting/untreated natural fiber long pants
3) Fire resistant (FR) safety glasses

**Insulating Tools and Equipment:** All tools should be insulated

**Special Precautionary Techniques**

1. Electrical: exposed energized conductors; high voltage cables; different types of electricity requiring different measuring devices (series circuits, parallel circuits, high-voltage circuits)
2. Confined space hazards (hazardous atmospheres, entrapment, engulfment)

**Electrical Diagrams:** As-built diagrams should be made available to field electricians performing the work.

**Equipment Details:** Use only approved connector kits and splices

**Other Reference Documents or Materials:** None

**Steps to Take When Jumpering Circuits**

1. Plan your work and work your plan. Expect the unexpected. Use as-built drawings to determine the circuits to be jumpered and the paths that will be taken. Obtain approved connector kits, splices, insulated tools, and safety equipment. If non-lighting circuits will be encountered, arc flash/arc blast protective equipment will be needed.

2. Place the circuits to be jumpered in an *electrically safe work condition*. There must be two qualified electricians working the tasks whenever working with voltages greater than 600V or when working with exposed energized conductors.

3. If entering any confined space, obtain a Confined Space Entry Permit (see the DAA Confined Space Entry Program).
   a. Calibrate the air testing equipment prior to dropping it into the pit
   b. Obtain air quality readings from the readouts on the sniffer. When acceptable, proceed into the space. If acceptable readings cannot be obtained, introduce ventilation until acceptable readings are obtained. Once acceptable air readings are obtained, enter the pit.
   c. The sniffer should continuously monitor the space and alarm if and when the air quality deteriorates. **EXIT THE PIT IMMEDIATELY UPON HEARING A SNIFFER ALARM OR IF YOU FEEL FAINT OR NAUSEOUS!**
d. Ensure that the rescue and buddy system procedures are in place

4. If any exposed conductors will be encountered during the jumpering work, arc flash/arc blast protective gear may be required. If working in pits, vaults, voids, or other tight enclosures, ensure that there are no other exposed conductors.

5. Using the proper testing equipment, verify that the circuits to be jumpered are dead (de-energized).

Leave any confined spaces immediately after completing the jumper
G. Continuity Testing of Series Lighting Circuits

Purpose

Continuity testing of airfield lighting circuits is done regularly. In all cases, the circuit is de-energized and locked out.

Qualifications and Number of Employees to be Involved:

1. Putting the circuit in an electrically safe work condition: Qualified electricians only
2. Other electricians may perform the actual continuity testing but must have received training on this procedure.

Hazards:

5 kV shock hazard should an electrician fail to de-energize the circuit prior to conducting a continuity test.

Limits of Approach:

Since this procedure is done with circuit in an electrically safe work condition, limits of approach are not applicable. Note, however, that if adjacent electrical hazards exist, limits of approach for those hazards must be calculated and adhered to

Protective Clothing and Equipment Required

Not needed if circuit is in an electrically safe work condition

Safe Work Practices:

1. Ensure that the test equipment is designed for and capable of testing the circuits being worked on
2. At no time should an electrician reach blindly into a can or other enclosure that may contain energized equipment.
3. If working in confined or enclosed spaces such as manholes or vaults, ensure there are no other exposed energized conductors in the vicinity.

Insulating Tools and Equipment: Not needed if circuit is in an electrically safe work condition

Special Precautionary Techniques: None
**Electrical Diagrams:** As-built diagrams should be made available to field electricians performing the work.

**Equipment Details:** None

**Other Reference Documents or Materials:** None

**Steps to Take When Doing Continuity Tests on Airfield Lighting Circuits**

1. Plan your work and work your plan. Expect the unexpected. Use as-built drawings to determine the circuits to be tested.

2. Place the circuits to be tested in an *electrically safe work condition*.

3. If entering any confined space, obtain a Confined Space Entry Permit (see the DAA Confined Space Entry Program).

4. If any exposed conductors will be encountered during the testing work, arc flash/arc blast protective gear may be required. If working in pits, vaults, voids, or other tight enclosures, ensure that there are no other exposed conductors.

5. Using the proper testing equipment, verify that the circuits to be test are dead (de-energized).

6. Perform the continuity testing in accordance with the test equipment manufacturer’s instructions.
H. Manual Meggering® of Series Lighting Circuits

Purpose

Manual Meggering® of airfield lighting circuits is done regularly. In all cases, the circuit is de-
ergized and locked out.

Qualifications and Number of Employees to be Involved:

1. Putting the circuit in an electrically safe work condition: Qualified electricians only
2. Other electricians may perform the actual Meggering® but must have received training
   on this procedure.

Hazards:

5 kV shock hazard should an electrician Megger® the circuit while energized

Limits of Approach:

Since this procedure is done with circuit in an electrically safe work condition, limits of approach
are not applicable. Note, however, that if adjacent electrical hazards exist, limits of approach
for those hazards must be calculated and adhered to

Protective Clothing and Equipment Required

Not needed if circuit is in an electrically safe work condition

Safe Work Practices:

1. Ensure that the test equipment is designed for and capable of testing the circuits being
   worked on
2. At no time should an electrician reach blindly into a can or other enclosure that may contain
   energized equipment.
3. If working in confined or enclosed spaces such as manholes or vaults, ensure there are no
   other exposed energized conductors in the vicinity.
**Insulating Tools and Equipment:** Not needed if circuit is in an *electrically safe work condition*

**Special Precautionary Techniques:** None

**Electrical Diagrams:** As-built diagrams should be made available to field electricians performing the work.

**Equipment Details:** None

**Other Reference Documents or Materials:** None

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**Steps to Take When Doing Manual Meggering® on Airfield Lighting Circuits**

1. Plan your work and work your plan. Expect the unexpected. Use as-built drawings to determine the circuits to be tested.

2. Place the circuits to be tested in an *electrically safe work condition*.

3. If entering any confined space, obtain a Confined Space Entry Permit (see the DAA Confined Space Entry Program).

4. If any exposed conductors will be encountered during the testing work, arc flash/arc blast protective gear may be required. If working in pits, vaults, voids, or other tight enclosures, ensure that there are no other exposed conductors.

5. Using the proper testing equipment, verify that the circuits to be test are dead (de-energized).

6. Perform the Meggering® in accordance with the test equipment manufacturer’s instructions.
I. **Output Voltage Measurements on CCR**

**Purpose**

Airfield lighting electricians sometimes need to take output voltage measurements on constant current regulators (CCR) to troubleshoot an overheating or erratically operating CCR or to determine why a CCR is not maintaining design output current. CCR’s develop high voltages that can cause severe injury and electrocution. Consequently, potential voltage transformers must be used to obtain voltage measurements.

**Qualifications and Number of Employees to be Involved:** Qualified electricians only - a minimum of two – trained in this procedure

**Hazards:**

1. High voltage electrical shock hazards from contact across the output terminals of CCR’s.
2. Arc flash and arc blast hazards if maintenance is performed with cabinet doors or panels removed

**Limits of Approach:**

<table>
<thead>
<tr>
<th>Limited Approach Boundary:</th>
<th>5'0”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restricted Approach Boundary:</td>
<td>2’2”</td>
</tr>
<tr>
<td>Prohibited Approach Boundary:</td>
<td>0'7”</td>
</tr>
<tr>
<td>Flash Protection Boundary:</td>
<td>Not applicable if cabinet doors remain closed and panels remain on, since only constant currents at 6-20 amps – no significant bolted fault current are expected for this task. If panel covers are off or CCR doors are open, the flash protection boundary should be established at four (4’) feet.</td>
</tr>
</tbody>
</table>

**Protective Clothing and Equipment Required**

Only the basic protective clothing in #1-3 below is needed if circuit is in an *electrically safe work condition* and observations are done outside the restricted approach boundary. **Note that if the CCR cabinet is open, however, electricians are exposed to arc flash and arc blast hazards.** Refer to the CCR Maintenance procedure earlier in this section if CCR cabinets are to remain open during the test procedure.

2) Non-melting/untreated natural fiber t-shirt (long sleeve)
3) Non-melting/untreated natural fiber long pants
4) Fire resistant (FR) safety glasses

**Safe Work Practices:**

1. Use a voltage measurement transformer recommended by the CCR manufacturer. Typically this is a transformer with a 40:1 ratio and a primary voltage rating of 4800 volts.
2. Never attempt to measure the voltage across the output terminals of a CCR without the load connected! If an open circuit exists, voltages as high as 10 kV can be reached before an open circuit shutdown occurs.

3. Use only true RMS current measurement equipment to verify whether or not a series circuit is dead (de-energized).

4. At no time should an electrician reach blindly into a can or other enclosure that may contain energized equipment.

5. If working in confined or enclosed spaces such as manholes or vaults, ensure there are no other exposed energized conductors in the vicinity.

**Insulating Tools and Equipment:** Voltage measurement equipment must be insulated. Other equipment need not be insulated if circuit is in an electrically safe work condition and the restricted approach boundary is not breached.

**Special Precautionary Techniques:** The CCR can reach dangerous voltages (up to 10 kV) before protective features operate. Ensure the CCR is in an electrically safe work condition prior to attaching the potential voltage measurement transformer. Use a transformer having a 40:1 ratio and a primary voltage rating of 4800 volts.

**Electrical Diagrams:** None

**Equipment Details:** Review the specific voltage measurement procedure in the CCR technical manual

**Other Reference Documents or Materials:** None
Steps to Take When Taking Output Voltage Measurements on a CCR

1. Plan your work and work your plan. Expect the unexpected. Use the technical manual for the specific CCR on which you are working, since many CCR’s are different.

2. Prior to starting the CCR output voltage measurement procedure, ensure that all lamps in the circuit supplied by the CCR are working (this is to ensure more accurate measurements of output voltage).

3. Place the CCR in an electrically safe work condition. This includes keeping the CCR cabinet doors closed and panels on. If cabinet doors are to remain open or cabinet panels are to remain off during the test, arc flash/arc blast protective clothing must be worn if approaching within 4’ of the CCR (see the CCR Maintenance procedure earlier in this section).

4. With the CCR in an electrically safe work condition, attach the output measurement transformer.

5. Re-energize the CCR and increase the brightness to the highest step.

6. Record the voltage measured and multiply it by the current associated with the brightness step of the CCR.
J. **Work at Heights from Bucket Truck**

**Purpose**

On occasion, electricians work from a bucket truck on series street lighting circuits around the airfield. Re-lamping airfield lights is typically done without the power supply (the constant current regulator (CCR)) locked out due to the infeasibility of such a lockout. It is infeasible because for most re-lamping tasks, electricians on the airfield would need to lock out the CCR in the vault and then drive long distances to the airfield to do the re-lamping. The electrician would then need to drive back to the vault, clear the lockout, and drive back to the lamp to ensure that it is working.

By definition, performing work on electrical circuits without a system lockout means that the circuit is NOT in an electrically safe work condition. As such, **significant hazards remain with this task.** Therefore, additional precautions must be taken to provide a level of protection equivalent to an electrically safe work condition. An electrician who does not maintain control of the circuit on which he works by placing his or her own lock on the CCR disconnect is placing himself at additional risk.

Note: Although it is rarely possible to do re-lamping tasks with the circuit in an electrically safe work condition (that is, with the CCR locked out by the electrician doing the re-lamping), it remains the preferred method of doing re-lamping tasks. When re-lamping is done with the circuit in an electrically safe work condition, this procedure need not be followed. Only the procedure to place the circuit in an electrically safe work condition need be followed.

**Qualifications and Number of Employees to be Involved:** Qualified electricians only - a minimum of two – trained in this procedure

**Hazards:**

1) Fall-from-heights while working from bucket
2) 5 kV electrical shock hazard from series circuit being worked on
3) Shock hazard from secondary side (lamps)

**Limits of Approach:**

<table>
<thead>
<tr>
<th>Boundary Type</th>
<th>Limit</th>
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<tbody>
<tr>
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</tr>
<tr>
<td>Flash Protection Boundary</td>
<td>Not applicable (constant current at 6-20 amps – no significant bolted fault current)</td>
</tr>
</tbody>
</table>

**Personal Protective Equipment Needed**
1. Class 1 voltage-rated gloves (for protection up to 7.5 kV) with leather protective covers;
2. Fire-resistant safety glasses
3. Non-melting/untreated natural fiber t-shirt (long sleeve)
4. Non-melting/untreated natural fiber long pants

**Safe Work Practices:**

1. Refer to the DAA Fall Protection Program prior to commencing work.

2. Fall protection equipment must be worn and attached to the anchor inside the bucket at all times before raising the bucket, even if being raised to a height less than six (6’) feet. This is to prevent you from being thrown from the bucket.

3. Use a full body harness only. Do not use a back belt – serious injuries can result if you fall and are arrested by a back belt.

4. If possible, all work from the bucket truck should be done with circuits in an *electrically safe work condition*.

5. Use only true RMS current measurement equipment to verify whether or not a series circuit is dead (de-energized).

6. At no time should an electrician reach blindly into a can or other enclosure that may contain energized equipment.

7. Because you will not have direct control over the power source of the lighting circuit on which you will be working, you must complete this task as quickly and safely as possible. Planning is essential.

8. Establish radio contact with the person overseeing the CCR in the vault. A headset or other hands-free device should be used. Radio communications should be constant.

9. A second, qualified electrician who is trained in emergency procedures is standing by during the re-lamping task.

10. No one other than a qualified electrician is permitted within the *limited approach boundary* (5’). If an unqualified person needs to come within the *limited approach boundary*, he or she should be advised of the hazards and continuously escorted by a qualified person. **At no time** should the unqualified person be allowed within the *restricted approach boundary* (2’2”).

11. No un-insulated body parts are permitted past the *restricted approach boundary* (2’2”).

12. No un-insulated tools or materials (e.g. replacement parts) that are in contact with an un-insulated part of the electrician’s body are permitted within the *restricted approach boundary* (2’2”).

13. Class 1 voltage-rated gloves (for protection up to 7.5 kV) must be worn when inside the *restricted approach boundary* (2’2”). These insulating gloves should be covered with leather outer-gloves.
14. The secondary side of the lamp should be tested to verify that a primary-to-secondary short does not exist. A VOM or DMM capable of testing up to the maximum expected voltage must be used.

15. All tools must be insulated.

16. At no time should an electrician reach blindly into a can or other enclosure that may contain energized equipment.

17. No energized electrical work may be done without proper illumination.

18. No conductive jewelry or clothing may be worn

19. If working in confined or enclosed spaces such as manholes or vaults, ensure there are no other exposed energized conductors in the vicinity.

**Insulating Tools and Equipment:** Required

**Special Precautionary Techniques:** Refer to the DAA Fall Protection Program. Fall protection equipment must be worn at all times, properly attached to the anchor in the bucket.

**Electrical Diagrams:** If available, use as-built drawings to confirm which lighting circuits are supplied by a specific CCR

**Equipment Details:** None

**Other Reference Documents or Materials:** None

**Steps to Take When Performing Lamp Replacement from the Bucket Truck**

1. Plan your work and work your plan. Expect the unexpected. Because you will not have direct control over the power source of the lighting circuit on which you will be working, you must complete this task as quickly and safely as possible. Planning is essential.

2. If possible, place the CCR powering the lighting circuit in an electrically safe work condition. If this is not possible, establish radio contact with the person overseeing the CCR in the vault or tower. A headset or other hands-free device should be used. Radio communications should be constant. A second, qualified electrician who is trained in emergency procedures is standing by during the re-lamping task.

3. Inspect your fall protection equipment. Put it on and attach it to the anchor in the bucket truck only if it is free of defects.

4. Prior to breaching the restricted approach boundary (2’2”), inspect your Class 1 insulated gloves and put them on (do not use the gloves if they are ripped or damaged). Cover the gloves with leather outer gloves.
5. Test the circuit for the presence of current using a true RMS ammeter. If no current is detected, proceed with the re-lamping task. Be aware that because the CCR is not locked out, power could inadvertently be turned on at any time. Test the circuit for the presence of current each time you return to the task after walking away from it.

6. Repair the lamp, remaining aware of the possibility of the high voltage hazards associated with primary to secondary shorts.

7. When repair is complete, step outside the restricted approach boundary and ask the electrician in the vault to energize the circuit. Visually confirm that the lamp is lit.

8. Ask the vault to de-energize the CCR

9. Do not remove your gloves until you are finished working inside the restricted approach boundary.

10. When outside the restricted approach boundary, inform the vault that it is safe to re-energize the circuit.

11. Lower the bucket to the ground before removing fall protection harness.
K. **Switching Leads from One CCR to Another**

**Purpose**

This task is done rarely, but there are instances where the leads from one constant current regulator (CCR) are switched to a backup CCR or to an adjacent CCR. The task is easily and safely accomplished when both CCR’s are placed in an *electrically safe work condition*, but is hazardous if done improperly or if cable leads are improperly handled or identified.

**Qualifications and Number of Employees to be Involved:** Qualified electricians only - a minimum of two – trained in this procedure

**Hazards:**

1. Up to 10 kV shock hazard if leads are disconnected while the CCR is still energized (open circuit protective devices often do not function until voltage levels reach 10 kV)
2. 5 kV shock hazard from handling groups of cables that are *not* de-energized (such as those in the patch panel or behind the CCR’s)

**Limits of Approach:**

- Limited Approach Boundary: 5’0”
- Restricted Approach Boundary: 2’2”
- Prohibited Approach Boundary: 0’7”
- Flash Protection Boundary: Not applicable (constant current at 6-20 amps – no significant bolted fault current)

**Personal Protective Equipment Needed**

2. Class 1 voltage-rated gloves with leather covers
3. Fire-resistant safety glasses
4. Non-melting/untreated natural fiber t-shirt (long sleeve)
5. Non-melting/untreated natural fiber long pants

**Safe Work Practices:**

1. Place the CCR in an *electrically safe work condition* prior to switching leads
2. A second, qualified electrician who is trained in emergency procedures is standing by during the re-lamping task.
3. Class 1 voltage-rated gloves (for protection up to 7.5 kV) must be worn due to the nature of the task. Numerous cables must be handled behind the regulator and inside the patch panel when performing this task.
4. No one other than a qualified electrician is permitted within the limited approach boundary (5’). If an unqualified person needs to come within the limited approach boundary, he or she should be advised of the hazards and continuously escorted by a qualified person. At no time should the unqualified person be allowed within the restricted approach boundary (2’2”).

5. No un-insulated body parts are permitted past the restricted approach boundary (2’2”).

6. No un-insulated tools or materials (e.g. replacement parts) that are in contact with an un-insulated part of the electrician’s body are permitted within the restricted approach boundary (2’2”).

7. At no time should an electrician reach blindly into a can or other enclosure that may contain energized equipment.

**Insulating Tools and Equipment:** Not required if the CCR is in an electrically safe work condition

**Special Precautionary Techniques:**
1. De-energize the CCR before disconnecting the lead
2. Wear Class 1 voltage-rated gloves due to the potentially-energized cables that must be handled in patch panels and behind regulators

**Electrical Diagrams:** none

**Equipment Details:** None

**Other Reference Documents or Materials:** Refer to the cable tags on leads and other information provided in patch panels or other sources of cable path information.
Steps to Take When Switching the Leads on a CCR

1. Plan your work and work your plan. Expect the unexpected.
2. Place **BOTH** CCR’s in an *electrically safe work condition*.
3. Don voltage-rated gloves prior to handling any cables.
4. Using an RMS clamp-on ammeter, verify that the circuit is dead before removing/switching leads.
5. Using cable tags, diagrams inside patch panels, and other sources of information, ensure that the leads to be switched are correct.
6. Switch the leads.
7. Re-energize the CCR’s.
SECTION XI: PROGRAM ADMINISTRATION

- This program will be reviewed with SRE employees annually. At that time the program will be reviewed and changed to reflect changes in procedures due to safety or updated equipment.
- PPE inspection will be conducted in July annually as part of the overall review of the program. This does not preclude the pre-use inspections that must be conducted prior to using the PPE.
- Policies
  - Standards to use as references
  - Abandoned cables and conduit – marking and other decommissioning procedures
  - Excavation policy
  - Enforcement and discipline- refer to appendix C of this program
SECTION XII: TRAINING

- Safety Training Requirements
  o Must include all hazards encountered, what types of injuries can occur, and how they affect the body
  o May be done via classroom, on-the-job training, or both

- Training protocol for qualified electricians
  o Must include general and task-specific safe work practices
  o Must include training on specific equipment and tasks
  o Must be trained in the hazards and protective equipment related to shock hazards and arc flash and arc blast hazards.
  o Must be trained on how to determine nominal voltage
  o Must be trained on how to test a circuit dead
  o Must be trained how to recognize energized conductors
  o Must be trained how to establish and work within approach boundaries
  o Must include emergency procedures, including how to release someone from a live circuit as well as first aid/CPR

- Lockout Training
  o Required for all personnel who are directly or indirectly exposed to the hazards of an improperly executed circuit lockout
  
  o Qualified electricians must be trained on:
    ▪ The contents of this program (when implemented, upon hire, or when transferred into the group).
    ▪ The specific lockout procedures for each piece of equipment requiring its own lockout procedure (annually)

  o Other persons exposed but not directly affected by a lockout must be trained on this program when the program is implemented, upon hire, or when transferred into the group. **Tower personnel should be trained on the basic components of the program.**

- Contractors must be trained to an equivalent or better level

SECTION XIII: BUDGET

- startup costs
  o insulated tools cost
  o gloves cost
  o other protective equipment costs

- maintenance costs
  o insulated tools cost
  o gloves cost
  o other protective equipment costs
SECTION XIV: AUDITS AND RECORDKEEPING

- **LOTO annual observations** will be conducted in July. Each employee whose duties require that they lock out equipment will be observed and recorded using the form in appendix A of this program. LOTO observation records will be maintained by the ASM in a separate file.
- **Airfield bulb training records** will be maintained in the SRE training file by the ASM.