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ELECTRICAL SAFETY PROGRAM

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ELECTRICAL SAFETY PROGRAM
REVIEW SUMMARY

Revision(s)	*By*	*Affiliation*	*Date*	*Changes*

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1.0 INTRODUCTION

All matter is made up of atoms and atoms are made up of smaller particles. When electrons move from one atom to another atom, a current of electricity is created.

The purpose of this Electrical Safety Program is to define the electrical safety requirements that are necessary for the practical safeguards of employees while working with electricity at Simmons College (Simmons). This program is for employees working on or near electrical circuits of up to 600 volts (V). It does not include **high voltage (> 600 V) work.** For high voltage work, please contact the Director of EH&S or designee for the specific requirements.

This program complies with the U.S. Occupational Safety and Health Administration's (OSHA) 29 Code of Federal Regulations 1910 Subpart S – Electrical, the National Fire Protection Association (NFPA) 70 – *National Electrical Code* dated 2014 (NEC), NFPA 70E – *Standard for Electrical Safety in the Workplace* dated 2015 (NFPA 70E), and the Massachusetts Electrical Code, 527 Code of Massachusetts Regulations 12.00 of the Board of Fire Prevention Regulations. Appendix A provides the definitions associated with this program except for Qualified and Unqualified Employee, which are defined in Section 2.1.

Depending on the installation year of the electrical work, the requirements vary. OSHA provides an Electrical Safety eTool outlining the requirements depending on the year. In addition, electrical wiring and equipment must comply with regulations and standards referenced above.

2.0 ROLES AND REPSONSIBILITIES

Employees are responsible for adhering to the electrical safety policies and procedures outlined in this manual. Below outlines specific responsibilities for certain individuals within Simmons.

2.1 Employees

Employees performing work on energized equipment shall follow the requirements of this procedure, wear the appropriate personal protective equipment (PPE), and bring forward any electrically hazardous or unsafe condition to the attention of their supervisor and/or the Director of Environmental Health and Safety (EH&S). In addition, employees will inspect equipment for irregularities prior to using it.

Only qualified employees with the proper PPE are allowed to cross the Flash Protection Boundary and the Limited Approach Boundary when electrical equipment is open and energized parts are exposed as part of the work. In addition, it is the responsibility of the qualified employee to prevent any unqualified or qualified employee without proper PPE from entering the work area. Below are the definitions for qualified employee and unqualified employee. Appendix B provides a list of qualified employees.

- Qualified employee: A qualified employee shall be trained and knowledgeable of the construction and operation of equipment or a specific work method and be trained to recognize and avoid the electrical hazards that might be present with respect to that equipment or work method.
    a) Such persons shall also be familiar with the proper use of the special precautionary techniques, personal protective equipment, including arc-flash, insulating and shielding

materials, and insulated tools and test equipment. A person can be considered qualified with respect to certain equipment and methods but still are an unqualified for others.

b) An employee who is undergoing on-the-job training and who, in the course of such training, has demonstrated an ability to perform duties safely at his or her level of training and who is under the direct supervision of a qualified person shall be considered to be a qualified person for the performance of those duties.

c) Such persons permitted to work within the Limited Approach Boundary of exposed live parts operating at 50 volts or more shall, at a minimum, be additionally trained in all of the following:

   1. The skills and techniques necessary to distinguish exposed energized parts from other parts of electrical equipment.
   2. The skills and techniques necessary to determine the nominal voltage of exposed live parts.
   3. The approach distances specified in Approach Boundaries Table and the corresponding voltages to which the qualified person will be exposed.
   4. The decision-making process necessary to determine the degree and extent of the hazard and the personal protective equipment and job planning necessary to perform the task safely.

- Unqualified employee: An employee who has not been trained and is not authorized to perform electrical work.

2.2 Department Directors, Managers, and Supervisors

Department Directors, Managers, and Supervisors will ensure that their employees have been trained in the details of this procedure. When hazardous or unsafe conditions are brought forward by the employees, the supervisor will address these deficiencies and inform the Director of EH&S or Director of Buildings and Grounds about the condition and the area for improvement for correction. If the supervisor is unable to address the deficiency then (s)he will contact the Director of EH&S for assistance.

In addition, (s)he will:

- Verify that each employee is complying with these electrical safety work practices at least annually. In addition, (s)he must ensure that each employee understands what specific tasks the employee is qualified to perform.
- Identify employees, who will be qualified employees, as defined in Section 2.1.
- Ensure that electrical safety inspections are conducted on an annual basis, at a minimum. See Section 8.0 for additional information.
- Provide the appropriate PPE for employees. Refer to Section 7.0 for details.
- Ensure that new electrical equipment and components comply with codes and regulations.
- Implement updates to the codes and regulations regarding electrical safety and lockout/tag out.
- Ensure employees or contractors obtain electrical permit when applicable.
- Maintain the completed Energized Electrical Work Permits for their departments. See Section 9.0 for details.

2.3 Director of Environmental Health and Safety

The Director of Environmental Health and Safety (EH&S) will conduct the activities. (S)he may obtain help from a contractor, if needed.

- Periodically audit the program to ensure the procedures are being followed;
- Provide technical assistance as needed for the development of nonstandard procedures;
- Ensure electrical safety policies are reviewed at least annually;
- Periodically audit and review employee's work practices to ensure safety related requirements are being followed; and
- Conduct or coordinate Electrical Safety training.

2.4 Talent and Human Capital Strategy and Public Safety

Talent and Human Capital Strategy (THCS), which is Simmons' Human Resource Department, and Public Safety will assist with emergencies. In addition, THCS will maintain training records.

3.0 TYPES OF ELECTRICITY

There are two types of electricity: Static Electricity and Current Electricity. Static Electricity is made by rubbing together two or more objects and making friction while current electricity is the flow of electric charge across an electrical field.

3.1 Static Electricity

Static electricity is when electrical charges build up on the surface of a material. It is usually caused by rubbing materials together. The result of a build-up of static electricity is that objects may be attracted to each other or may even cause a spark to jump from one to the other.

3.2 Current Electricity

Current is the rate of flow of electrons. It is produced by moving electrons and it is measured in amperes (amps). Unlike static electricity, current electricity must flow through a conductor, usually copper wire. With electricity, current is a measure of the amount of energy transferred over a period of time. That energy is called a flow of electrons. One of the results of current is the heating of the conductor.

There are different sources of current electricity including the chemical reactions taking place in a battery. The most common source is the generator. A simple generator produces electricity when a coil of copper turns inside a magnetic field. In a power plant, electromagnets spinning inside many coils of copper wire generate vast quantities of current electricity.

There are two main kinds of electric current: Direct (DC) and Alternating (AC). The difference between AC and DC lies in the direction in which the electrons flow. In DC, the electrons flow steadily in a single direction, or "forward." In AC, electrons keep switching directions, sometimes going "forward" and then going "backward." Alternating current is the best way to transmit electricity over large distances. Table 1 provides a comparison chart for these currents.

Table 1 – Electrical Current Comparison Chart

Descriptive	Alternating Current	Direct Current
Types	Sinusoidal, Trapezoidal, Triangular, Square	Pure and pulsating
Amount of energy that can be carried	Safe to transfer over longer city distances and can provide more power.	Voltage of DC cannot travel very far until it begins to lose energy.
Cause of the direction of flow of electrons	Rotating magnet along the wire.	Steady magnetism along the wire.
Frequency	The frequency of alternating current is 50Hz or 60Hz depending upon the country.	The frequency of direct current is zero.
Direction	It reverses its direction while flowing in a circuit.	It flows in one direction in the circuit.
Current	It is the current of magnitude varying with time	It is the current of constant magnitude.
Flow of Electrons	Electrons keep switching directions - forward and backward.	Electrons move steadily in one direction or 'forward'.
Obtained from	AC Generator and mains	Cell or Battery
Passive Parameters	Impedance	Resistance only
Power Factor	Lies between 0 & 1	Always 1

4.0 RISK ASSESSMENT

Each of Simmons' facilities, regardless of their size or function, shall have an electrical arc flash risk assessment conducted by a qualified person. The arc flash risk assessment shall be updated whenever significant changes are made to the processes or facility. The risk assessment will include proper identification and labeling of the PPE categories of all of our electrical enclosures.

For those instances with typical work on 480 VAC circuits and lower, NFPA 70E (2015) provides for conditional relief from some of the PPE requirements via the implementation of a Task-Based PPE Risk Assessment. Based on the results of this assessment, as performed by a qualified person, it can result in the avoidance and or elimination of various elements of the PPE requirements for specific tasks.

5.0 HAZARDS

Electricity is a serious work place hazard, capable of causing both health hazards (shocks, burns) as well as physical hazards (fires and explosions). In addition, arc flash will be discussed in this section.

5.1 Health Hazards

In 2014, there were 156 cases of employees being exposed to electricity.[1] There are four main types of injuries: electrocution, electric shock, burns, and falls. Injuries can happen in various ways. Below are some examples on how an injury may occur.

- Direct contact with exposed energized conductors or circuit parts. When electrical current travels through our bodies, it can interfere with the normal electrical signals between the brain and our muscles.

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[1] Source: NATIONAL CENSUS OF FATAL OCCUPATIONAL INJURIES IN 2014 (http://www.bls.gov/news.release/pdf/cfoi.pdf), viewed January 25, 2016.

- When the electricity arcs (jumps, or "arcs") from an exposed energized conductor or circuit part (e.g., overhead power lines) through a gas (such as air) to a person who is grounded (that would provide an alternative route to the ground for the electrical current).
- Thermal burns including burns from heat generated by an electric arc, and flame burns from materials that catch on fire from heating or ignition by electrical currents or an electric arc flash. Contact burns from being shocked can burn internal tissues while leaving only very small injuries on the outside of the skin.
- Thermal burns from the heat radiated from an electric arc flash. Ultraviolet (UV) and infrared (IR) light emitted from the arc flash can also cause damage to the eyes.
- An arc blast can include a potential pressure wave released from an arc flash. This wave can cause physical injuries, collapse your lungs, or create noise that can damage hearing.

5.1.1 Electrocution/Electrical Shock

The human body will conduct electricity. If direct body contact is made with an electrically energized part while similar contact is made simultaneously with another conductive surface that is maintained at a different electrical potential, a current will flow, entering the body at our contact point, traversing the body, and then exiting at the other contact point, usually the ground.

An electric shock can result in anything from a slight tingling sensation to immediate cardiac arrest. The severity depends on the following:

- the amount of current flowing through the body,
- the current's path through the body,
- the length of time the body remains in the circuit, and
- the current's frequency.

Table 2 provides the affect on the person when exposed to current. Current not voltage causes electrical shock.

Table 2 – Current's Affect on Person

Current in milliamperes (mA)	Affect on Person
0.5 – 3	Tingling sensations
3 – 10	Muscle contractions and pain
10 – 40	"Can't let go!" – Onset of sustained muscular contraction
30 – 75	Respiratory paralysis
100 – 200	Ventricular fibrillation
200 – 500	Heart clamps tight
1,500+	Tissues and organs start to burn, Possible death

Static electricity also can cause a shock, though in a different way and generally not as potentially severe as the type of shock described previously. Static electricity can build up on the surface of an object and, under the right conditions, can discharge to a person, causing a shock. The most familiar example of this is when a person reaches for a door knob or other metal object on a cold, relatively dry day and receives a shock.

5.1.2 Burns

Below are the three types of burns. In some circumstances, all three types of burns may be produced simultaneously.

1. Electrical burns are the result of the electrical current flowing in the tissues, and may be either skin deep or may affect deeper layers or both. Tissue damage is caused by the heat generated from the current flow; if the energy delivered by the electric shock is high, the body cannot dissipate the heat, and the tissue is burned. Typically, such electrical burns are slow to heal.
2. Arc burns are the result of high temperatures produced by electric arcs or by explosions close to the body.
3. Thermal contact burns are those normally experienced from the skin contacting hot surfaces of overheated electric conductors, conduits, or other energized equipment.

5.1.3 Falls

Muscle contractions, or a startle reaction, can cause a person to fall from a ladder, scaffold or aerial bucket. The fall can cause serious injuries or even death.

5.2 Physical Hazards

An arc fault is an unintended arc created by current flowing through an unplanned path. Arcing creates high intensity heating at the point of the arc resulting in burning particles that may easily ignite surrounding material, such as wood framing or insulation. The temperatures of these arcs can exceed 10,000 degrees Fahrenheit (°F). In addition, fires can also be created by overheating equipment or by conductors carrying too much current. In atmospheres that contain explosive gases or vapors or combustible dusts, even low-energy arcs can cause violent explosions.

Static electricity also can discharge to an object with much more serious consequences, as when friction causes a high level of static electricity to build up at a specific spot on an object. This can happen simply through handling plastic pipes and materials or during normal operation of rubberized drive or machine belts found in many worksites. In these cases, for example, static electricity can potentially discharge when sufficient amounts of flammable or combustible substances are located nearby and cause an explosion. Grounding or other measures may be necessary to prevent this static electricity buildup and the results. Refer to Section 6.0 for details.

5.3 Arc Flash

An arc flash is the light and heat produced from an electric arc supplied with sufficient electrical energy to cause substantial damage, harm, fire, or injury. Electrical arcs experience negative incremental resistance, which causes the electrical resistance to decrease as the arc temperature increases. Therefore, as the arc develops and gets hotter the resistance drops, drawing more and more current (runaway) until some part of the system melts, trips, or evaporates, providing enough distance to break the circuit and extinguish the arc. Electrical arcs, when well controlled and fed by limited energy, produce very bright light, and are used in arc lamps (enclosed, or with open electrodes), for welding, plasma cutting, and other industrial applications. Welding arcs can easily turn steel into a liquid with an average of only 24 DC volts. When an uncontrolled arc forms at high voltages, and especially where large supply-wires or high-amperage conductors are used, arc flashes can produce deafening noises, supersonic concussive-forces, super-heated shrapnel, high temperatures, and high-energy radiation capable of vaporizing nearby materials.

Arc flash temperatures can reach or exceed 35,000 °F at the arc terminals. The massive energy released in the fault rapidly vaporizes the metal conductors involved, blasting molten metal and expanding plasma outward with extraordinary force. A typical arc flash incident can be inconsequential but could conceivably easily produce a more severe explosion.

In addition to the explosive blast, called the arc blast of such a fault, destruction also arises from the intense radiant heat produced by the arc. The metal plasma arc produces tremendous amounts of light energy from IR to UV. Surfaces of nearby objects, including people, absorb this energy and are instantly heated to vaporizing temperatures. The effects of this can be seen on adjacent walls and equipment and may result in thermal burns.

6.0 CONTROLS

Electrical accidents result from one of the following three factors:

1. Unsafe equipment or installation
2. Unsafe environment
3. Unsafe work practices

The following controls are ways to prevent these accidents:

- Insulation
- Guarding
- Grounding
- Circuit Protection
- Safe Work Practices
- Labeling
- Permits
- Personal Protective Equipment (PPE), which is presented in Section 7.0.

6.1 Insulation

Insulators such as glass, mica, rubber, or plastic used to coat metals and other conductors help stop or reduce the flow of electrical current. This helps prevent shock, fires, and short circuits. To be effective, the insulation must be suitable for the voltage used and conditions such as temperature and other environmental factors like moisture, oil, gasoline, corrosive fumes, or other substances that could cause the insulator to fail.

Insulation on conductors is often color coded. Insulated equipment grounding conductors usually are either solid green or green with yellow stripes. Insulation covering grounded conductors is generally white or gray. Ungrounded conductors, or "hot wires," often are black or red, although they may be any color other than green, white, or gray.

Before connecting electrical equipment to a power source, it's a good idea to check the insulation for any exposed wires for possible defects. Insulation covering flexible cords such as extension cords is particularly vulnerable to damage.

6.2 Guarding

Guarding involves locating or enclosing electric equipment to make sure employees don't accidentally come into contact with its live parts. Effective guarding requires equipment with exposed parts operating at 50 V or more to be placed where it is accessible only to authorized employees qualified to work with it. Recommended locations are a room, vault, or similar enclosure; a balcony, gallery, or elevated platform; or a site elevated 8 feet (2.44 meters) or more above the floor. Sturdy, permanent screens also can serve as effective guards.

6.3 Grounding

Grounding is the process of *removing* the excess charge on an object by means of the transfer of electrons between it and another object of substantial size. When a charged object is grounded, the excess charge is balanced by the transfer of electrons between the charged object and a ground. A ground is simply an object that serves as a seemingly infinite reservoir of electrons; the ground is capable of transferring electrons to or receiving electrons from a charged object in order to neutralize that object.

There are two types of grounding:

- System or Service Ground: In this type of ground, a wire called "the neutral conductor" is grounded at the transformer, and again at the service entrance to the building. This is primarily designed to protect machines, tools, and insulation against damage.
- Equipment Ground: This is intended to offer enhanced protection to the employees themselves. If a malfunction causes the metal frame of a tool to become energized, the equipment ground provides another path for the current to flow through the tool to the ground.

There is one disadvantage to grounding: a break in the grounding system may occur without the user's knowledge.

6.4 Circuit Protection

Circuit protection devices limit or stop the flow of current automatically in the event of a ground fault, overload, or short circuit in the wiring system. Well-known examples of these devices are fuses, circuit breakers, ground-fault circuit interrupters, and arc-fault circuit interrupters.

6.4.1 Fuse and Circuit Breakers

Fuses and circuit breakers open or break the circuit automatically when too much current flows through them. When that happens, fuses melt and circuit breakers trip the circuit open. Fuses and circuit breakers are designed to protect conductors and equipment. They prevent wires and other components from overheating and open the circuit when there is a risk of a ground fault. Figure 1 demonstrates the difference between these two devices.

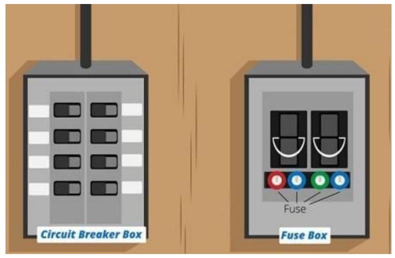

Figure 1 – Circuit Breaker and Fuse Boxes

6.4.2 Ground-fault Circuit Interrupters

Using a ground-fault circuit interrupter (<u>GFCI</u>) is one way of overcoming grounding deficiencies. It is used in wet locations, construction sites, and other high-risk areas. A GFCI is a fast-acting circuit breaker designed to shut off electric power in the event of a ground-fault within as little as 1/40 of a second. It works by comparing the amount of current *going to* and *returning from* equipment along the circuit conductors. When the amount *going* differs from the amount *returning* by approximately 5 mA, the GFCI interrupts the current. Figure 2 demonstrate typical GFCIs.

Receptacle **Portable Type** **Cord-connect Type**

Figure 2 – Types of GFCIs

6.4.3 Arc-fault Circuit Interrupters

Arc Fault Circuit Interrupters (AFCIs) are required by the NEC for certain electrical circuits. An AFCI is a product that is designed to detect a wide range of arcing electrical faults to help reduce the electrical system from being an ignition source of a fire. Conventional over current protective devices do not detect low level hazardous arcing currents that have the potential to initiate electrical fires. The objective is to protect the circuit in a manner that will reduce its chances of being a source of an electrical fire.

6.5 Safe Work Practices

A majority of electrical accidents are preventable by following safe work practices. The sections below outline the safe work practices based on the equipment or activity except for Lockout/Tag Out and Hot Work Permits, which are provided in separate documents.

6.5.1 Portable Electrical Equipment and Extension Cords

The following requirements apply to the use of cord-and-plug-connected equipment and flexible cord sets (extension cords):

- Extension cords may only be used to provide temporary power (no more than one month).

- Portable cord and plug connected equipment and extension cords must be visually inspected before use on any shift for external defects such as loose parts, deformed and missing pins, or damage to outer jacket or insulation, and for possible internal damage such as pinched or crushed outer jacket. Any defective cord or cord-and-plug-connected equipment must be removed from service and no person may use it until it is repaired and tested to ensure it is safe for use.
- Extension cords must be of the three-wire type. Extension cords and flexible cords must be designed for hard or extra hard usage (for example, types S, ST, and SO). The rating or approval must be visible and are required to be indelibly marked approximately every foot along the length of the cord.
- Job-made extension cords are forbidden.
- Personnel performing work on renovation or construction sites using extension cords or where work is performed in damp or wet locations must be provided, and must use, a GFCI.
- Portable equipment must be handled in a manner that will not cause damage. Flexible electric cords connected to equipment may not be used for raising or lowering the equipment.
- Extension cords must be protected from damage. Sharp corners and projections must be avoided. Flexible cords may not be run through windows or doors unless protected from damage, and then only on a temporary basis. Flexible cords may not be run above ceilings or inside or through walls, ceilings or floors, and may not be fastened with staples or otherwise hung in such a fashion as to damage the outer jacket or insulation.
- Cords must be covered by a cord protector or tape when they extend into a walkway or other path of travel to avoid creating a trip hazard.
- Extension cords used with grounding type equipment must contain an equipment-grounding conductor (i.e., the cord must accept a three-prong, or grounded, plug).
- Attachment plugs and receptacles may not be connected or altered in any way that would interrupt the continuity of the equipment grounding conductor. Additionally, these devices may not be altered to allow the grounding pole to be inserted into current connector slots. Clipping the grounding prong from an electrical plug is prohibited.
- Flexible cords may only be plugged into grounded receptacles. The continuity of the ground in a two-prong outlet must be verified before use. It is recommended that the receptacle be replaced with a three-prong outlet. Adapters that interrupt the continuity of the equipment grounding connection may not be used.
- All portable electric equipment and flexible cords used in highly conductive work locations, such as those with water or other conductive liquids, or in places where employees are likely to contact water or conductive liquids, must be approved for those locations.
- Employee's hands must be dry when plugging and unplugging flexible cords and cord and plug connected equipment if energized equipment is involved.
- If the connection could provide a conducting path to employees' hands (for example, if a cord connector is wet from being immersed in water), the energized plug and receptacle connections must be handled only with insulating protective equipment.
- Locking type connectors must be properly locked into the connector.
- Lamps for general illumination must be protected from breakage, and metal shell sockets must be grounded.
- Temporary lights must not be suspended by their cords unless they have been designed for this purpose.

- Extension cords are considered to be temporary wiring, and must also comply with the Section 6.5.2, Requirements for Temporary Wiring, in this program.

6.5.2 Requirements for Temporary Wiring

Temporary electrical power and lighting installations 600 V or less, including flexible cords, cables and extension cords, may only be used during and for renovation, maintenance, repair, or experimental work. The duration for temporary wiring used for decorative lighting for special events and similar purposes may not exceed 90 days. The following additional requirements apply:

- Ground-fault protection (e.g., GFCI) must be provided on all temporary-wiring circuits, including extension cords, used on construction sites.
- In general, all equipment and tools connected by cord and plug must be grounded. Listed or labeled double insulated tools and appliances need not be grounded.
- Feeders must originate in an approved distribution center, such as a panel board, that is rated for the voltages and currents the system is expected to carry.
- Branch circuits must originate in an approved power outlet or panel board.
- Neither bare conductors nor earth returns may be used for the wiring of any temporary circuit.
- Receptacles must be of the grounding type. Unless installed in a complete metallic raceway, each branch circuit must contain a separate equipment-grounding conductor, and all receptacles must be electrically connected to the grounding conductor.
- Flexible cords and cables must be of an approved type and suitable for the location and intended use. They may only be used for pendants, wiring of fixtures, connection of portable lamps or appliances, elevators, hoists, connection of stationary equipment where frequently interchanged, prevention of transmission of noise or vibration, data processing cables, or where needed to permit maintenance or repair. They may not be used as a substitute for the fixed wiring, where run through holes in walls, ceilings or floors, where run through doorways, windows or similar openings, where attached to building surfaces, or where concealed behind building walls, ceilings or floors.
- Suitable disconnecting switches or plug connects must be installed to permit the disconnection of all ungrounded conductors of each temporary circuit.
- Lamps for general illumination must be protected from accidental contact or damage, either by elevating the fixture or by providing a suitable guard. Hand lamps supplied by flexible cord must be equipped with a handle of molded composition or other approved material and must be equipped with a substantial bulb guard.
- Flexible cords and cables must be protected from accidental damage. Sharp corners and projections are to be avoided. Flexible cords and cables must be protected from damage when they pass through doorways or other pinch points.

6.5.3 Wet or Damp Locations

Work in *wet* or *damp* work *locations* (i.e., areas surrounded or near water or other liquids) should not be performed unless it is absolutely critical. Electrical work should be postponed until the liquid can be cleaned up. The following special precautions must be incorporated while performing work in *damp locations*:

- Only use electrical cords that have GFCIs;

- Remove standing water before beginning work. Work is prohibited in areas where there is standing water;
- Do not use electrical extension cords in wet or damp locations; and
- Keep electrical cords away from standing water.

6.5.4 Working on De-Energized Equipment

The most important principle of electrical safety is to **assume all electric circuits are energized unless each involved worker ensures they are not.** Every circuit and conductor must be tested every time work is done on them. Proper PPE must be worn until the equipment is proven to be de-energized.

- Voltage rated gloves and leather protectors must be worn.
- Safety glasses must be worn.
- The required Arc Flash PPE must also be worn when verifying the de-energized state. All arc flash and electrical PPE can be removed once the enclosure has been verified as "dead."

The NFPA lists six steps to ensure conditions for electrically safe work.

1. Identify all sources of power to the equipment.
2. Remove the load current, and then open the disconnecting devices for each power source.
3. Where possible, visually verify that blades of disconnecting devices are fully open or that draw out-type circuit breakers are fully withdrawn.
4. Apply lockout/tag out devices in accordance with a formal, written policy.
5. Test each phase conductor or circuit part with an adequately rated voltage detector to verify that the equipment is de-energized. Test each phase conductor or circuit part both phase-to-phase and phase-to-ground. Check the voltage detector before and after each test to be sure it is working.
6. Properly ground all possible sources of induced voltage and stored electric energy (such as, capacitors) before touching. If conductors or circuit parts that are being de-energized could contact other exposed conductors or circuit parts, apply ground-connecting devices rated for the available fault current.

The process of de-energizing is "live" work and can result in an arc flash due to equipment failure. When de-energizing, follow the procedures described in Section 6.5.5, Working On or Near Live Equipment.

6.5.5 Working On or Near Energized Equipment

Working on live circuits means actually touching energized parts. Working near live circuits means working close enough to energized parts to pose a risk even though work is on de-energized parts. Common tasks where there may be a need to work on or near live circuits include, but are not limited to:

- Taking voltage measurements
- Opening and closing disconnects and breakers
- Racking breakers on and off the bus
- Removing panels and dead fronts
- Opening electric equipment doors for inspection
- Obtaining an Energized Electrical Work Permit from the Director of EH&S or designee. Refer to Appendix C for the permit.

Precautions

When working on de-energized parts, but while still inside the arc flash protection boundary for nearby live exposed parts:

- If the parts cannot be de-energized, barriers such as insulated blankets must be used to protect against accidental contact or PPE must be worn.
- Employees shall not reach blindly into areas that might contain exposed live parts.
- Employees shall not enter spaces containing live parts unless illumination is provided that allows the work to be performed safely.
- Conductive articles of jewelry and clothing (such as watchbands, bracelets, rings, key chains, necklaces, metalized aprons, cloth with conductive thread, metal headgear, or metal frame glasses) shall not be worn where they present an electrical contact hazard with exposed live parts.
- Conductive materials, tools, and equipment that are in contact with any part of an employee's body shall be handled in a manner that prevents accidental contact with live parts. Such materials and equipment include, but are not limited to long conductive objects such as ducts, pipes, tubes, conductive hose and rope, metal-lined rules and scales, steel tapes, pulling lines, metal scaffold parts, structural members, and chains.
- When an employee works in a confined space or enclosed spaces (such as a manhole or vault) that contains exposed live parts, the employee shall use protective shields, barriers or insulating materials as necessary to avoid contact with these parts. Doors, hinged panels, and the like shall be secured to prevent them from swinging into employees. Refer to Simmons' confined space program.

Insulated Tools and Materials

Only insulated tools and equipment shall be used when exposed to energized parts.

- Insulated tools shall be rated for the voltages on which they are used.
- Insulated tools shall be designed and constructed for the environment to which they are exposed and the manner in which they are used.
- Fuse or fuse holder handling equipment, insulated for the circuit voltage, shall be used to removed or install a fuse if the fuse terminals are energized.
- Ropes and hand-lines used near exposed energized parts shall be nonconductive.
- Portable ladders used for electrical work shall have nonconductive side rails.

Protection Boundaries

The NFPA 70E defines three boundaries for electrical employees to observe. Two boundaries deal specifically with shock hazards and are intended to prevent shock and electrocution. The third boundary is the arc flash boundary. The arc flash boundary has a primary purpose of preventing burn injury due to arc flash incidents. Figure 3 demonstrates the protection boundaries. This figure was provided by Electrical Diagnostic Surveys.

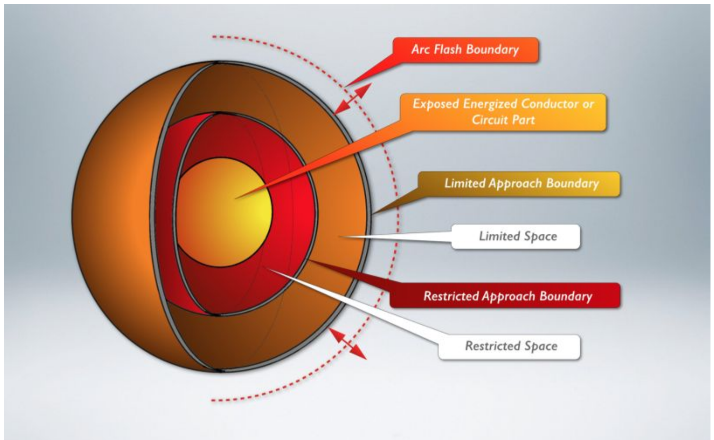

Figure 3 – Protection Boundaries

The Limited, and Restricted approach boundaries deal strictly with shock prevention and are based upon nominal system voltage. These boundaries are not calculated and apply only when exposed energized conductors or circuit parts are present.

Qualified employees shall not approach or take any conductive object closer to live parts than the approach boundaries given in Table 3, unless:

a. The Qualified Person is insulated or guarded from the live parts (Insulating gloves compliant with Table 6), arc-face shield and protective clothing are considered insulation only with regard to the energized parts upon which work is being performed), OR
b. The live part is insulated from the employee and from any other conductive object at a different potential.

Table 3 – Approach Boundaries

Nominal System Voltage Range Phase to Phase Voltage	Limited Approach Boundary		Restricted Approach Boundary
	Exposable Movable Conductor	Exposed Fixed Circuit	
Part Less than 50	Not Specified	Not Specified	Not Specified
50 V to 150 V	10 ft., 0 in	3 ft., 6 in	Avoid Contact
151 V to 750 V	10 ft., 0 in	3 ft., 6 in	1 ft., 0 in
751 V to 15 kV	10 ft., 0 in	5 ft., 0 in	2 ft., 2 in
15.1 kV- 36 kV	10 ft., 0 in	6 ft., 0in	2 ft., 7 in

Access-Limiting Equipment

Barricades shall be used in conjunction with safety signs to prevent or limit access to work areas containing live parts. Conductive barricades shall not be used where they might cause an electrical hazard. These barricades are designed to prevent un-qualified and/or unprotected employees from entering the electrical hazard area.

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

6.5.6 Working Space about Electric Equipment

Sufficient access and working space shall be provided and maintained about all electric equipment to permit ready and safe operating and maintenance of such equipment. Enclosures that house electric apparatus and are controlled by lock and key shall be considered accessible to qualified persons. Table 4 provides the working space required when working with electric equipment.

Table 4 – Working Space Requirements

Nominal Voltage to Ground	Minimum Clear Distance		
	Condition A	**Condition B**	**Condition C**
0-150	900mm(3 ft)	900 mm(3 ft)	900mm(3 ft)
151-600	900mm(3 ft)	1m(3-1/2 ft)	1.2 m (4 ft)

NOTES:
Minimum clear distances may be 0.7 m (2.5 ft) for installations built before April 16, 1981.

1. Conditions A, B, and C are as follows:
   - Condition A -- Exposed live parts on one side and no live or grounded parts on the other side of the working space, or exposed live parts on both sides effectively guarded by suitable wood or other insulating material. Insulated wire or insulated busbars operating at not over 300 volts are not considered live parts.
   - Condition B -- Exposed live parts on one side and grounded parts on the other side.
   - Condition C -- Exposed live parts on both sides of the work space (not guarded as provided in Condition A) with the operator between.
2. Working space is not required in back of assemblies such as dead-front switchboards or motor control centers where there are no renewable or adjustable parts (such as fuses or switches) on the back and where all connections are accessible from locations other than the back. Where rear access is required to work on de-energized parts on the back of enclosed equipment, a minimum working space of 762 mm (30 in.) horizontally shall be provided.

Illumination shall be provided for all working spaces about service equipment, switchboards, panel boards, or motor control centers installed indoors. Additional lighting outlets shall not be required where the work space is illuminated by an adjacent light source. In electrical equipment rooms, the illumination shall not be controlled by automatic means only.

All switchboards, panel boards, distribution boards, and motor control centers shall be located in dedicated spaces and protected from damage. *Exception: Control equipment that by its very nature or because of other rules of the standard must be adjacent to or within sight of the operating machinery shall be permitted in those locations.*

6.6 Labeling

A representative from Buildings and Grounds is required to field mark electrical equipment as part of their arc flash risk assessment for electrical equipment installed in 2015 or later. The label must contain the following information:

- At least one of the following:
  - Available incident energy and the corresponding distance
  - Minimum arc rating of clothing
  - Site specific level of PPE
  - PPE Category in 130.7(C)(15) for equipment

- Nominal system voltage
- Arc flash boundary

The information displayed on the label should only be present based on the method used to determine the PPE risk assessment. If the table method is used, only the PPE category should appear (1-4). If incident energy analysis method is used the incident energy (cal/cm^2) should appear. Both should not appear on the same label. Must be one or the other displayed. See example below.

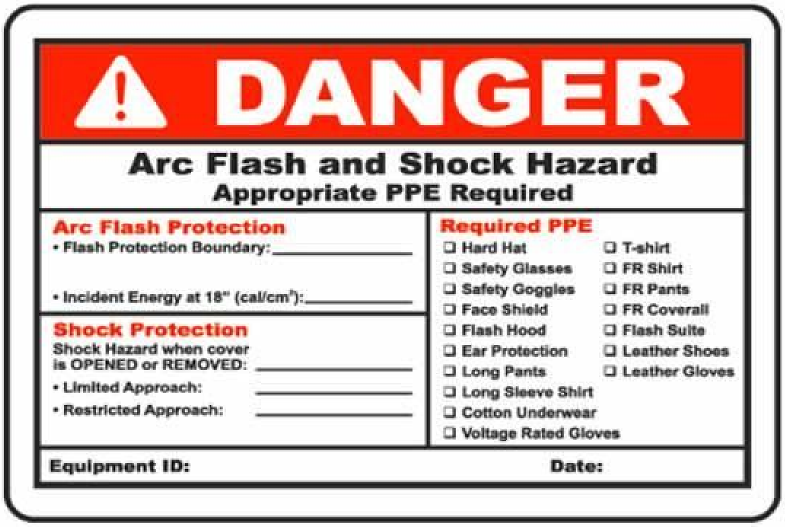

Figure 4 – Sample Equipment Label

7.0 PERSONAL PROTECTIVE EQUIPMENT

Employees working in areas where there are potential electrical hazards must be provided with and use personal protective equipment (PPE) that is appropriate for the specific work to be performed. The electrical tools and protective equipment must be specifically approved, rated, and tested for the levels of voltage of which an employee may be exposed.

- Employees shall wear nonconductive head protection whenever there is a danger of head injury from electric shock or burns due to contact with live parts or from flying objects resulting from an electrical explosion.
- Employees shall wear protective equipment for the eyes whenever there is a danger of injury from electric arcs, flashes, or from flying objects resulting from an electrical explosion.
- Employees shall wear rubber insulating gloves where there is a danger of hand or arm contact with live parts or possible exposure to arc flash burn. Leather 'protector' gloves shall be worn over the rubber insulating gloves. Exposures to live conductors of 50 VAC or greater requires the use of rubber insulating gloves and leather protector gloves.
- Face shields without arc rating shall not be used for electrical work. Safety glasses or goggles must always be worn underneath face shields.
- Additional illumination may be needed when using tinted face shields as protection during electrical work.
- Electrical protective equipment must be selected to meet the criteria established by the American

Society of Testing and Materials (ASTM) and by the America National Standards Institute (ANSI).

- Insulating equipment made of materials other than rubber shall provide electrical and mechanical protection at least equal to that of rubber equipment.
- PPE must be maintained in a safe, reliable condition and be inspected for damage before each day's use and immediately following any incident that can reasonably be suspected of having caused damage.
- Employees must use insulated tools and handling equipment that are rated for the voltages to be encountered when working near exposed energized conductors or circuit. Tools and handling equipment should be replaced if the insulating capability is decreased due to damage. Protective gloves must be used when employees are working with exposed electrical parts above 50 V.
- Fuse handling equipment (insulated for circuit voltage) must be used to remove or install fuses when the fuse terminals are energized. Ropes and hand lines used near exposed energized parts must be non-conductive.
- Protective shields, barriers or insulating materials must be used to protect each employee from shock, burns, or other electrical injuries while that person is working near exposed energized parts that might be accidentally contacted or where dangerous electric heating or arcing might occur.

7.1 Protective Clothing and PPE

NFPA 70E (2015) provides four (4) PPE categories. PPE Category 0 has been officially eliminated from the standard and is no longer recognized by OSHA or the NFPA as a legitimate PPE Category. Table 5 explains the four categories and the protective clothing and PPE required for the work.

Table 5 – Protective Clothing and PPE Requirements		
Category	**Clothing & PPE Description**	**Minimum ATPV Rating**
1	Arc-Rated Clothing: Arc-rated long-sleeve shirt and pants or arc-rated coverall, arc-rated face shield or arc-flash suit hood, arc-rated jacket, parka, rainwear or hard hat liner as needed Protective Equipment: Hard hat, safety glasses or goggles, hearing protection, leather gloves, leather footwear	4 cal/cm^2
2	Arc-Rated Clothing: Arc-rated long-sleeve shirt and pants or arc-rated coverall, arc rated face shield and arc-rated balaclava or arc-flash suit hood, arc-rated jacket, parka, rainwear or hard hat liner as needed Protective Equipment: Hard hat, safety glasses or goggles, hearing protection, leather gloves, leather footwear	8 cal/cm^2
3	Arc-Rated Clothing: Arc-rated long-sleeve shirt, arc-rated pants, arc-rated coverall, arc-rated flash suit jacket, arc-rated flash suit pants, arc-rated flash suit hood, arc-rated gloves, arc-rated jacket, parka, rainwear or hard hat liner as needed Protective Equipment: Hard hat, safety glasses or goggles, hearing protection, leather gloves, leather footwear	25 cal/cm^2
4	Arc-Rated Clothing: Arc-rated long-sleeve shirt, arc-rated pants, arc-rated coverall, arc-rated flash suit jacket, arc-rated flash suit pants, arc-rated flash suit hood, arc-rated gloves, arc-rated jacket, parka, rainwear or hard hat liner as needed Protective Equipment: Hard hat, safety glasses or goggles, hearing protection, leather gloves, leather footwear	40 cal/cm^2

NOTES:

1. ATPV means Arc Thermal Performance Value. See definitions.
2. Cal/cm^2 (calories/squared centimeter) are the units of incident energy that the PPE can withstand. A value of 1.2 cal/cm^2 results in 2nd degree burns to bare skin, and 8 cal/cm^2 in 3rd degree burns.
3. When incident energy exceeds 40 cal/cm^2 at the working distance, greater emphasis may be necessary with respect to de-energizing before performing your task.
4. A balaclava provides additional head and neck protection which the face shield and hardhat cannot provide alone. The balaclava must be made of Arc-Rated (AR) fabric and is only worn for PPE Category 2 tasks. See picture below:

Figure 5 – Balaclava

Appendix D provides the NFPA 70E Arc Flash Identification for AC and DC Systems. The table lists the task, equipment condition, and the arc flash PPE required for the task.

7.1.1 Undergarments

All employees will be properly trained on the importance of wearing ONLY 100% cotton undergarments. Synthetic materials, such as poly/cotton blends, Under Armor, etc., pose a serious burn hazard in the event of an arc flash event. Synthetic fabrics have a low melting threshold and can melt to an employee's skin, even when worn under the proper AR outer garments.

7.1.2 Wet Weather Gear

Any clothing or protective wear worn over the AR garments, such as wet weather gear, shall also be made of arc-rated fabric. Synthetic rain gear, such as traditional nylon rain jackets, ponchos or slickers, pose a serious burn hazard in the event of an arc flash event.

7.1.3 Cold/Winter Weather Gear

Any clothing or protective wear worn over the AR garments, such as cold weather or winter weather gear (Carhartt jackets, vests, parkas, etc.), shall also be made of arc-rated fabric.

7.1.4 AR Reminder

Any garment that an employee wears while performing live electrical tasks are required to be made of AR fabric. The only exception to this is the undergarments which are required to be 100% cotton.

7.2 Glove Classes

It is recommended that Class 00 gloves be provided to each qualified person. Electrical safety gloves are categorized by the level of voltage protection they provide and whether or not they're resistant to ozone. Refer to Table 6.

Table 6 – Electrical Safety Gloves Classes

Class	Maximum Use Voltage (AC)	Tested (VAC)	Tested (VDC)
00	500	2,500	10,000
0	1,000	5,000	20,000

1	7,500	10,000	40,000
2	17,000	20,000	50,000
3	26,500	30,000	60,000
4	36,000	40,000	70,000

Rubber is susceptible to the effects of the ozone, which can cause cracking and compromise the integrity of the glove. If the gloves are used in an environment where the levels of ozone are high due to pollution, ozone resistance is critical. Ozone resistance is covered by the "Type" designation. A Type I glove is not ozone-resistant; Type II is ozone-resistant.

Electrically-insulated rubber gloves are required to be inspected each day (prior to use) by the qualified employee, and tested every six (6) months by a certified third party. The certified third party shall mark each glove with their company name and the date of the inspection.

7.3 Usage and Maintenance

Protective equipment must be stored and used in accordance with manufacturer's recommendations. Regular tests and inspections will be required to ensure that any equipment is still fit for purpose and use. Equipment can include but is not limited to voltage-rated gloves, arc-rated hard hats and face shields, safety glasses, hearing protection, safety footwear and arc-rated (AR) clothing.

All Arc-Rated Clothing (ARC) shall be laundered and maintained according to the manufacturer's specifications. Employees are not permitted to make alterations to any AR apparel. It is recommended that a uniform company be contacted to discuss the proper care and maintenance/laundering/repair of the AR garments.

In addition to the arc-rated clothing, applicable employees will also be provided with insulated hand tools, arc-rated hardhat and face shield, and electrically-insulated rubber gloves.

Any additional PPE (fall protection, cut protection, eye protection, etc.) shall be determined by a PPE risk assessment of the task.

Prior to establishing an electrically safe work condition, all qualified persons within the flash protection boundary of a presumed live component must be suitably protected with personal protective equipment for that specific hazard category. Once an electrically safe work condition has been established and verified, electrical personal protective equipment can be removed.

Conductive articles of clothing or jewelry (such as watchbands, bracelets, rings, key chains, pens, necklaces, metalized aprons cloth with conductive thread, metal headgear, metal frame glasses, etc.) shall not be worn where they present an electrical contact hazard with live parts, unless they are rendered non-conductive by covering or wrapping with insulated material.

All unqualified personnel shall be kept a safe distance from exposed energized components. Safe distance shall be the longer of the two boundaries (Shock and Flash Protection).

8.0 TRAINING

8.1 Employees

Safety training shall be provided to employees who face a risk of electrical shock that is not reduced to a safe level by the electrical installation requirements of OSHA's Electrical Safety Standards. Employees shall be trained in and familiar with the safety related work practices and procedures as needed to provide them protection from the electrical hazards associated with their respective job tasks.

This training should include the identification of electrical hazards, potential injuries and special precautionary measures that should be taken in order to minimize the possibility for injury. Training shall consist of classroom training, on the job training, or a combination of both. The degree of training shall be determined by the risk to the employee and the job task assigned. Retraining shall be provided anytime there is a change in the process and when an audit or incident investigation indicates a need. All training shall be documented and retained for the duration of employment.

8.2 Qualified Employee Training

A "Qualified Employee" shall be trained and knowledgeable of the construction and operation of equipment or a specific work method, and be trained to recognize and avoid the electrical hazards that might be present with respect to that equipment or work method. Employees who are "Qualified Employees" shall also be familiar with the proper use of special precautionary techniques, personal protective equipment, insulating and shielding materials, and insulated tools and test equipment. A person can be considered "Qualified" with respect to certain equipment and methods but "Unqualified" for others.

Such persons permitted to work within limited approach of exposed energized conductors and circuit parts shall, at a minimum, be additionally trained in all of the following:

1. The skills and techniques necessary to distinguish exposed energized parts from other parts of electric equipment;
2. The skills and techniques necessary to determine the nominal voltage of exposed energized parts;
3. The approach boundaries and the corresponding voltages to which the qualified person will be exposed; and
4. The decision-making process necessary to determine the degree and extent of the hazard and the personal protective equipment and job planning necessary to perform the task safely.

Qualified employees working on or near exposed energized parts shall be trained in emergency actions (i.e. removing victim from live circuits), first aid and cardiopulmonary resuscitation (CPR).

8.3 Unqualified Employee Training

Unqualified employees shall be trained in and familiar with any of the electrical safety related practices that are necessary for their safety. This includes, but is not limited to the general training requirements listed above.

9.0 RECORD KEEPING

9.1 Annual Review

This Electrical Safety Program will be reviewed at least annually by the Director of EH&S, a representative from the Buildings and Grounds Department, and the licensed electrician for Simmons. It will be revised as necessary. Revisions will be documented in the table provided at the beginning of this document. The review will include at a minimum:

1. Review of electrical practices and procedures to determine compliance.
2. Review of OSHA, NFPA, and/or industry data to help improve the overall program.
3. Review accidents or incidents associated with electricity.
4. Evaluate the efficacy of the procedures outlined in this program.

9.2 Training

THCS will document that the required training has been provided to the affected employees. Training sign-in sheets or an on-line program will be part of this documentation. A qualified instructor will be utilized for this training and training certificates will be provided by instructor or the on-line program.

9.3 Energized Electrical Work Permit

An Energized Electrical Work Permit (EEWP) is a document that clearly describes the following:

- The circuit, equipment, and location of the job/task at hand.
- The work that is to be done.
- Justification of why the circuit or equipment cannot be de-energized or the work deferred until the next scheduled outage.

The EEWP document should also include a section for the Electrically Qualified Person to assess the task at hand and determine if the job can be done safely. In order to do this he or she must be able to provide the following information:

- A detailed job description procedure to be used when performing the job/task at hand.
- A description of the safe work practices to be employed.
- Results of the Arc Flash Hazard Analysis and Shock Hazard Analysis.
- Shock Protection Boundaries.
- Necessary personal protective equipment to safely perform the assigned task.
- Means employed to restrict the access of unqualified persons from the work area.
- Evidence of completion of a Job Briefing including discussion of any job-related hazards.

The document shall include the signatures (and dates) of the following personnel:

- Electrically Qualified Person performing the job/task at hand
- Manufacturing Manager
- Safety Manager
- General Manager
- Maintenance or Engineering Manager
- Electrically Knowledgeable Person

Justification of work on or near electrically exposed parts that are more than 50 volts to ground must be put into an electrically safe work condition. The only two exceptions are:

- Situations where powering down equipment becomes an increased hazard
- When it is simply infeasible to power down

Each department will be responsible for maintaining their EEWPs.

10.0 STANDARDS, REFERENCES, AND REGULATIONS

The following standards, references, and regulations were reviewed or used to develop this Electrical Safety Program:

- *What is an AFCI?,* dated 2016, prepared by National Electrical Manufacturers Association (http://www.afcisafety.org/qa.html)
- *Controlling Electrical Hazards,* OSHA 3075, dated 2002, prepared by OSHA (https://www.osha.gov/Publications/3075.html)
- *Electrical Safety in the Workplace*, dated September 2008, prepared by OSHA (https://www.osha.gov/dte/grant_materials/fy09/sh-18794-09/electrical_safety_manual.pdf)
- *Electrical Safety in the Workplace Program,* dated January 2015, prepared by UNC Charlotte Environmental Health and Safety.
- Electrical Safety Policy, dated
- *NFPA 70: NEC*, dated 2014, prepared by NFPA
- *NFPA 70E: Standard for Electrical Safety in the Workplace*, dated 2015, prepared by NFPA
- *Subpart S – Electrical,* 29 CFR 1910, last updated October 5, 2015

APPENDIX A

DEFINITIONS

Ampacity – the current, in amperes, that a conductor can carry continuously under the conditions of use without exceeding its temperature rating.

Arc – the passage of substantial electric current through ionized air.

Arc Blast – a pressure wave containing gaseous forms of metal created from an electrical circuit fault. The arc blast may be of sufficient intensity to knock a standing person down or off a ladder. The arc blast may also be of sufficient intensity to product human injury.

Arc Flash – the expanding arc or fireball emanating from the source of the arc. It may be from a fraction of an inch to ten feet or more in size. It involves extremely intense heat and may ignite anything combustible in its path. The duration is usually a fraction of a second. An arc flash can reach temperatures of 35,000 degrees and can produce a concussive force of expanding gases and metal plasma.

Arc Rating - the maximum incident energy resistance demonstrated by a material (or a layered system of materials) prior to break open or at the onset of a second degree skin burn. Arc rating is normally expressed in cal/cm2. (NFPA fine print note): Break open is a material response evidenced by the formation of one or more holes in the innermost layer of flame-resistant material that would allow flame to pass through the material.

Arc Thermal Performance Value (ATPV) – this is the rating of a protective garment or shield. Refers to the maximum amount of energy that the garment or shield can withstand without breaking open or transmitting heat that would cause more than a second-degree burn.

Bolted Fault Current – the maximum current flow possible with a very near zero resistance fault, equivalent to two wires with lugs bolted together.

Bonding – refers to deliberately connecting (electrically) all metal parts in a system that does not carry current. This means that all these parts have the same electrical potential, and differences in current do not exist, reducing the electrical danger.

Boundary, Flash Protection – the linear distance in all directions from an exposed energized electrical component that is just far enough away from the source to prevent permanent injury from an arc flash due to a fault current.

Boundary, Limited Shock – the linear distance in all directions from an exposed energized electrical part that defines the safe approach distance for unqualified persons.

Break-open threshold energy (EBT) – maximum incident energy values that do not cause Flame Resistant (FR) material to break-open, and do not cause second degree burns on skin covered by the FR material.

Capacitor – any device that stores electrical energy using an electrostatic field.

Certified – equipment is “certified” if it bears a label, tag, or other record of certification that the equipment:

- Has been tested and found by a national recognized testing laboratory to meet nationally recognized standards or to be safety for use in a specified manner; or
- Is of a kind whose production is periodically inspected by a nationally recognized testing laboratory and is accepted by the laboratory as safe for its intended use.

Circuit breaker – a device designed to open and close a circuit by non-automatic means and to open the circuit automatically on a predetermined over current without damage to itself when properly applied within its rating.

Conduit – can be thought of as an electrical piping system that protects and routes the electrical wires and cables between electrical devices.

Conductor – the physical elements that allow electricity to flow along a path. They include three types:

1. Bare. A conductor having no covering or electrical insulation whatsoever.
2. Covered. A conductor encased within material of composition or thickness that is not recognized by Subpart S of the OSHA standard.
3. Insulated. A conductor encased within material of composition and thickness that is recognized by Subpart S of the OSHA standard.

Contractor – service provider that performs facility-related work including equipment service/maintenance or construction type activities. Contractors are typically hired to install new equipment, perform service, maintain or modify an existing facility or related equipment. Contractors may be called upon to perform a wide variety of work including but not limited to construction activities, demolition, crane/rigging services, electrical contracting, mechanical contracting, painting, landscaping/lawn care, janitorial services, etc.

Curable Burn – An electrical burn that is second degree or less.

Current – is the volume of electricity (number of electrons) moving past a point in a 1-second time period. Current is best described as the flow of electrons through an electrical circuit. On an electrical schematic or drawing or in calculations, current is represented by the letter I.

Electricity – is the flow of electrons through a conductor.

Energized – Electrically connected to or having a source of voltage.

Energized Electrical Work – Work performed on or near energized electrical systems or equipment with exposed components operating at 50 volts or greater and as defined by Restricted Approach Boundary and Prohibited Approach Boundary terminology.

Equipment – A general term including material, fittings, devices, appliances, luminaires (fixtures), apparatus, and the like used as a part of, or in connection with, an electrical installation.

Exposed – Capable of being inadvertently touched or approached by personnel nearer than a safe distance. This applies to parts that are not suitably guarded, insulated, or isolated. For the purposes of NFPA Article 450, the word exposed means that the circuit is in such a position that, in case of failure of supports or insulation, contact with another circuit may result.

Exposed - (as applied to live parts) - Capable of being inadvertently touched or approached nearer than a safe distance by a person. It is applied to parts that are not suitably guarded, isolated, or insulated.

Exposed - (as applied to wiring methods) - On or attached to the surface or behind panels designed to allow access.

Facility – any Simmons facility that is owned, operated, and maintained by Simmons.

Flame Resistant (FR) - The property of a material whereby combustion is prevented, terminated, or inhibited following the application of a flaming or no flaming source of ignition, with or without subsequent removal of the ignition source. (NFPA fine print note): Flame resistance can be an inherent property of a material, or it can be impacted by a specific treatment applied to the material.

Flammable Material – Any substance that is easily ignited and is capable of burning with great rapidity and flame. Flammable liquids have a flash point below 100 degrees Fahrenheit.

Flash Hazard Analysis – A study investigating an employee's potential exposure to arc flash energy, conducted for the purpose of injury prevention and determination of safe work practices and the appropriate levels of PPE.

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 (see Figure 3)

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

Ground Fault Circuit Interrupter (GFCI) – A device intended for the protection of personnel that functions to de-energize a circuit or portion thereof within an established period of time when a current to ground exceeds the values established for a Class A device. (NFPA Fine Print Note): Class A ground-fault circuit-interrupter trips when the current to ground has a value in the range of 4 mA to 6 mA. For further information, see UL 943, Standard for Ground-Fault Circuit Interrupters.

Hi-pot Testing - The Hi-pot test is a nondestructive test that determines the adequacy of electrical insulation for the normally occurring overvoltage transient. This is a high-voltage test that is applied to all devices for a specific time in order to ensure that the insulation is not marginal. Another reason for conducting the hi-pot test is that it also detects possible defects such as inadequate creepage and clearance distances introduced during the manufacturing process.

Insulated – Separated from other conducting surfaces by a dielectric (including air space) offering a high resistance to the passage of current.

Insulated Tools – Tools tested and approved by the manufacturer for the rated voltage or tools that are covered, surrounded or separated with a nonconductive material in order to prevent or reduce the transfer of electricity. Insulated tools are rated to a specific voltage.

Live Parts – energized conductive components. Load- is any device that converts electrical energy to motion, light, heat, or sound.

Limited Approach Boundary – An approach limit at a distance from an exposed live part within which a shock hazard exists (see Figure 3).

May – Indicates permission is granted.

Near – conditions where contact with exposed electrical components is possible by slipping, tripping, falling, the actions of others, or inadvertent action of reasonable probability.

Panelboard – a single panel or group of panel units designed for assembly in the form of a single panel, including buses and automatic over current devices, and equipped with or without switches for the control of light, heat, or power circuits; designed to be placed in a cabinet or cutout box placed in or against a wall, partition, or other support; and accessible only from the front.

Power – is the rate of doing work or using energy and is represented by the letter P. Power can be best described as the rate at which electrical energy is transferred by an electrical circuit. It is measured in watts or kilowatts.

Resistance – the opposition to the flow of electrons and is measured in ohms. On an electrical schematic or drawing, or in calculations, resistance is represented by the letter R.

Restricted Approach Boundary –an approach limit at a distance from an exposed live part within which there is an increased risk of shock, due to electrical arc over combined with inadvertent movement, for personnel working in close proximity to the live part (see Figure 3).

Service Equipment – the necessary equipment, usually consisting of a circuit breaker or switch and fuses, and their accessories, located near the point of entrance of supply conductors to a building or other structure, or an otherwise designated area, and intended to constitute the main control and cutoff of the supply.

Single-Phase Power - single phase power refers to two wire Alternating Current (AC) power circuits, typically with one power (leg) conductor and one neutral conductor. In the US, 120 VAC is the standard single phase voltage with one 120V power (leg) conductor and one neutral conductor.

Three-Phase Power - in a three-phase power supply system, three conductors each carry an alternating current (of the same frequency) but the phase of the voltage on each conductor is displaced from each of the other conductors by 120 degrees.

Transformer – used the principle of electromagnetic induction to raise or lower voltage levels as needed. They can step down (reduce) voltages to desired levels, and can be single-phased, or three-phased.

Voltage – is the electromotive force (EMF) or “push” that moves electrons along a conductor. It can be described as the amount of electrical pressure in a circuit. It is either direct current (DC) or alternating current (AC). On an electrical schematic or drawing, or in calculations, voltage is represented by the letter E.

APPENDIX B

LIST OF QUALIFIED EMPLOYEES

Name	Department

APPENDIX C – Energized Electrical Work Permit

Energized Electrical Work Permit

Department:		**Building:**	
		Room:	
Start Date:		**Expiration Date:**	
Supervisor:			
Description of Work:			
Description of Circuit/Equipment:			
Justification for why equipment cannot by de-energized:			

TO BE COMPLETED BY THE ELECTRICALLY QUALIFIED PERSON(S) DOING THE WORK

- □ Employees must be trained, qualified, and have full knowledge of equipment
- □ Ensure Shock Protection Boundary of at least **10 feet** unless specified on electrical equipment
- □ Ensure Arc Flash Protection Boundary of at least **4 feet** unless specified on electrical equipment
- □ Ensure only natural fiber clothing is being worn
- □ Ensure Fire Retardant Clothing is being worn
- □ Ensure employees are wearing the required additional PPE
- □ Ensure the following safe work practices are being followed:
  - □ All measuring/test tools are rated to be safely used on the equipment to be worked on.
  - □ Safety watch – This person must be trained in emergency actions (i.e. removing victim from live circuits), the location to cut off power, first aid and cardiopulmonary resuscitation (CPR). (S)he must have access to a telephone to call 911 in case of an emergency.
  - □ Insulated tools and equipment
  - □ Remove all jewelry
  - □ Use safety signs, attendants, or other means of barricading to restrict access of unqualified person from the work area
- □ Do you agree that the work can be completed safely?
  - □ YES
  - □ NO

AUTHORIZED EMPLOYEES

Name (Printed)	**Signature**	**Date**

APPROVALS

Name (Printed)	**Signature**	**Date**
Supervisor:		
EH&S:		

Appendix D – NFPA 70E Arc Flash Identification for AC and DC Systems