Electrical Safety Policy (EHS-0018)

For

KENT STATE UNIVERSITY

Issued: April 2012
Revised: September 2014

KENT STATE UNIVERSITY

001
COPY#

Electrical Safety Policy
OHS-0018

Dates
Original: April 2, 2012
Revised: September 09, 2014

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1.0 PURPOSE

The purpose of this policy is to inform interested persons, including employees that Kent State University is complying with the OSHA Electrical Safety Standard, Title 29 Code of Federal Regulations 1910.331 - 1910.335 and the National Fire Protection Association 70E (2012 Edition). Kent State University is committed to an employee Safety and Health Program that meets the standards established by the State of Ohio, Federal Occupational Safety and Health Administration (OSHA), and local agencies. As a result, Kent State University will establish written procedures for preventing electric shock, arc flash or other injuries resulting from direct/indirect electrical contact to employees working on or near energized parts.

If, after reading this policy, you have any questions, please contact your immediate supervisor. It is the goal of the University to provide clear understanding, safe work practices, and involvement in the policy from every level within the University.

2.0 SCOPE

All University employees will abide by all procedures set forth in this document. It is understood that an employee's failure to follow these policies and procedures may subject that employee to disciplinary action.

3.0 DOCUMENT CONTROL

3.1 Approvals: This procedure as well as all Environmental, Health and Safety (EH&S) procedures must be approved by the Manager, Environmental Health and Safety (MEHS).

Approved by: Dennis Bole Date: August 27, 2014
Manager, Environmental Health and Safety

3.2 Responsibility:

3.2.1 The Administrator of this procedure is the MEHS. This includes updating or revising the procedure, arranging for typing and providing revised copies to the Master Copy Holder for distribution. The Administrator will establish a review schedule for this procedure so as to ensure that this procedure contains only the most current information relevant to existing federal, state and local laws and regulations governing electrical safety.

3.2.2 The Master Copy Holder for this procedure is the MEHS. MEHS is responsible for ensuring that relevant elements of applicable quality control procedures governing policies, programs, procedures and checklists are being followed. This includes the preparation of revisions to this procedure, obtaining approvals, recording changes, distribution and compliance with other document(s).

4.0 DEFINITIONS

Affected employee An employee whose job requires him/her to operate or use a machine or equipment on which servicing or maintenance is being performed under lockout or tagout, or whose job requires him/her to work in an area in which such servicing or maintenance is being performed.

Authorized employee An authorized employee is one who locks out or tags out machines or equipment in order to perform servicing or maintenance on that machine or equipment. An affected employee becomes an authorized employee when that employee's duties include performing servicing or maintenance covered under this section.

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

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

Boundaries

Arc Flash Protection Boundary: when an arc flash hazard exists, an approach limit at a distance from a prospective arc source within which a person could receive a second degree burn if an electrical arc flash were to occur.

Limited Approach Boundary: A limited approach boundary is the distance from an exposed energized electrical conductor or circuit part within which a shock hazard exits.

Restricted Approach Boundary: An approach limit at a distance from an exposed energized electrical conductor or circuit 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 energized electrical conductor or circuit part

Building Maintenance Employees While there are many employees associated with building maintenance; in this case, building maintenance employees include the following positions: Maintenance Repair Workers, Maintenance Facilities Workers, Recreation Facilities Workers, Pool Technicians, All Campus Preventive Maintenance (ACPM) Specialists, and Welder.

Capable of being locked out An energy isolating device is capable of being locked out if it has a hasp or other means of attachment to which, or through which, a lock can be affixed, or it has a locking mechanism built into it.

Energized Connected to an energy source or containing residual or stored energy.

Energy isolating device A mechanical device that physically prevents the transmission or release of energy.

Energy source Any source of electrical, mechanical, hydraulic, pneumatic, chemical, thermal, or other energy.

Lockout The placement of a lockout device on an energy isolating device, in accordance with an established procedure, ensures that the energy isolating device and the equipment being controlled cannot be operated until the lockout device is removed.

Lockout device A device that utilizes a positive means such as a lock, either key or combination type, to hold an energy isolating device in the safe position and prevent the energizing of a machine or equipment.

Lockout/Tagout Procedure Form The document outlining the procedures identifying each isolation point and the method for isolating and locking out or tagging out each point.

Other Employee Employees whose work operations are or may be in an area where energy control procedures may be utilized. Other employees shall be instructed about the procedure and about the prohibition relating to an attempt to restart or re-
energize machine and equipment, which are locked and/or tagged out.

Qualified Employee A qualified employee is a person who possesses a recognized degree, certification, or professional standing, or one who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received training to recognize and avoid the hazards involved.

Servicing/Maintenance Any activity, such as repairing, adjusting, lubricating or cleaning equipment where an employee may be exposed to unexpected energization or startup of equipment or unexpected release of hazardous energy.

Stored Energy Residual energy that could be potentially hazardous and released unexpectedly.

Tagout The placement of a tagout device on an energy isolating device, in accordance with an established procedure, to indicate that the energy isolating device and the equipment being controlled may not be operated until the tagout device is removed.

Tagout device A prominent warning device, such as a tag and a means of attachment, which can be securely fastened to an energy isolating device in accordance with an established procedure, to indicate that the energy isolating device and the equipment being controlled may not be operated until the tagout device is removed.

Troubleshooting Testing energized circuits. Troubleshooting is the method used to test energized electrical components with an approved metering or testing device to identify the presence of voltage, amperage, faults or lack thereof.

Working On (energized electrical conductors or circuit parts): Intentionally coming in contact with energized electrical conductors or circuit parts with the hands, feet, or other body parts with tools, probes, or other test equipment, regardless of the personal protective equipment a person is wearing. There are two categories of "working on":

Diagnostic (testing): is taking readings or measurements of electrical equipment with approved test equipment that does not require making any physical change to the equipment. An energized work permit is not required for testing or troubleshooting;

Repair: is any physical alteration or electrical equipment (such as tightening connections, removing or replacing components, etc.).

5.0 COVERED WORK

5.1 Electrical safety work practices for all personnel working on, near or with the following installations:

5.1.1 Premises wiring. Installations of electric conductors and equipment within or on buildings or other structures, and on other premises such as yards, parking lots, and substations.

5.1.2 Wiring for connection to supply. Installations of conductors that connect to the supply of electricity.

5.1.3 Other wiring. Installations of other outside conductors on the premises.

5.1.4 Optical fiber cable. Installations of optical fiber cable where such installations are made along with electric conductors.

5.1.5 Installations in vehicles and/or equipment.

5.1.6 Generation, transmission and distribution of electric energy (including communication and metering) located in buildings used for such purposes or located outdoors.

5.1.7 All other electrical work as required.

6.0 EXCLUDED WORK

6.1 The provisions of CFR 29 1910.331 through 1910.335 do not apply to work performed by qualified persons on or directly associated with the following installations:

6.1.1 Communications installations. Installations of communication equipment to the extent that the work is covered by CFR 29 1910.268

7.0 ROLES AND RESPONSIBILITIES

7.1 **Manager, Environmental Health and Safety** has overall responsibility for coordinating safety and health programs for the University. The Manager will review and update the policy as necessary. Copies of the written policy may be obtained from your immediate supervisor.

7.2 **Department Supervisors** are responsible for enforcing the operating rules and practices within their department.

7.3 **Employees and/or Student Employees** who operate and/or work on or around electrical equipment at Kent State University are required to be aware of and follow all procedures listed in the Electrical Safety Policy and the appropriate *Safety Check-Off List.*

7.4 **Qualified Employees** (those familiar with the construction and operation of equipment and the hazards of working on or near exposed energized parts), Kent State University employees who are qualified to work on, near, or with energized electric circuits and equipment are described in Appendix A- Qualified Workers List.

7.4.1 Task specific qualified Employees: Those employees who by education, training and evaluation are approved for specific tasks that expose workers to a limited and specific amount and type of electrical hazards.

EXAMPLES:

- Tasks that avoid opening of electrical enclosures/cabinets that would expose a worker to 50 volts and above
- Ballast and Bulb repair/replacement – provided training and evaluations have taken place and proper PPE is used at all required times.

7.5 **Unqualified Employees** Kent State University employees who have limited knowledge of electrical circuitry and equipment are:

7.5.1 All other University employees

Constant awareness of and respect for electrical hazards, and compliance with all safety rules are considered conditions of employment. Any employee who fails to follow all safety procedures may be subject to disciplinary procedures.

8.0 EMPLOYEE INFORMATION AND TRAINING

8.1 The goal of the Kent State University Electrical Safety Policy is to ensure all employees understand the hazards associated with electric energy and that they are capable of performing the necessary steps to protect themselves and their co-workers.

8.2 Every employee at Kent State University who faces the risk of electric related injury from working on or near energized or de-energized electrical sources receives training in electrical related safety work practices pertaining to the individual's job assignment.

8.3 Some of the electrical safety training issues that are covered are indicated below:

Qualified/Authorized Personnel (See Appendix A for Qualified Authorized Worker List)

These individuals will receive initial and refresher training in:

- Electrical safe work practices – Including University Electrical Safety Policy
- LOTO training for authorized persons
- Voltage testing safety basics
- Training on employee voltage tester (as many as applies to their duties)
- Arc Flash Risks and Barriers

Unqualified Persons

These individuals will receive initial and refresher training:

- Basic Electrical Safety
- Basics of LOTO, Labeling, Arc Flash Risks and Barriers

8.4 Qualified employees are required to take successfully complete all tests as required by each department. See appropriate Appendix for department grouping.

8.5 Training is conducted prior to employee assignment to work on or near electrical equipment or circuitry. Additional training sessions, information and testing are ongoing and are required by all qualified employees.

8.6 Every employee involved with the Electrical Safety Policy signs a record verifying that they have received a copy of the policy and the information presented, and that they will follow all University policies and procedures regarding electrical safety.

8.7 Each department will be responsible for custody of the signed training records, as well as all training materials and relevant documentation.

9.0 ARC FLASH HAZARDS

Kent State University has completed a partial Arc Flash Survey and will continue to perform arc flash surveys on new and renovated facilities. Where the arc flash survey has been completed electrical disconnects, panels, fuses and other electrical service areas will be labeled (see Appendix J). The labels contain the following information:

- Warning or Danger
  - Warning for disconnects with incident energies ≤ 40 cal/cm2
  - Danger for disconnects with Incident energies > 40 cal/cm2
- Hazard Boundaries
- Incident Energy
- Voltage/Shock Hazard with cover removed

University Employees will be taught how to apply the information on the labels to setup the appropriate boundaries and what PPE is necessary to protect them from Arc Flash and shock hazards.

Where an Arc Flash Survey has not been completed or Arc Flash Labels are not present, Kent State University is following the guidance in the National Fire Protection Association (NFPA) 70E, 2012 Edition, and safety-related work practices (Appendices I, K, and L). The work practices have been established to protect against arc flash hazards resulting from either direct or indirect electrical contacts of 50 volts or more when work is performed near or on equipment of circuits that are or may be energized

9.1 Approach boundaries to energized electrical conductors or circuit parts for shock protection (Please see Appendix I, or NFPA 70E, 2012 Edition Table 130.2(c)).

9.2 Arc Flash Protection Boundary

9.2.1 Voltage levels between 50 Volts and 600 Volts. In those cases where detailed arc flash hazard analysis calculations are not performed for systems that are between 50 volts and 600 volts, the Arch Flash Protection Boundary shall be 4.0 ft, based on the product clearing time of 2 cycles (0.033 seconds) and the available bolted fault current of 50 kA or any combination not exceeding 100 kA cycles (1667 ampere seconds). When the product of clearing times and bolted fault current exceeds 100 kA, the Arc Flash Protection Boundary shall be calculated.

10.0 WORK PRACTICES

Safety-related work practices have been established to prevent electric shock or other injuries resulting from either direct or indirect electrical contacts, when work is performed near or on equipment or circuits that are or may be energized.

10.1 Pre-job Briefing A pre-job briefing on the type of work being performed and what is involved should always be done first. When simple lockout/tagout is performed and an employee is simply verifying a zero energy state on equipment with only one energy source, and only one employee is conducting the work then a job briefing is only necessary at the beginning of a work shift. Items to be covered include:

- Information needed to perform the job
- Teamwork requirements
- Safety items such as a review of the hazards involved
- Personal protective equipment and clothing requirements
- Lockout/tagout requirements
- Hot work or other special issues
- Expected outcomes
- What to do if there is a problem or unexpected response
- Emergency procedures
- Emergency escape routes

10.2 Electrical Safe Work Condition

Energized electrical conductors and circuit parts to which an employee might be exposed shall be put into an electrically safe work condition before an employee performs work if any of the following conditions exists:

- The employee is within the limited approach boundary
- The employee interacts with equipment where conductors or circuit parts are not exposed, but an increased risk of injury from an exposure to an arc flash hazard exists.
- The employee is within the arc flash boundary with exposed energized electrical conductors or circuit parts.

10.2.1 Energized work shall only be permitted where the university can demonstrate that de-energizing introduces additional hazards or increased risk. A Energized Work Permit is required for all energized work.

10.2.1.1 Examples of increased or additional hazards include, but are not limited to, interruption of life support equipment, deactivation of emergency alarm systems, shut-down of hazardous location ventilation equipment, or removal of illumination for an area.

10.2.1.2 Examples of work that may be performed on or near exposed energized conductors or circuit parts because of infeasibility due to equipment design or operational limitations include:

- Testing
- Troubleshooting
- Steps required to verify an electrical safe work condition

10.2.2 Conductors and parts of electric equipment that have been de-energized but have not been locked out or tagged shall be treated as energized parts.

10.3 Control of Hazardous Energy Program (Lockout/Tagout)

While any employee is exposed to contact with parts of fixed electric equipment or circuits which have been de-energized, the circuits energizing the parts shall be locked out, tagged out, or both locked and tagged out in accordance with the Kent State University Control of Hazardous Energy Program (Lockout/Tagout).

10.3.1 As used in this section, fixed equipment refers to equipment fastened in place or connected by permanent wiring methods.

10.4 Vehicular and Mechanical Equipment

Any vehicle or mechanical equipment capable of having parts of its structure elevated near energized overhead lines shall be operated so that a clearance of 10 ft. (305 cm) is maintained. If the voltage is higher than 50kV, the clearance shall be increased 4 in. (10 cm) for every 10kV over that voltage. However, under any of the following conditions, the clearance may be reduced:

10.4.1 If the vehicle is in transit with its structure lowered, the clearance may be reduced to 4 ft. (122 cm). If the voltage is higher than 50kV, the clearance shall be increased 4 in. (10 cm) for every 10 kV over that voltage.

10.4.2 If insulating barriers are installed to prevent contact with the lines, and if the barriers are rated for the voltage of the line being guarded and are not a part of or an attachment to the vehicle or its raised structure, the clearance may be reduced to a distance within the designed working dimensions of the insulating barrier.

10.4.3 If the equipment is an aerial lift insulated for the voltage involved, and if a qualified person performs the work, the clearance (between the uninsulated portion of the aerial lift and the power line) may be reduced to the distance given in the Approach Distances for Qualified Employees Table. Appendix I.

10.4.4 Employees standing on the ground may not contact the vehicle or mechanical equipment or any of its attachments, unless:

10.4.4.1 The employee is using protective equipment rated for the voltage; or

10.4.4.2 The equipment is located so that no uninsulated part of its structure (the portion of the structure that provides conductive path to employees on the ground) can come closer to the line than permitted in this section.

10.4.4.3 If any vehicle or mechanical equipment capable of having parts of its structure elevated near energized overhead lines is intentionally grounded, employees working on the ground near the point of grounding may not stand at the grounding location whenever there is a possibility of overhead line contact.

10.4.4.4 Additional precautions, such as the use of barricades or insulation, shall be taken to protect employees from hazardous ground potentials, depending on earth resistivity and fault currents, which can develop within the first few feet or more outward from the grounding point.

10.5 Illumination

10.5.1 Employees may not enter spaces containing exposed energized parts, unless illumination is provided that enables the employees to perform the work safely.

10.5.2 Where lack of illumination or an obstruction precludes observation of the work to be performed, employees may not perform tasks near exposed energized parts. Employees may not reach blindly into areas that may contain energized parts.

10.6 Confined or Enclosed Work Spaces

10.6.1 When an employee works in a confined or enclosed space (such as a manhole or vault) that contains exposed energized parts, the employer shall provide, and the employee shall use, protective shields, protective barriers, or insulating materials as necessary to avoid inadvertent contact with these parts.

10.6.2 Doors, hinged panels, and the like shall be secured to prevent their swinging into an employee and causing the employee to contact exposed energized parts.

10.6.3 Refer to Kent State University Confined Space Program.

10.7 Conductive Materials and Equipment

Conductive materials and equipment shall not be inside the Limited approach boundary to exposed energized conductors or circuit parts.

10.8 Portable Ladders

Portable ladders shall have nonconductive side rails if they are used where the employee or the ladder could contact exposed energized parts.

10.9 Conductive Apparel

10.9.1 Conductive articles of jewelry and clothing (such a watch bands, bracelets, rings, key chains, necklaces, metalized aprons, cloth with conductive thread, or metal headgear) may not be worn if they might contact exposed energized parts.

10.9.2 Metal frame glasses (prescription or otherwise) shall be covered with arc rated shield and secured with approved strap whenever qualified worker is inside the limited approach boundary to live parts.

10.9.3 Such articles may be worn if they are rendered nonconductive by covering with approved and rated insulated protective equipment such as gloves. It is still recommended to remove to protect from heat that could be caused by arc flash and still cause injury.

10.10 Housekeeping Duties

10.10.1 Where live parts present an electrical contact hazard, employees may not perform housekeeping duties within the limited approach boundary, unless adequate safeguards (such as insulating equipment or barriers) are provided.

10.10.2 Electrically conductive cleaning materials (including conductive solids such as steel wool, metalized cloth, and silicon carbide, as well as conductive liquid solutions) may not be used within the Restricted Approach Boundary unless procedures are followed which will prevent electrical contact.

10.11 Interlocks

10.11.1 Only a qualified person following the requirements of this section may defeat an electrical safety interlock, and then only temporarily while he or she is working on the equipment.

10.11.2 The interlock system shall be returned to its operable condition when this work is completed.

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11.0 USE OF EQUIPMENT

The following Electrical Safety Related Work Practices have been adapted from CFR 29 1910.334, Use of Equipment.

11.1 Portable Electric Equipment

11.1.1 Portable Electric Equipment applies to the use of cord and plug connected equipment, including flexible cord sets (extension cords).

11.1.2 Equipment must be handled in a way that will not cause damage. Electric cords connected to equipment may not be used for hoisting or lowering the equipment; may not be fastened with staples or hung in a manner that could damage the outer jacket or insulation.

11.1.3 A visual inspection shall be exercised before use on each shift for external defects and for evidence of possible internal damage. If a defect or evidence of damage is noted, remove the equipment from service and return it to the Department Supervisor.

11.1.4 Attachment plugs that are to be connected to a receptacle shall be checked to ensure that they are of proper mating configuration.

11.1.5 A flexible cord used with grounding type equipment shall contain an equipment-grounding conductor.

11.1.6. Attachment plugs and receptacles may not be connected or altered in a manner that would prevent proper continuity of the equipment-grounding conductor at the point where plugs are attached to receptacles.

11.1.6.1 Additionally, these devices may not be altered to allow the grounding pole of a plug to be inserted into slots intended for connection to the current carrying conductors.

11.1.6.2 Adapters that interrupt the continuity of the equipment grounding connection may not be used.

11.1.7 Portable electric equipment and flexible cords used in highly conductive work locations (such as those inundated with water or other conductive liquids), or in job locations where employees are likely to contact water or conductive liquids, shall be approved for those locations and shall be ground fault protected (GFCI).

11.1.8 Employees hands may not be wet when plugging and unplugging flexible cords and cord and plug connected equipment, if energized equipment is involved.

11.1.9 Energized plug and receptacle connections may be handled only with insulating protective equipment if the condition of the connection could provide a conducting path to the employee's hand (if, for example, a cord connector is wet from being immersed in water).

11.1.10 Locking type connectors shall be properly secured after connection.

11.2 Electric Power and Lighting Circuits

11.2.1 Load rated switches, circuit breakers, or other devices specifically designed as disconnecting means shall be used for the opening, reversing, or closing of circuits under load conditions.

11.2.2 Cable connectors not of the load break type, fuses, terminal lugs, and cable splice connections may not be used for such purposes, except in an emergency.

11.2.3 After a circuit is de-energized by a circuit protective device, the circuit may not be manually re-energized until it has been determined that the equipment and circuit can be safely energized.

11.2.4 Repetitive, manual re-closing of circuit breakers or reenergizing circuits through replaced fuses is prohibited.

11.2.4.1 When it can be determined from the design of the circuit and the overcurrent devices involved that the automatic operation of a device was caused by an overload rather than a fault condition, no examination of the circuit or connected equipment is needed before the circuit is re-energized.

- A qualified-Authorized person shall investigate and document that the circuit is safe to re-energize.

11.3 Overcurrent protection of circuits and conductors may not be modified, even on a temporary basis, beyond that allowed by 29 CFR 1910.304(e).

11.4 Test Instruments and Equipment

11.4.1 Only qualified persons may perform testing work on electric circuits or equipment.

11.4.2 Test instruments and equipment and all associated test leads, cables, power cords, probes, and connectors shall be visually inspected for external defects and damage before the equipment is used.

11.4.2.1 If there is a defect or evidence of damage that might expose an employee to injury, the defective or damaged item shall be removed from service and forwarded to the employee's Supervisor.

11.4.2.2 No employee may use it until repairs and tests necessary to render the equipment safe have been made. Repairs shall only be done by approved/authorized department personnel.

11.4.3 Test instruments and equipment and their accessories shall be rated with an overvoltage category of 3 or better for the circuits and equipment to which they will be connected and shall be designed for the environment in which they will be used.

- Testers and Leads shall be rated for the same voltages and categories (no mix and match).

11.5 Use of Flammable or Ignitable Materials

11.5.1 Where flammable materials are present, electric equipment capable of igniting them shall not be used, unless measures are taken to prevent hazardous conditions from developing.

11.5.2 Such materials include, but are not limited to: flammable gases, vapors or liquids; combustible dust; and ignitable fibers or filings.

11.5.3 Electrical installation requirements for locations where flammable materials are present on a regular basis are contained in 29 CFR 1910.307.

12.0 PROTECTIVE EQUIPMENT

12.1 Personal Protective Equipment

12.1.1 Personal protective equipment requirements are contained in CFR 29 1910.137, Electrical Protective Equipment

12.1.2 Employees working in areas where there are potential electrical hazards shall be provided with, and shall use, electrical protective equipment that is appropriate for the specific parts of the body to be protected and for the work to be performed.

12.1.3 Protective equipment shall be maintained in a safe, reliable condition and shall be periodically inspected or tested.

12.1.4 If the insulating capability of protective equipment may be subject to damage during use, the insulating material shall be protected. (For example, an outer covering of leather is sometimes used for the protection of rubber insulating material.)

12.1.5 Employees shall wear nonconductive head protection wherever there is a danger of head injury from electric shock or burns due to contact with exposed energized parts.

12.1.6 Employees shall wear protective equipment for the eyes and face wherever there is danger of injury to the eyes or face from electric arcs, flashes, blasts or Electrical shock. (See Appendix L)

12.1.7 Undergarments shall be made of non-melting or untreated natural fiber. Waste bands are exempt from this requirement.

12.2 General Protective Equipment and Tools

12.2.1 When working near exposed energized conductors or circuit parts nearer than the Limited Approach Boundary, each qualified employee shall use insulated tools or handling equipment if the tools or handling equipment might make contact with such conductors or parts.

12.2.1.1 If the insulating capability of insulated tools or handling equipment is subject to damage, the insulating material shall be protected.

12.2.2 Fuse handling equipment, insulated for the circuit voltage, shall be used to remove or install fuses when the fuse terminals are energized.

12.2.3 Ropes and hand lines used near exposed energized parts shall be nonconductive.

12.3 Protective shields, barriers, or insulating materials

12.3.1 Protective shields, barriers, or insulating materials shall be used to protect each qualified employee from shock, burns, or other electrically related injuries while that employee is working near exposed energized parts which might be accidentally contacted or where dangerous electric heating or arcing might occur.

12.3.2 When employees are exposed to live parts nearer than the restricted approach boundary they must create an electrical safe working condition or guard the live parts to prevent accidental damage (voltage rated gloves are only considered proper guarding for the parts a worker intends on contacting).

12.4 Alerting Techniques

12.4.1 The following alerting techniques shall be used to warn and protect employees from hazards that could cause injury due to electric shock, burns, or failure of electric equipment parts:

12.4.1.1 Safety signs, safety symbols, labels, or accident prevention tags shall be used where necessary to warn employees about electrical hazards that may endanger them, as required by CFR 29 1910.145.

12.4.1.2 Barricades shall be used in conjunction with safety signs where it is necessary to prevent or limit employee access to work areas exposing employees to uninsulated energized conductors or circuit parts.

12.4.1.3 Conductive barricades may not be used where they might cause an electrical contact hazard.

12.4.1.4 If signs and barricades do not provide sufficient warning and protection from electrical hazards, an attendant shall be stationed to warn and protect employees.

APPENDIX A
Qualified Workers List

Group # 1 – Electrical Workers and Electrical Supervisors
Group # 2 – HVAC Technicians and HVAC Supervisors
Group # 3 – Energy Technicians and their Supervisors
Group # 4 – Stationary Engineers and Their Supervisors
Group # 5 – Building Maintenance Workers and Their Supervisors
- All Campus Preventive Maintenance (ACPM) Specialists
- Maintenance Repair Workers,
- Maintenance Facilities Workers
- Recreation Facilities Workers
- Pool Technicians
- Plumbers
- Steamfitters
- Welder
- Water Treatment Technicians

Group # 6 - Fleet Services Employees and Their Supervisors
- Equipment Mechanics Automotive
- Mechanics
- Automotive Maintenance Crew Leader
- Fleet Services Superintendent

Group # 7 – Other University Employees
- Manufacturing Laboratory
- Technician Equipment Laboratory
- Technician Research Engineer

APPENDIX B
Qualified Workers – Group # 1
Electricians and Electrical Supervisors

Qualified Person per NFPA
70 E (Definitions)

"One who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training on the hazards involved"

Kent State University Electricians are considered "qualified" to work on electrical systems and equipment. As a requirement for employment, Kent State University Electricians are required to successfully pass a written and "hands-on" electrical test as well as provide proof of extensive electrical work experience. In addition to their previous safety training, each electrician is required to take regularly scheduled electrical safety courses provided by the university. Specialized training is also provided to the electricians for electrical work that requires additional skills such as medium voltage switching.

Where the Kent State University Arc Flash Study has been completed the label is used to determine boundary distances, shock hazard, and incident energy. From this appropriate PPE can be selected. Where the study has not been completed at the date of this publication, thus, NFPA 70E tables and other sections have been used as the standard for the safe work practices and levels of required PPE required by the electricians (including the Electrical Supervisor) (See Part IV).

All university electricians are provided FR rated 8 cal/cm^2, long sleeve shirt and pants as their daily uniform.

Part I **Kent State University Electrical Safety Procedure Checklist**

Part II **Energized Electrical Work Permit Chart**

Part III **Energized Electrical Work Permit**

Part IV **Engineered Safe Work Practices**

Part I

KENT STATE UNIVERSITY

UNIVERSITY FACILITIES MANAGEMENT
ELECTRICAL SAFETY PROCEDURE CHECKLIST

DATE: _____ TIME: _____

EMPLOYEE: _____

DESCRIPTION OF JOB: _____

WORK LOCATION: _____

WORK ORDER #: _____

DATE & TIME SUPERVISOR VISITED JOB SITE FOR SAFETY CHECKS: _____

YES	NO	ELECTRICAL SAFETY CHECK OFF LIST	PERSONAL PROTECTIVE EQUIPMENT REQUIREMENTS
		I have reviewed this job assignment with my supervisor and have been made aware of possible safety issues and proper procedures to follow.	☐ Lockout/Tag Out ☐ Ground fault protection ☐ 500V insulated gloves ☐ 5 KV gloves ☐ 15 KV gloves ☐ Protective sleeves ☐ Electrical hard hat ☐ Insulator boots ☐ Insulator mat ☐ Insulator blanket ☐ 1000V rated insulated tools ☐ Arc rated Jacket ☐ Safety harness and tripod ☐ Force air machine ☐ Respirator ☐ Eye and face protection ☐ Long sleeved shirt ☐ Ear protection ☐ Caution tape or barriers ☐ Balaclava (Head Sock) or Arc Flash Hood ☐ Other _____
		Do I know and understand the proper procedures to do the job?	
		Do I have the right PPE and tools for the job I've been assigned?	
		Have I informed the affected personnel that I will be de-energizing the panel, circuit, and/or equipment and have I relayed the approximate time of the outage?	
		Is my work environment well lit?	
		Is my work area free of water, tripping hazards or any other hazards?	
		If I have identified any safety hazards, have I contacted my supervisor and/or other responsible parties in order to remedy the situation?	
		If using extension cords or power tools, are the cords free from damage (cracked, cut, or taped)?	
		Do I feel that I can do the job safely? Have I communicated this with my supervisor? My alertness is not impaired by illness or fatigue and I shall not reach blindly into areas containing live parts.	
		What is the operating voltage?	
		Are there internal safety mechanisms?	
		After turning disconnecting means to the "OFF" position, have I checked to see if the conductors are de-energized using the appropriate tester?	
		During troubleshooting, if testing equipment in an energized state, have I used the proper PPE equipment and tools for the job?	

Employee Signature: _____

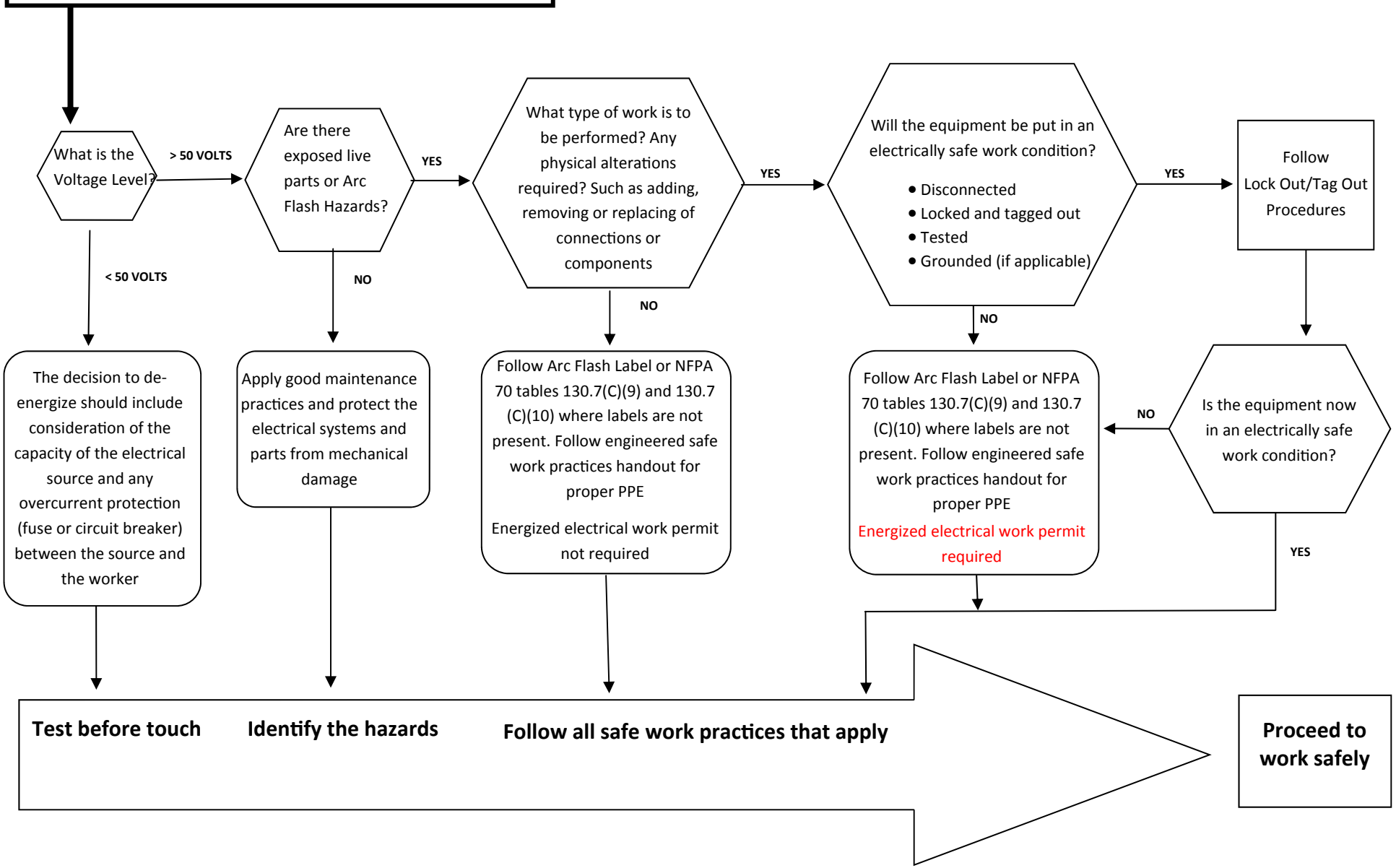
Supervisor Signature: _____

This document must be completed on each project as required by University Facilities Management

Part II

Flowchart Reviewed By: _____

Review *Before* Starting Electrical Work



Part III
ENERGIZED ELECTRICAL WORK PERMIT

Part 1: TO BE COMPLETED BY THE REQUESTER:		
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:		
Requester/Title	Requester's Signature	Date
Part II: TO BE COMPLETED BY THE ELECTRICALLY QUALIFIED* PERSONS *DOING* THE WORK:		
1. Description of the Safe Work Practices to be employed [NFPA 70E, 110.8 (B)]:		
2. Shock Hazard Analysis: Voltage Level Phase to Phase		
Limited Approach Boundaries [NFPA 70E, Table 130.2 (c)] or Label:	Restricted | Prohibited	
	3. Results of Hazard/Risk Analysis [NFPA 70E, 130.3]:	
Flash Protection Boundary:	Assumed (100 KA or less) or Calculated **(Circle one)**	
Hazard/Risk Category	OR Calculated Incident Energy at 18"	
4. List personal protective equipment to be used to perform the assigned task [Appendix L]: **(Circle PPE Required below)**		
Arc –rated jacket(20 Calories)/Arc Flash hood / Face shield/head sock/ Electrical Hardhat/ Safety glasses or goggles/Ear protection/ Arc rated rubber and leather gloves**		
5. Means employed to restrict the access of unqualified persons from the work area [NFPA 70E, 110.8(A) (2)]: **(Circle restriction method(s) being used) Signs/ Barrier/Qualified Attendant**		
6. Evidence of completion of a Job Briefing including discussion of any job-related hazards [NFPA 70E, Table 110.7(G)]:**Electrical Safety Procedure Checklist**		
7. Do you agree the above described work can be done safely? **YES / NO** (Circle: If ***no*** return to requester)		
Electrically Qualified Persons*	Date	
Electrically Qualified Persons*	Date	
Duration of Work: Beginning Date /Time	Ending Date/Time	
Part III: SIGNATURES TO PERFORM ENERGIZED ELECTRICAL WORK AND WITNESS TO WORK PERFORMED:		
Electrical Supervisor or Manager	Date /Time Witnessed	
**** One who has skills and knowledge related to the construction and operation of the electrical equipment and Installations and has received safety training on the hazards involved per NFPA 70E definition.***		
***** Arc Rated Uniforms and Leather shoes standard issue to KSU Electricians and thus assumed and not listed in the selection of Personal Protection Equipment***		

Part IV
Engineered Safe Work Practices
(For KSU Electricians)

	A	B	C
5	**Electrical Task to be Performed**	**Engineered Safe Work Practices**	**Hazard /Risk Category**
6			
7	**13,200 Volt Equipment**		
8	Main Breaker Line Up	Main Feeder Breakers on the 13,200 volt line up will only be switched remotely from the Power Plant Control Room	No Hazard,Remote Switching
9	Switching Main Transformers	Main Transformers (T1 and T2) will only be switched remotely from the ASCO control panel located NW of GT1 Turbine in the Power Plant	No Hazard,Remote Switching
10			
11	Tie breakers	Buddy System, Supervisory Authorization Required	4
12	ASCO Equipment	Control and Display Panel only	No PPE Required
13	Switching Transformers (Padmount) Exterior		
14	1) Primary Side (13,200)	Buddy System, Switching rotory Switches, switching procedures required	4
15	2) Secondary Side (208 or 480)	Infrared Imaging, verifying de-energized state	2
16			
17	Transformers (Dry) interior	Buddy System, Switching	2
18			
19	Switches (Exterior)	Buddy System, Performing switching, Switching procedures required	2
20	S&C PME Switches	Buddy System, Performing switching, Switching procedures required	2
21	S&C Vista Switches	Buddy System, Performing switching, Switching procedures required	2
22	Switches (Interior)	Buddy System, Performing switching, Switching procedures required	2
23	G&W Knife Switches		
24	Manholes	Buddy System, Supervisory Authorization Required	PPE TBD Per Event
25	Junction Boxes	Call Electrical contractor for inspection and repair	0
26	Use of Phasing Sticks	KSU Personnel will not use phasing sticks on 13.2v gear	N/A
27	**Electrical Task to be Performed**	**Engineered Safe Work Practices**	**Hazard /Risk Category**
28			
29	**4160 Volt Equipment**		
30	Transformers (Padmount) Exterior	Buddy System, Performing switching, Switching procedures required	2
31			
32	Transformers (Dry) interior	Buddy System, Performing switching, Switching procedures required	2
33			
34	Switches		
35	Switches (Exterior)	Buddy System, Performing switching, Switching procedures required	2

Part IV
Engineered Safe Work Practices
(For KSU Electricians)

	A	B	C
5	**Electrical Task to be Performed**	**Engineered Safe Work Practices**	**Hazard /Risk Category**
36	Switches (Interior)	Buddy System, Performing switching, Switching procedures required	2
37	G&W Knife Switches	Buddy System, Performing switching, Switching procedures required	2
38	Main breaker line up	Buddy System, Supervisory Authorization Required	4
39	Tie breakers	Isolate Intermediate Transformers using main breakers before operating, Buddy system, Supervisory Authorization required	0
40	Junction Boxes	Call Electrical contractor for inspection and repair	0
41	Manholes	Buddy System, Supervisory Authorization Required,	PPE TBD Per Event
42	Use of Phasing Sticks	KSU Personnel will not use phasing sticks on 4160v gear	N/A
43	Allerton Building Transformer	Isolate transformer remotely using breaker at substation, Buddy System, Supervisory Authorization Required	4
44	Allerton Sectionizers	Isolate sectionizer remotely using breaker at substation, test and pull load break elbows de-energized, Buddy System, Supervisory Authorization Required	4
45	**Electrical Task to be Performed**	**Engineered Safe Work Practices**	**Hazard /Risk Category**
46			
47	**Misc. Electrical Equipment**		
48	Repairing Tunnel lights	De-energize and lockout/tagout circuits, use battery light for illumination, Buddy System	0
49	Removing lid on Quazite box	Take caution when lifting lid, Isolate, LO/TO if possible	0
50	Hand holes on Light Poles (testing for voltage)	Isolate, LO/TO if possible	2
51	Lighting Timers (testing)	Isolate, LO/TO if possible	2
52	Allerton Medium voltage rooms	Buddy System, Supervisory Authorization Required	
53	Junction Boxes		
54	120/208 Volts (inside 3 ft 6 in approach boundry)	Proper PPE required	2
55	277/480 Volts (inside 3 ft 6 in approach boundry)	Proper PPE required	2
56	120/208 or 277/480 volts (outside 3 ft 6 in approach boundry)	Proper PPE required	0
57	Using Metal fishtape in conduit or Junction boxes		
58	120/208 Volts (inside 3 ft 6 in approach boundry)	Proper PPE required	2
59	277/480 Volts (inside 3 ft 6 in approach boundry)	Proper PPE required	2
60	120/208 or 277/480 volts (outside 3 ft 6 in approach boundry)	500 volt rubber and leather gloves required for shock protection	0 (see glove comments on left)
61	Using Non-Metal fishtape in conduit or Junction boxes		
62	120/208 Volts (inside 3 ft 6 in approach boundry)	Proper PPE required	2
63	277/480 Volts (inside 3 ft 6 in approach boundry)	Proper PPE required	2
64	120/208 or 277/480 volts (outside 3 ft 6 in approach boundry)	Proper PPE required	0

Part IV
Engineered Safe Work Practices
(For KSU Electricians)

	A	B	C
5	**Electrical Task to be Performed**	**Engineered Safe Work Practices**	**Hazard /Risk Category**
65	Testing Variable Frequency Drives	Proper PPE required	2
66	Removing fuses 600v or less	Proper PPE required	2
67	Resetting Breakers that are tripped	Proper PPE required	2
68	120/208 Volts (Lighting circuits only)	Max allow reset is 1 with Proper PPE worn	0
69	277/480 Volts (Lighting circuits only)	Max allow reset is 1 with Proper PPE worn	2
70			
71			
72	**Electrical Task to be Performed**	**Engineered Safe Work Practices**	**Hazard /Risk Category**
73			
74	**Misc. Electrical Equipment**		
75	Resetting Breakers that are tripped (Non-lighting circuits) 120/208 or 277/480 v	If overload of circuit **can** be verified and corrected, breaker can be reset with Proper PPE If overload **cannot** be verified, fault must be cleared and corrected before resetting the breaker using proper PPE	2
76	Work performed where energized parts exposed (Live Work) for voltages not greater than 480 volts	Tighting of lugs (Panels, Disconnects, Motor starters, etc) permitted with use of 1000v insulated tools and proper PPE without Electrical Work Permit. Alterations such as adding, removing, or replacement of connections or components require a Energized Electrical Work permit.	2
77	Florescent Fixtures with Battery backup	Use 500 volt rated gloves instead of leather glove to provide shock protection	0 (see glove comments on left)

APPENDIX C

Qualified Workers – Group #2
HVAC Technicians and Their Supervisors

The level of knowledge and skill the qualified personnel in this group include the ability to trouble-shoot, test and repair the electrical supply and control circuits from the disconnecting means to the energized load. These circuits will include: the heating, ventilating, refrigeration and air conditioning systems, and their associated equipment installed at Kent State University.

The authorized work, trouble-shooting and testing level by persons in this group is not to exceed 480 volts circuits live or de-energized. The only exception will be high voltage ignition systems used on gas fired equipment. Trouble-shooting and circuit testing are the only procedures that can be conducted on live circuits above 50 volts. It is mandatory that 500 volt gloves with leather protectors, face shields and fire resistant (FR) rated clothing be worn by all technicians when testing and trouble-shooting these live circuits. Only after all circuits are verified de-energized, all stored energy sources are released and the proper lockout/tagout procedure has been followed can repairs be made without protective gear.

This group of qualified electrical workers is limited to 480 volts, and incident energy of 8 cal./cm^2 where the arc flash survey has been completed or NFPA 70E Hazard Risk Category 2 where the study has not been completed. Where the arc flash study has not been completed, determine hazard risk category and appropriate PPE by using the NFPA tables found in Appendices K and L.

Part I HVAC Technician Safety Check-Off List

Part II HVAC Technician Flow Chart

Part I

GROUP 2: HVAC TECHNICIAN SAFETY CHECK-OFF LIST

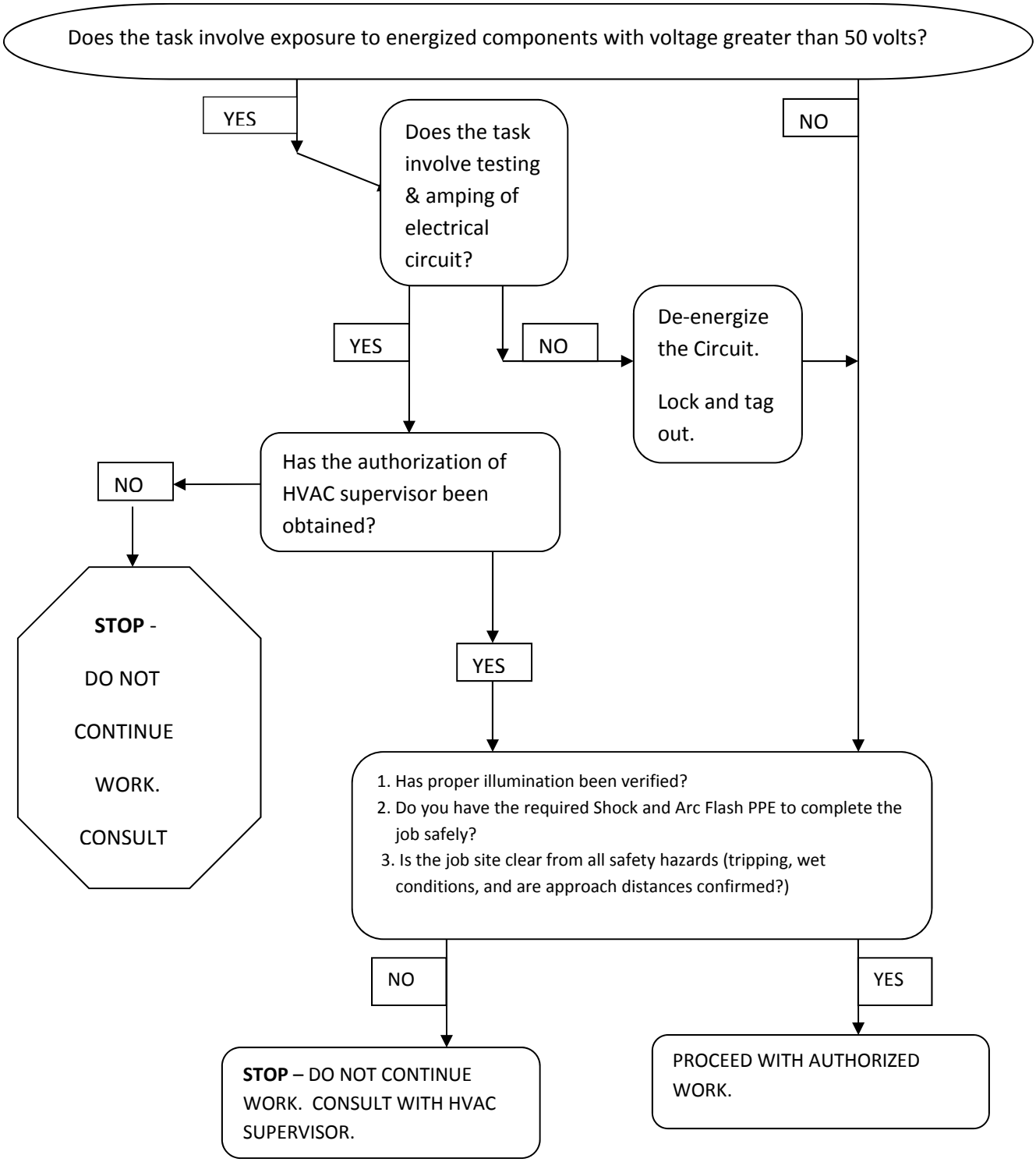
YES	NO	ITEM TO CONSIDER	PROCEDURES & PERSONAL PROTECTIVE EQUIPMENT REQUIREMENTS
		I have reviewed this job assignment with my supervisor and have been made aware of possible safety issues and proper procedures to follow.	☐ Lockout/Tag Out ☐ Ground fault protection ☐ 500V insulated gloves ☐ Leather protector gloves ☐ Safety harness and tripod ☐ Force air machine ☐ Respirator ☐ Eye or face protection ☐ Long sleeved shirt ☐ Ear protection ☐ Caution tape or barriers ☐ Electrical Hard Hat/w Shield ☐ Air space monitor ☐ Lifting platform or crane ☐ Asbestos abatement required ☐ Confined space permit ☐ Hot work permit ☐ Fire extinguisher ☐ Balaclava [Head Sock] or Arch Flash Hood ☐ Other _____
		Do I know and understand the proper procedures to do the job?	
		Do I have the right PPE and tools for the job I have been assigned?	
		Have I informed the affected personnel that I will be de-energizing the panel, circuit, and/or equipment and have I relayed the approximate time of the outage?	
		Is my work environment well lit?	
		Is my work area free of water, tripping hazards or any other hazards? i.e. Was dry ice ever used in this space?	
		If I have identified any safety hazards, have I contacted my supervisor and/or other responsible parties in order to remedy the situation?	
		If using extension cords or power tools, are the cords free from damage (ground pin removed, cracked, cut, or taped)?	
		Do I feel that I can do the job safely? Have I communicated this with my supervisor? My alertness is not impaired by illness or fatigue and I shall not reach blindly into areas containing live parts.	
		What is the operating voltage? What is the HRC or Incident Energy(480 volt, HRC 2, Incident Energy 8 cal/cm^2 max!) _____	
		Are there internal safety mechanisms? I.e. Anything other than the obvious devices like H.O.A. or disconnects, that could start or stop this equipment.	
		After turning disconnecting means to the "OFF" position, have I checked to see if the conductors are de-energized using the appropriate tester? There may be more than one energy source in the device.	
		During troubleshooting, if testing equipment in an energized state, have I used the proper PPE equipment and tools for the job?	

Print Name: _____ Print Name: _____

(Employee) (Supervisor)

Employee Signature: _____ Supervisor Signature: _____

GROUP 2, PART II: HVAC Technician Flow Chart



APPENDIX D
Qualified Workers - Group # 3
Energy Technicians and Their Supervisors

The level of knowledge and skill of the qualified personnel in this group includes the ability to troubleshoot, test and repair the low voltage electrical supply and control components from the digital controller power source to the controlled device. These circuits will include: Facilities Management and Automation Control Systems, electronic data communication and acquisition networks, heating, ventilating, refrigeration and air conditioning control systems, and their associated peripheral equipment installed at Kent State University

The authorized work, trouble-shooting and testing level by persons in this group is not to exceed 120 volt circuits live or de-energized. They are limited to Hazard Risk Category 2 or incident energy up to 8 cal/cm2. Trouble-shooting and circuit testing are the only procedures that can be conducted on live circuits above 50 volts. It is mandatory that 500 volt gloves with leather protectors, Arc Rated face shields, and clothing be worn by all technicians when testing and troubleshooting these live circuits over 50 volts. Only after all circuits are verified de-energized, all stored energy sources are released and the proper lockout/tagout procedure has been followed can repairs be made without protective gear.

This group of qualified electrical workers is limited to 480 volts, and incident energy of 8 cal./cm^2 where the arc flash survey has been completed or NFPA 70E Hazard Risk Category 2 where the study has not been completed. Where the arc flash study has not been completed, determine hazard risk category and appropriate PPE by using the NFPA tables found in Appendices K and L.

Part I Energy Technician Safety Check-Off List

Part II Energy Technician Safety Flow Chart

Part I

GROUP 2: ENERGY TECHNICIAN SAFETY CHECK-OFF LIST

Date:_____ Time:_____

Employee: _____

Description of Job: _____

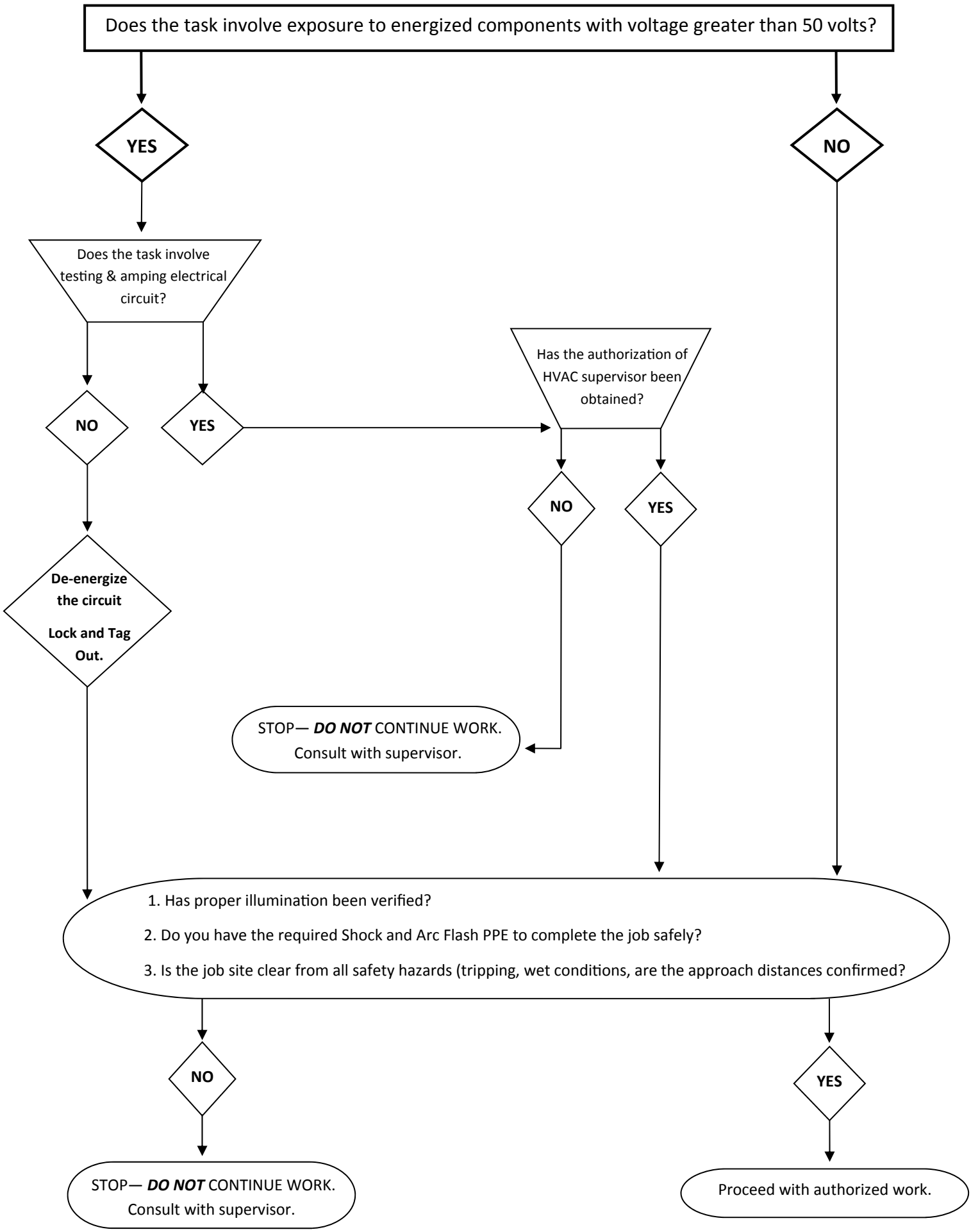
Work Location: _____

Work Order or Log Number: _____

Date, Time & Initials Supervisor Visited Job Site for Safety Checks: _____

YES	NO	ELECTRICAL SAFETY CHECK OFF LIST	PERSONAL PROTECTIVE EQUIPMENT REQUIREMENTS
		I have reviewed this job assignment with my supervisor and have been made aware of possible safety issues and proper procedures to follow.	☐ Lockout/Tag Out ☐ Ground fault protection ☐ 500V insulated gloves ☐ 5 KV gloves ☐ 15 KV gloves ☐ Protective sleeves ☐ Electrical hard hat ☐ Insulator boots ☐ Insulator mat ☐ Insulator blanket ☐ 1000V rated insulated tools ☐ Arc rated Jacket ☐ Safety harness and tripod ☐ Force air machine ☐ Respirator ☐ Eye and face protection ☐ Long sleeved shirt ☐ Ear protection ☐ Caution tape or barriers ☐ Balaclava (Head Sock) or Arc Flash Hood ☐ Other _____
		Do I know and understand the proper procedures to do the job?	
		Do I have the right PPE and tools for the job I've been assigned?	
		Have I informed the affected personnel that I will be de-energizing the panel, circuit, and/or equipment and have I relayed the approximate time of the outage?	
		Is my work environment well lit?	
		Is my work area free of water, tripping hazards or any other hazards?	
		If I have identified any safety hazards, have I contacted my supervisor and/or other responsible parties in order to remedy the situation?	
		If using extension cords or power tools, are the cords free from damage (cracked, cut, or taped)?	
		Do I feel that I can do the job safely? Have I communicated this with my supervisor? My alertness is not impaired by illness or fatigue and I shall not reach blindly into areas containing live parts.	
		What is the operating voltage? What is the Incident Energy? What are the boundaries? (480 volts, HRC 2 or Incident Energy 8 cal/cm^2 Max!) _____ _____	
		Are there internal safety mechanisms? i.e. Anything other than the obvious devices like H.O.A. or disconnects, that could start or stop this equipment?	
		After turning disconnecting means to the "OFF" position, have I checked to see if the conductors are de-energized using the appropriate tester? There may be more than on energy source in this device.	
		During troubleshooting, if testing equipment in an energized state, have I used the proper PPE equipment and tools for the job?	

GROUP 2, PART II: Energy Technician Flow Chart



APPENDIX E

Qualified Workers – Group #4
STATIONARY ENGINEERS AND THEIR SUPERVISORS

The knowledge and skill of the authorized personnel in this group includes the ability to perform Lockout/Tag-out on equipment to be maintained or regularly inspected. Routine maintenance procedures in the Power Plant have Lockout/Tagout procedures in place.

Power Plant personnel are prohibited from operating by direct contact with equipment rated higher than 500 volts. Control equipment which places personnel outside the limited approach boundary rated at 120 volts or less used to control equipment rated 480 volts or higher is not considered to be in this category.

The authorized work, trouble-shooting and testing level by persons in this group is not to exceed 500 volts live or de-energized. Trouble-shooting and circuit testing are the only procedures that can be conducted on live circuits above 50 volts. It is mandatory that 500 volt gloves with leather protectors (class 00), Arc Rated face shields and clothing be worn by all personnel when testing and troubleshooting these live circuits. Arc Rated jackets are considered to be in this category. Only after all circuits are verified de-energized, all stored energy sources are released and the proper lockout/tag out procedure has been followed can repairs be made without protective gear.

This group of qualified electrical workers is limited to 480 volts, and incident energy of 8 cal./cm^2 where the arc flash survey has been completed or NFPA 70E Hazard Risk Category 2 where the study has not been completed. Where the arc flash study has not been completed, determine hazard risk category and appropriate PPE by using the NFPA tables found in Appendices K and L.

APPENDIX F

Qualified Workers – Group #5

ACPM Specialists, Maintenance Repair Workers, Plumbers, Steam Fitters, Welders, Water Treatment Technicians, Pool Technicians, Maintenance Facility Workers, Recreation Facility Workers, and their Supervisors.

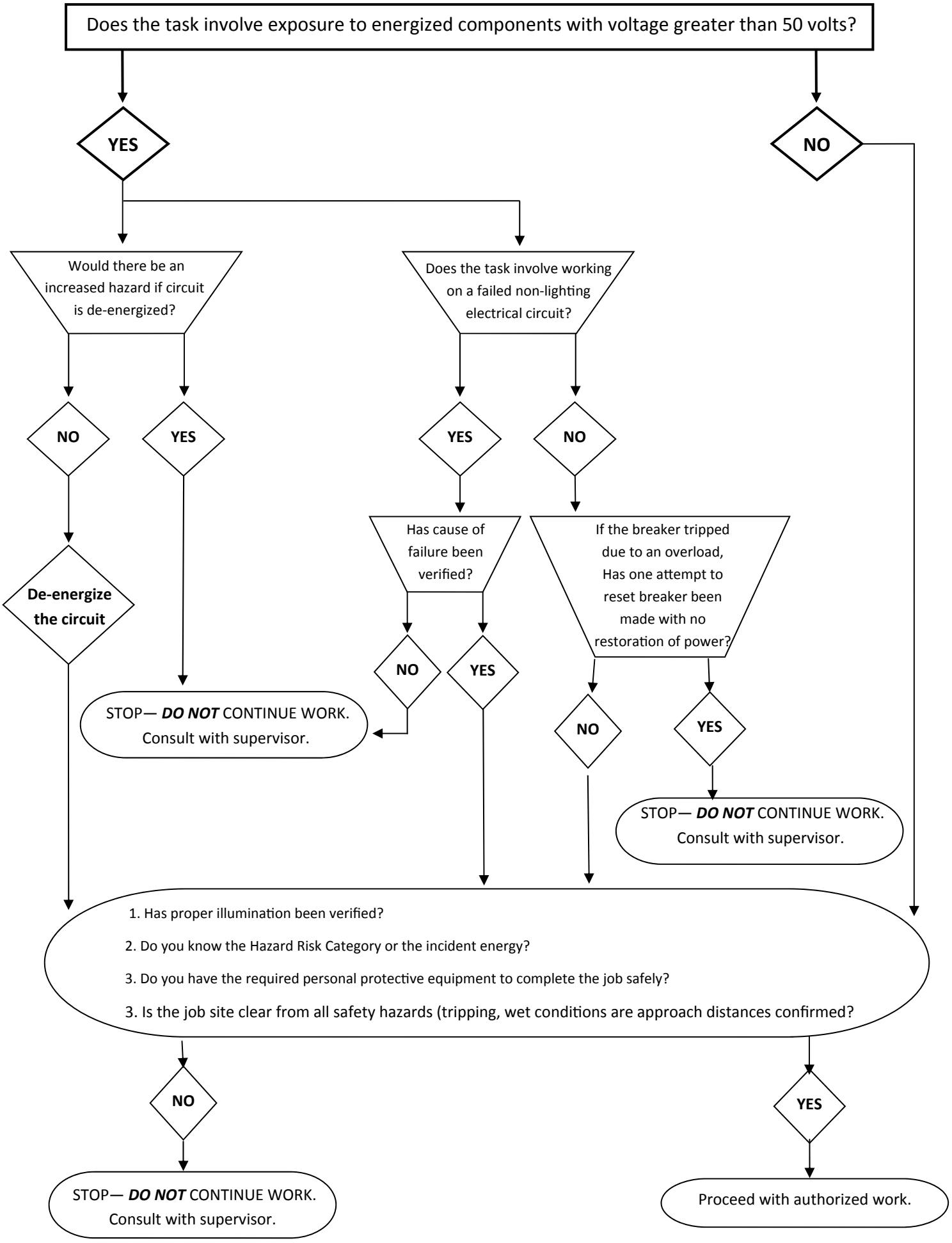
The level of knowledge and skill of the qualified personnel in this group includes the ability to troubleshoot, test and repair electrical circuits from the disconnecting means of the energized load. These circuits will include wall receptacles, lighting circuits, ventilation and exhaust fan motors and circulating pumps installed at Kent State University.

This level is not to exceed 240 volt equipment or 277 lighting circuits. No work may be conducted until all circuits are verified de-energized, all stored energy sources released and the proper lockout/tagout procedure has been followed.

This group of qualified electrical workers is limited to 240 volt equipment or 277 volt lighting circuits, and incident energy of 8 cal./cm2 where the arc flash survey has been complete or NFPA 70E Hazard Risk Category 2 where the study has not been completed. Where the arc flash study has not been completed, determine hazard risk category and appropriate PPE by use the NFPA table found in Appendices K and L.

Part I: Maintenance Electrical Work Permit Chart

Maintenance Electrical Work Permit Flow Chart



Appendix G

Fleet Services Equipment Mechanics, Automotive Mechanics, Automotive Maintenance Crew Leader, Fleet Services Superintendent

Qualified Person per NFPA 70 E (Definitions)

"One who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training on the hazards involved"

Kent State University Fleet Services personnel (listed above) are considered "qualified" to work on systems not exceeding 480 volts AC, 480 volts primary DC, or 75,000 volt ignition systems, and incident energies not to exceed 40 cal./cm^2 or Hazard Risk Category 4. Each person listed above is required to take regularly scheduled electrical safety courses provided by the university. Specialized classroom and hands-on training is also provided to those persons.

Scope of duties include but are not limited to: mobile equipment, normal/hybrid/electric vehicles, lifts, shop equipment, AC/DC generators/transfer switches and their associated equipment, battery banks, chargers, UPS systems, inverters, fueling equipment, and all associated equipment sub-systems.

Testing/trouble-shooting Energized Circuits:
This operation may be performed using safe work practices and with appropriate PPE, in accordance to this document.

Working on Energized Circuits:
No work shall be done without authorization of this group's superintendent. Approved work will only be done when it can be accomplished safely. Approved work may be performed when a minimum of two qualified persons are present, using safe work practices, and appropriate PPE in accordance to this document.

Sufficient protection in the form of insulated tools and insulated protective equipment such as: rubber gloves with protectors, blankets, sleeves, mats, shields, line hose, line guards, insulator hoods, arc flash equipment/clothing, and access boards shall be used while testing and/or trouble-shooting when working on energized circuits.

Where the Kent State University Arc Flash Study has been completed the label is used to determine boundary distances, shock hazard, and incident energy. From this appropriate PPE can be selected. Where the study has not been completed, NFPA 70E tables and other sections have been used as the standard for the safe work practices and levels of required PPE required by the Fleet Services personnel listed above (see Part IV).

Part I **Fleet Services Safety procedure Checklist**

Part II **Energized Work Permit Chart**

Part III **Energized Work Permit**

Part IV **Safe Work Practices**

PART I - FLEET SERVICES SAFETY PROCEDURE CHECK-OFF LIST

EMPLOYEE:_____ DATE: _____
(Print Name)

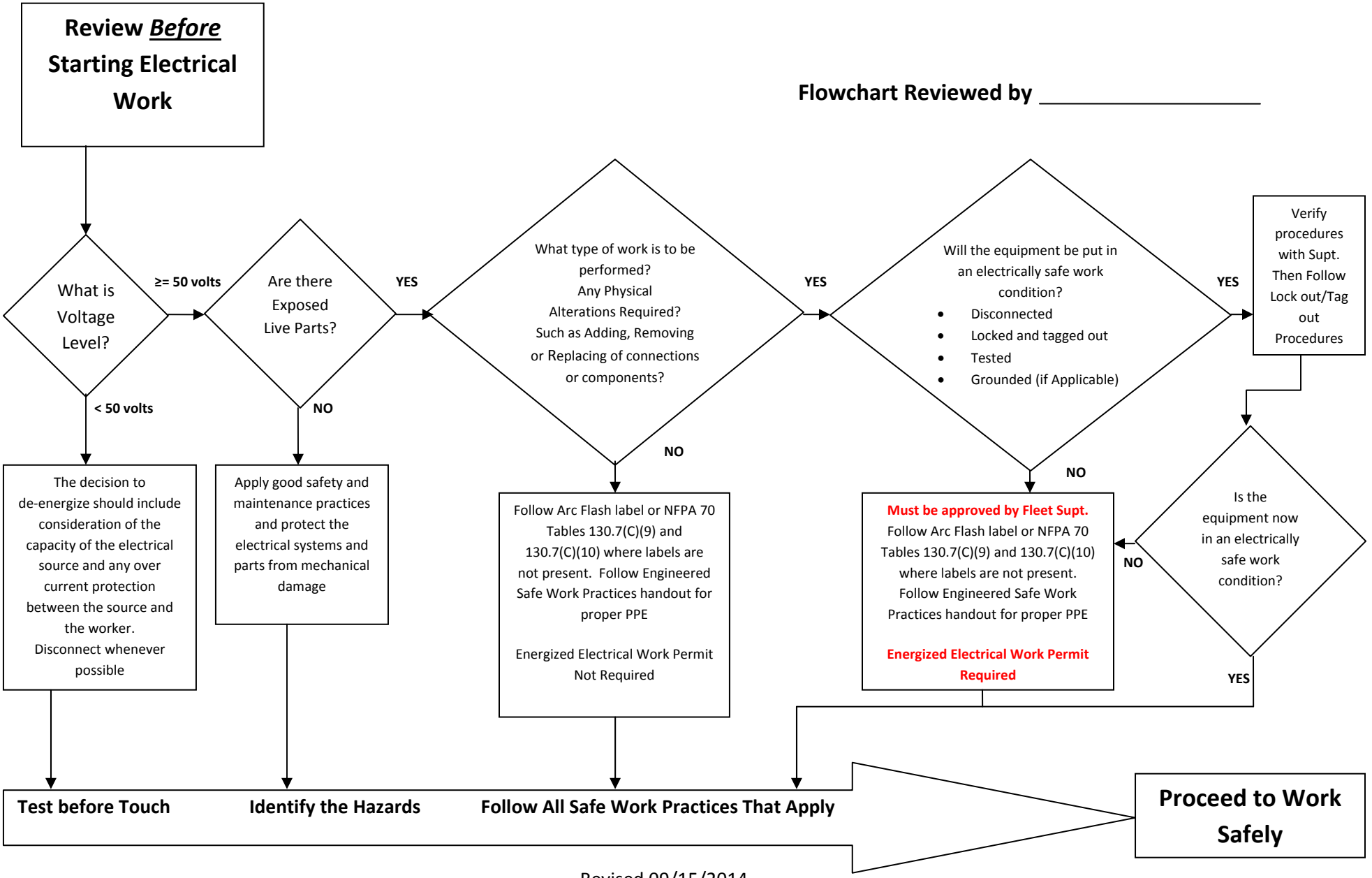
WORK ORDER NUMBER: _____ JOB & LOCATION: _____

YES	NO	ITEM TO CONSIDER *(Read each carefully)*	PERSONAL PROTECTIVE EQUIPMENT REQUIREMENTS
		I have reviewed this job assignment, I am familiar with the equipment, I am aware of possible safety issues, and the proper procedures to follow.	☐ Lockout/Tag Out supplies ☐ Ground fault protection (GFCI) ☐ 500V insulated gloves ☐ 1000V insulated gloves ☐ Electrical hard hat ☐ Insulator boots ☐ 1000V Protective sleeves ☐ Insulator mat ☐ Insulator blanket ☐ 1000V rated tools ☐ Radio – 2 way ☐ Gloves – leather, rubber, latex ☐ Safety harness and lanyard ☐ Lighting ☐ Respirator ☐ Eye and/ or face protection ☐ Long sleeved shirt ☐ Hearing protection ☐ Jack stands & props ☐ Welding/ cutting PPE (burn permit?) ☐ Fire Extinguisher ☐ Portable Eyewash Station ☐ Arc Flash Equipment & Clothing ☐ 100% Cotton Clothing ☐ Other _____
		Do I know and understand the proper procedures to do the job?	
		Do I have the right PPE and tools for the job I've been assigned?	
		Have I informed the affected personnel that I will be working and/or performing a lockout/tagout in the area and how it will affect them? (both before and after the repair and/or lockout/tagout)	
		Is my work environment well lit, clear of tripping hazards, water or other hazardous situations?	
		If I have identified any safety hazards, have I contacted my supervisor and/or other responsible parties in order to remedy the situation?	
		Do I feel that I can do the job safely? Is my alertness impaired by medicines, illness, fatigue or other reasons? Have I communicated these issues with my supervisor?	
		I have inspected my hand and power tools, test equipment, cords, and PPE for proper operation and condition. (cuts, abrasions, missing or broken items, meter lead insulation cut, cords taped, cracks, etc.)	
		What are the operating voltages and clearance limits? _____	
		During trouble-shooting, if testing equipment in an energized state, have I used the proper PPE equipment and tools for the job? Am I following procedures set forth in the UFM electrical safety procedures manual?	
		After de-energizing any equipment and performing lockout/tagout procedures as set forth in the UFM Lockout/Tagout procedures manual, and before I start my work, have I checked to see if all circuits/conductors or other sources of stored energy are actually de-energized using the appropriate tester and or method?	
		Expected Outcome:	
		Action to be taken if outcome is not as expected:	
		Emergency Procedures:	
		Emergency Escape Routes:	
		Quality Control <u>Has the unit been test driven/run?</u> <u>Is equipment clean and any messes cleaned up?</u> <u>Locks/ tags removed & equipment is back in its safe-normal condition?</u> <u>All safety interlocks restored and operational?</u> <u>Is genset now in the remote position?</u> <u>Are all tools, PPE cleaned, and turned in or put away?</u> <u>Has the Truck/Utiliity Vehicle been re-stocked?</u> <u>Are lockout tags, permits, lists completed and attached to the work order?</u>	<u>Lockout Tag Information Requirement</u> Identity of authorized person installing & removing. Signature of person installing & removing. Date and time installed and removed. Type of energy locked & tagged out. Procedure for verifying zero residual energy state. Statement on tag saying "safe to return to service".

Employee Signature: _____, Supervisor Signature: _____

This document must be completed on each project as required by University Facilities Management.

Part II
Fleet Services Energized Electrical Work Permit Flow Chart



Revised 09/15/2014

Part III

FLEET SERVICES ENERGIZED ELECTRICAL WORK PERMIT

Part 1: TO BE COMPLETED BY THE REQUESTER:			
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:			
Requester/Title	Requester's Signature		Date
Part II: TO BE COMPLETED BY THE ELECTRICALLY QUALIFIED* PERSONS *DOING* THE WORK:			
1. Description of the Safe Work Practices to be employed [NFPA 70E, 110.8 (B)]:			
2. Shock Hazard Analysis: Voltage Level Phase to Phase			
Limited Approach Boundaries [NFPA 70E, Table 130.2 (c)]:		Restricted	Prohibited
		3. Results of Hazard/Risk Analysis [NFPA 70E, 130.3]:	
Flash Protection Boundary:		Assumed (100 KA or less) or Calculated **(Circle one)**	
Hazard/Risk Category/Incident Energy		OR Calculated Flash Hazard at 18"	
4. List personal protective equipment to be used to perform the assigned task [NFPA 70E, Table 130.7(C) (9) (a)]:			
Arc –rated jacket (Cal = _____)/Arc Flash hood / Face shield/head sock/ Electrical Hardhat/ Safety glasses or goggles/Ear protection/ Arc rated rubber and leather gloves**			
5. Means employed to restrict the access of unqualified persons from the work area [NFPA 70E, 110.8(A) (2)]: **(Circle restriction method(s) being used) Signs/ Barrier/Qualified Attendant**			
6. Evidence of completion of a Job Briefing including discussion of any job-related hazards [NFPA 70E, Table 110.7(G)]:**Electrical Safety Procedure Checklist**			
7. Do you agree the above described work can be done safely? **YES / NO** (Circle: If ***no*** return to requester)			
Electrically Qualified Persons*		Date	
Electrically Qualified Persons*		Date	
Duration of Work: Beginning Date /Time		Ending Date/Time	
Part III: SIGNATURES TO PERFORM ENERGIZED ELECTRICAL WORK AND WITNESS TO WORK PERFORMED:			
Fleet Services Superintendent or Manager		Date /Time Witnessed	
**** One who has skills and knowledge related to the construction and operation of the electrical equipment and Installations and has received safety training on the hazards involved per NFPA 70E definition.***			
***** 100% Cotton Uniforms and Leather shoes are standard issue to KSU Fleet Services and thus are not listed in the selection of Personal Protection Equipment***			

Part IV
Fleet Services Safe Work Practices

3-30-11

	A	B	C
1	**Electrical Task to be Performed**	**Engineered Safe Work Practices**	**Arc Flash Hazard /Risk Category**
2			
3	**General:** Removing fuses 600v or less	Proper PPE required	2
4	**General:** Resetting Breakers that are tripped	Proper PPE required	2
5	120/208 Volts (Lighting circuits only)	Max allow reset is 1 with Proper PPE worn	0
6	277/480 Volts (Lighting circuits only)	Max allow reset is 1 with Proper PPE worn	2
7	**General:** Resetting Breakers that are tripped (Non-lighting circuits) 120/208 or 277/480 v	If overload of circuit **can** be verified and corrected, breaker can be reset with Proper PPE If overload **cannot** be verified, fault must be cleared and corrected before resetting the breaker using proper PPE	2
8	**General:** Testing or troubleshooting	Proper PPE required	2
9	**General:** Work performed where energized parts exposed (Live Work) for voltages not greater than 480 volts	Alterations such as adding, removing, or replacement of connections or components require a Energized Electrical Work permit.	3
10			
11	**ATS:** Testing or troubleshooting - Door closed	Proper PPE required	0
12	**ATS:** Testing, troubleshooting or imaging - Door open	Proper PPE required	2
13	**ATS:** Observing the switching operation - Door open	Superintendent Approval, Proper PPE required	3
14	**ATS:** Performing work (bulb changes) - Door closed	Proper PPE required	1
15	**ATS:** Performing work (components on inside of door- bulbs) - Door open	Proper PPE required	2
16	**ATS:** Performing work - Door open	1) Energized work permit required. 2) Proper PPE required. 3) Buddy System Required. 4) Superintendent/Supervisor Presence Required.	3
17	**ATS:** Manually bypassing power source - Door closed	Proper PPE required	0
18	**ATS:** Manually Isolating ATS - Door closed	Proper PPE required	0
19	**ATS:** Manually Isolating ATS - Door open	Proper PPE required, Buddy system required	2
20	**ATS:** Manually switching power source - Door closed	Proper PPE required, load to be shed to minimum if possible	2
21	**ATS:** Manually switching power source, Non-Life Safety Emergency - Door open	1) Superintendent Approval. 2) Buddy system required. 3) Proper PPE Required. 4) Normal & emergency powers sources to be disconnected & locked out. 5) Generator start to be disabled. 6) Load side breaker to be disconnected & locked out. 7) Verification of zero voltage state.	2
22	**ATS:** Manually switching power source, Life Safety Emergency - Door open	1) Superintendent Approval (if possible). 2) Buddy system required. 3) Proper PPE Required. 4) Load side breaker to be opened & locked out/guarded. 5) Generator output breaker to be opened and locked out/guarded. 6) Perform Manual ATS switching. 7) Generator output breaker to be closed. 8) Load side breaker to be closed.	3
23			

Part IV
Fleet Services Safe Work Practices

3-30-11

	A	B	C
24	**Electrical Task to be Performed**	**Engineered Safe Work Practices**	**Arc Flash Hazard /Risk Category**
25			
26	**Battery Bank, 120v+:** Testing or troubleshooting	Proper PPE required	2
27	**Battery Bank, 120v+:** Routine Maintenance (no work)	Proper PPE required, Buddy system required	2
28	**Battery Bank, 120v+:** Work, repairs, replacement	1) Energized work permit required. 2) Proper PPE required. 3) Buddy System Required.	3 (see notes 1 & 2)
29			
30	**UPS:** Battery testing or troubleshooting	Proper PPE required	2 (see note 2)
31	**UPS:** Battery routine maintainance	Proper PPE required, Buddy system required	2 (see note 2)
32	**UPS:** Battery work, repairs, replacement	1) Energized work permit required. 2) Proper PPE required. 3) Buddy System Required.	3 (see notes 1 & 2)
33	**UPS:** Manually bypassing UPS-inverter	Proper PPE required	0
34	**UPS:** Inverter area testing or troubleshooting	Proper PPE required	2
35	**UPS:** Control Panel repairs, replacement (not in inverter area)	1) Energized work permit required. 2) Proper PPE required. 3) Buddy System Required.	2
36	**UPS:** Inverter area routine maintainance, work, repairs, replacement	Not to be done while energized, Grounding clamps and 500v insulating gloves & protectors to be used due to capacitors	0
37			
38	**Battery Charger\Power Supply, 120v+:** Testing or troubleshooting	Proper PPE required	2*
39	**Battery Charger\Power Supply, 120v+:** Work, repairs, replacement	1) Energized work permit required. 2) Proper PPE required. 3) Buddy System Required. 4) Superintendent/Supervisor Presence Required.	3
40			
41	**Electric, Electric Hybrid Vehicle 50v to 75v:** Electrical system or Battery testing or troubleshooting	Proper PPE required	0 (see note 2)
42	**Electric, Electric Hybrid Vehicle 50v to 75v:** Electrical system work, repairs, replacement	Proper PPE required, Disconnect battery bank from electrical system via switch.	0
43	**Electric, Electric Hybrid Vehicle 50v to 75v:** Battery work, repairs, replacement	Proper PPE required, first step is to separate jars until connected jar votage is < 50v	0 (see note 2)
44			
45	**Electric, Electric Hybrid Vehicle Greater Than 75v:** Electrical system testing or troubleshooting	Proper PPE required	2
46	**Electric, Electric Hybrid Vehicle Greater Than 75v:** Electrical system work, repairs, replacement	Proper PPE required, Disconnect and lockout battery bank from electrical system via switch.	0
47	E**lectric, Electric Hybrid Vehicle Greater Than 75v:** Battery work, repairs, replacement	1) Energized work permit required. 2) Proper PPE required. 3) Buddy System Required. 4) Separate jars until connected jar votage is < 50v if possible.	3 (see notes 1 & 2)
48			
49	**Note 1:** HR 3 PPE must be utilized until connected jar voltage is reduced to < 50 volts.		
50	**Note 2:** Care must be exercised to not expose arc flash PPE to battery acid		

Appendix H
Group # 7 – Other University Qualified Employees

A qualified employee is "One who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training on the hazards involved".

This group of employees, described in Appendix A, is normally restricted to working on equipment in a de-energized state. Therefore, their exposure to electrical hazards will only occur while de-energizing and verifying a zero energy state. During this process, the employee must use proper lockout/tagout procedures. This employee must use the information provided on the label where an arc flash survey has been completed or determine the HRC found in Appendix K to select the appropriate PPE, Appendix L, that must be worn where an Arc Flash label is not present.

On rare occasions, it might be necessary to troubleshoot laboratory equipment while the equipment is energized. This should only be done as a last resort, and only done when the employee is "qualified" through experience and training to recognize the electrical hazards while working on any piece of equipment. When doing so, the employee must read and understand the labels where an arc flash survey has been completed or determine the hazard risk category do that appropriate PPE can be selected.

In no case, shall this group of employees install or repair electrical equipment other than what is described above. This group of employees is limited to no more than 240 volts and HRC 2/ 8 cal/cm^2, and only after that they received specific training and experience to conduct this category of electrical work safely.

APPENDIX I

Approach Boundaries to Energized Electrical Conductors or Circuit Parts for Shock Protection (All dimensions are distance from energized electrical conductor or circuit part to employee). Table 130.4(C)(a) of NFPA 70E – 2012 Edition

(1) Nominal System Voltage Range, Phase to Phase[a]	Limited Approach Boundary[b]		(4) Restricted Approach Boundary[b]; Includes Inadvertent Movement Adder	(5) Prohibited Approach Boundary[b]
	(2) Exposed Movable Conductor[c]	(3) Exposed Fixed Circuit Part		
Less than 50	Not specified	Not specified	Not specified	Not specified
50 to 300	3.0 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	Avoid contact	Avoid contact
301 to 750	3.0 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	.3 m (1 ft 0 in.)	25 mm (0 ft 1 in.)
751 to 15 kV	3.0 m (10 ft 0 in.)	1.5 m (5 ft 0 in.)	.7 m (2 ft 2 in.)	.2 m (0 ft 7 in.)
15.1 kV to 36 kV	3.0 m (10 ft 0 in.)	1.8 m (6 ft 0 in.)	.8 m (2 ft 7 in.)	.3 m (0 ft 10 in.)
36.1 kV to 46 kV	3.0 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	.8 m (2 ft 9 in.)	.4 m (1 ft 5 in.)
46.1 kV to 72.5 kV	3.0 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	1.0 m (3 ft 3 in.)	.6 m (2 ft 2 in.)
72.6 kV to 121 kV	3.3 m (10 ft 8 in.)	2.5 m (8 ft 0 in.)	1.0 m (3 ft 4 in.)	.8 m (2 ft 9 in.)
138 kV to 145 kV	3.4 m (11 ft 0 in.)	3.0 m (10 ft 0 in.)	1.2 m (3 ft 10 in.)	1.0 m (3 ft 4 in.)
161 kV to 169 kV	3.6 m (11 ft 8 in.)	3.6 m (11 ft 8 in.)	1.3 m (4 ft 3 in.)	1.1 m (3 ft 9 in.)
230 kV to 242 kV	4.0 m (13 ft 0 in.)	4.0 m (13 ft 0 in.)	1.7 m (5 ft 8 in.)	1.6 m (5 ft 2 in.)
345 kV to 362 kV	4.7 m (15 ft 4 in.)	4.7 m (15 ft 4 in.)	2.8 m (9 ft 2 in.)	2.6 m (8 ft 8 in.)
500 kV to 550 kV	5.8 m (19 ft 0 in.)	5.8 m (19 ft 0 in.)	3.6 m (11 ft 10 in.)	3.5 m (11 ft 4 in.)
765 kV to 800 kV	7.2 m (23 ft 9 in.)	7.2 m (23 ft 9 in.)	4.9 m (15 ft 11 in.)	4.7 m (15 ft 5 in.)

Note for Arc Flash Boundary see 130.5(A)

[a] For Single Phase Systems, select the range that is equal to system's maximum phase-to-ground voltage multiplied by 1.732

[b] See definition in Article 100 and test in 130.4(D)(2) and Annex C for elaboration

[c] This term describes a condition in which the distance between the conductor and the person is not under the control of the person. The term is normally applied to overhead line conductors supported by poles

Approach Boundaries[a] to Energized Electrical Conductors or Circuit Parts for Shock Protection (All dimensions are distance from energized electrical conductor or circuit part to employee). Table 130.4(C)(b) of NFPA 70E – 2012 Edition

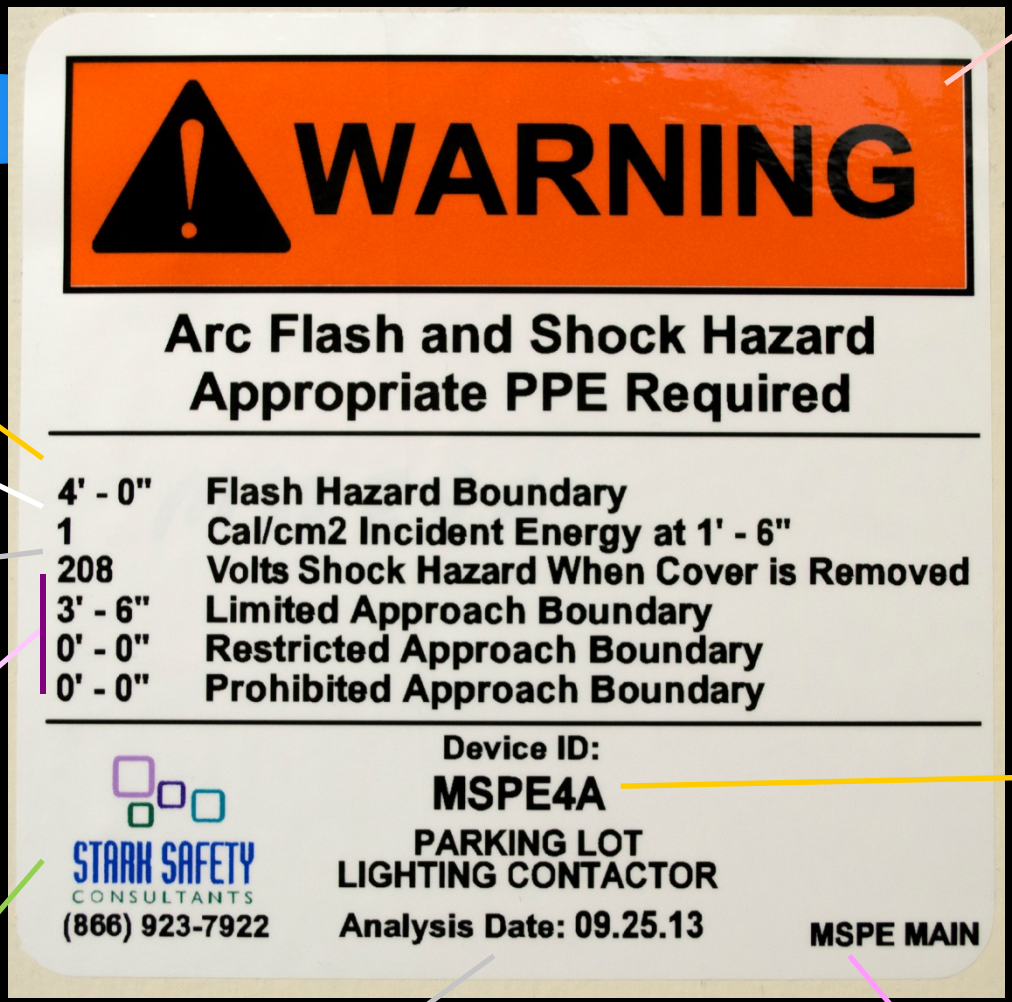
Direct-Current Voltage Systems

(1) Nominal Potential Difference	Limited Approach Boundary		(4) Restricted Approach Boundary$_1$; Includes Inadvertent Movement Adder	(5) Prohibited Approach Boundary$_1$
	(2) Exposed Movable Conductor[b]	(3) Exposed Fixed Circuit Part		
Less than 100	Not specified	Not specified	Not specified	Not specified
100 to 300	3.0 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	Avoid contact	Avoid contact
301 to 1 kV	3.0 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	0.3 m (1 ft 0 in.)	25 mm (0 ft 1 in.)
1.1 kV to 5 kV	3.0 m (10 ft 0 in.)	1.5 m (5 ft 0 in.)	0.5 m (1 ft 5 in.)	0.1 m (0 ft 4 in.)
5 kV to 15 kV	3.0 m (10 ft 0 in.)	1.5 m (5 ft 0 in.)	0.7 m (2 ft 2 in.)	0.2 m (0 ft 7 in.)
15.1 kV to 45 kV	3.0 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	0.8 m (2 ft 9 in.)	0.4 m (1 ft 5 in.)
45.1 kV to 75 kV	3.0 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	1.0 m (3 ft 2 in.)	0.7 m (2 ft 1 in.)
75.1 kV to 150 kV	3.3 m (10 ft 8 in.)	3.0 m (10 ft 0 in.)	1.2 m (4 ft 0 in.)	1.0 m (3 ft 2 in.)
150.1 kV to 250 kV	3.6 m (11 ft 8 in.)	3.6 m (11 ft 8 in.)	1.6 m (5 ft 3 in.)	1.5 m (5 ft 0 in.)
250.1 kV to 500 kV	6.0 m (20 ft 0 in.)	6.0 m (20 ft 0 in.)	3.5 m (11 ft 6 in.)	3.3 m (10 ft 10 in.)
500.1 kV to 800 kV	8.0 m (26 ft 0 in.)	8.0 m (26 ft 0 in.)	5.0 m (16 ft 5 in.)	5.0 m (16 ft 5 in.)

[a] All dimensions are distance from exposed energized electrical conductors or circuit parts to worker.

[b] This term describes a condition in which the distance between the conductor and a person is not under the control of the person. The term is normally applied to overhead line conductors supported by poles.

Appendix J
Arc Flash Warning Label



LABEL COLOR CODE

DISTANCE FROM THE FAULT A PERSON MAY BE EXPOSED TO AN INCIDENT ENERGY OF 1.2 CAL/CM^2

CALCULATED INCIDENT ENERGY AT A GIVEN DISTANCE 18”

AVAILABLE VOLTAGE LEVEL OF THE EQUIPMENT

APPROACH BOUNDARIES

EQUIPMENT NAME

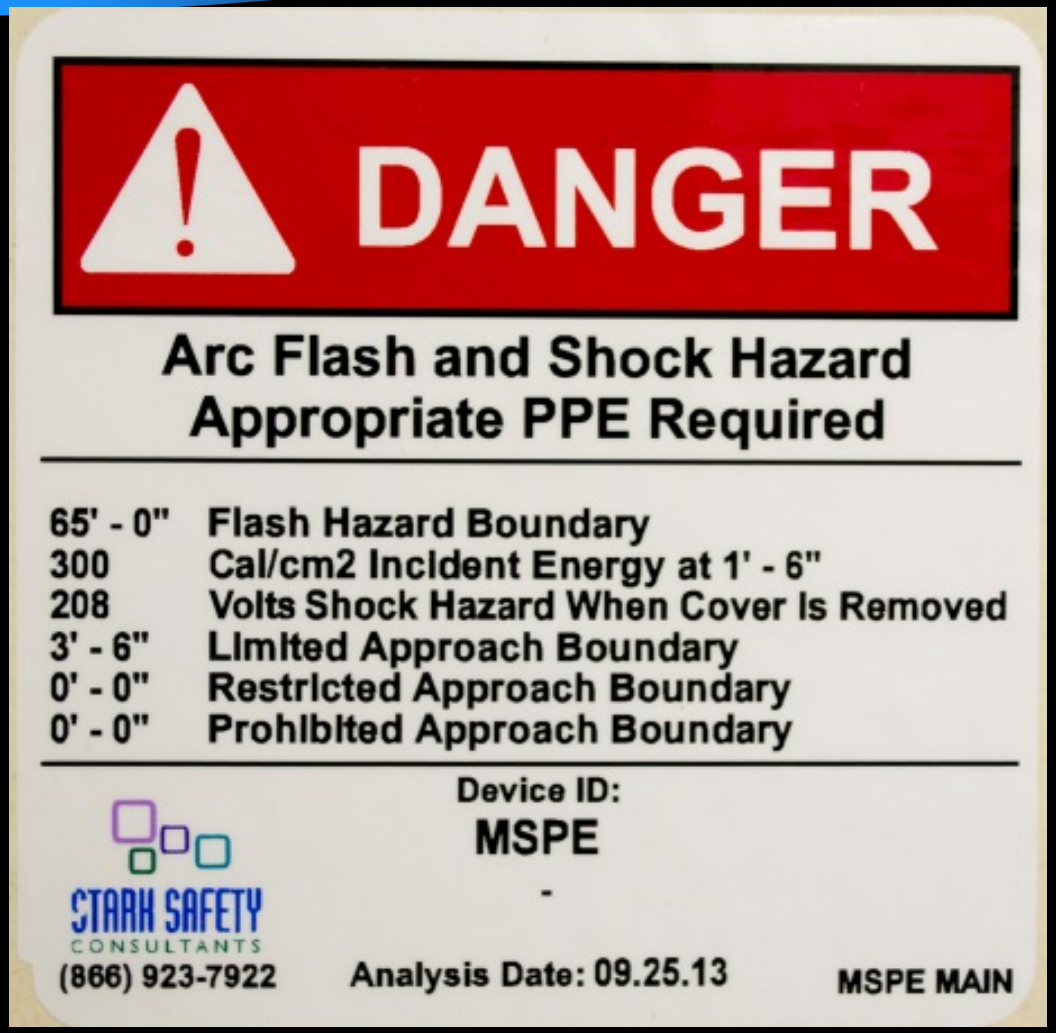
ENGINEER

DATE OF ARC FLASH STUDY

One Line Diagram Page

Arc Flash Danger Label

For hazards with greater than 40cal/cm2 posted on warning label, no electrical work or interaction with equipment will be permitted.



Hazard/Risk Category Classification Tables

ELECTRICAL SAFE WORK PRACTICE PROGRAM – 70E TABLES

TASK (Alternating Current) (Assumes equipment is energized, and work is done within the flash protection boundary)	Hazard/ Risk Category	Rubber Insulating Gloves	Insulated and Insulating Hand Tools
Panel boards or other equipment rated 240V and below – Note 1 – Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 19 in.			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	0	N	N
Circuit breaker (CB) or fused switch operation with covers on	0	N	N
CB or fused switch operation with covers off	0	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	1	Y	Y
Remove/install CBs or fused switches	1	Y	Y
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	1	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	0	N	N
Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the panel board	1	Y	Y
Panel boards or Switchboards rated >240V and up to 600V (with molded case or insulated case circuit breakers) Note 1 – Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 30 in.			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	1	N	N
Circuit breaker (CB) or fused switch operation with covers on	0	N	N
CB or fused switch operation with covers off	1	Y	N
Work on energized electrical conductors and circuit parts, including voltage testing	2	Y	Y
Remove/install CBs or fused switches	2	Y	Y
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	1	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	0	N	N
Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the panel board.	2	Y	Y
600V class motor control centers (MCCs) – Note 2 (except as indicated) – Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 53 in.			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	1	N	N
CB or fused switch or starter operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB or fused switch or starter operation with enclosure doors open	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2	Y	Y
Work on control circuits with energized electrical conductors and circuit parts 120V or below, exposed	0	Y	Y
Work on control circuits with energized electrical conductors and circuit parts >120V, exposed	2	Y	Y
Application of temporary protective grounding equipment, after voltage test	2	Y	N
Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the motor control center	2	Y	Y
600V class motor control centers (MCCs) – Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 165 in.			
Insertion or removal of individual starter "buckets" from MCC	4	Y	N
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	1	N	N
600V class switchgear (with power circuit breakers or fused switches) and 600 V class switchboards – Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 233 in.			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	2	N	N
CB or fused switch operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB or fused switch operation with enclosure doors open	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2	Y	Y
Work on control circuits with energized electrical conductors and circuit parts 120V or below, exposed	0	Y	Y
Work on control circuits with energized electrical conductors and circuit parts >120V, exposed	2	Y	Y
Insertion or removal (racking) of CBs from cubicle, doors open or closed	4	N	N
Application of temporary protective grounding equipment after voltage test	2	Y	N
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical and circuit parts	2	N	N
Other 600V class (277V through 600V, nominal) equipment – Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 53 in.			

TASK (Alternating Current) (Assumes equipment is energized, and work is done within the flash protection boundary)	Hazard/ Risk Category	Rubber Insulating Gloves	Insulated and Insulating Hand Tools
Lighting or small power transformers (600V, maximum)			
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	2	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2	Y	Y
Application of temporary protective grounding , after voltage testing	2	Y	N
Revenue meters (kW-hour, at primary voltage and current) insertion or removal	2	Y	N
Cable trough or tray cover removal or installation	1	N	N
Miscellaneous equipment cover removal or installation	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2	Y	Y
Application of temporary protective grounding equipment, after voltage test	2	Y	N
Insertion or removal of plug-in devices into or from busways	2	Y	N
NMEA E2 (fused contactor) Motor Starters, 2.3 kV through 7.2 kV – Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 422 in.			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	3	N	N
Contactor operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
Contactor operation with enclosure doors open	2	N	N
Work on energized electrical conductors and circuits parts, including voltage testing	4	Y	Y
Work on control circuits with energized electrical conductors and circuit parts 120V or below, exposed	0	Y	Y
Work on control circuits with energized electrical conductors and circuit parts >120V, exposed	3	Y	Y
Insertion or removal (racking) of starters from cubicles, doors open or closed	4	N	N
Application of temporary protective grounding equipment, after voltage test	3	Y	N
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	3	N	N
Insertion or removal (racking) of starters from cubicles of arc-resistant construction, tested in accordance with IEEE C37.20.7, doors closed only	0	N	N
Metal Clad Switchgear, 1 kV through 38 kV - Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 422 in.			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	3	N	N
CB operation with enclosure doors closed	2	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB operation with enclosure doors open	4	N	N
Work on energized electrical conductors and circuits parts, including voltage testing	4	Y	Y
Work on control circuits with energized electrical conductors and circuit parts 120V or below, exposed	2	Y	Y
Work on control circuits with energized electrical conductors and circuit parts >120V, exposed	4	Y	Y
Insertion or removal (racking) of CBs from cubicles, doors open or closed	4	N	N
Application of safety grounds, after voltage test	4	Y	N
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	3	N	N
Opening voltage transformer or control power transformer compartments	4	N	N
Arc-Resistant Switchgear Type 1 or 2 (for clearing times of <0.5 sec with a perspective fault current not to exceed the arc-resistant rating of the equipment) - Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 422 in.			
CB operation with enclosure door closed	0	N	N
Insertion or removal (racking) of CBs from cubicles, door closed	0	N	N
Insertion or removal of CBs from cubicles, door open	4	N	N
Work on control circuits with energized electrical conductors and circuit parts 120V or below, exposed	2	Y	Y
Insertion or removal (racking) of ground and test device with door closed	0	N	N
Insertion or removal (racking) of voltage transformers on or off the bus door closed	0	N	N
Other Equipment 1 kV through 38 kV - Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 422 in.			
Metal-enclosed interrupter switchgear, fused or unfused			
Switch operation of arc-resistant-type construction, tested in accordance with IEEE C37.20.7, doors closed only	0	N	N
Switch operation, doors closed	2	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	4	Y	Y

TASK (Alternating Current) (Assumes equipment is energized, and work is done within the flash protection boundary)	Hazard/ Risk Category	Rubber Insulating Gloves	Insulated and Insulating Hand Tools
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	3	N	N
Outdoor disconnect switch operation (hookstick operated)	3	Y	Y
Outdoor disconnect switch operation (gang-operated, from grade)	2	Y	N
Insulated cable examination, in manhole or other confined space	4	Y	N
Insulated cable examination, in open area	2	Y	N

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

Notes:

1) Rubber insulating gloves are gloves rated for the maximum line-to-line voltage upon which work will be done.
2) Insulated and insulating hand tools are tools rated and tested for the maximum line-to-line voltage upon which work will be done, and are manufactured and tested in accordance with ASTM F 1505, *Standard Specifications for Insulated and Insulating Hand Tools.*
3) The use of "N" does not indicate that rubber insulating gloves and insulated and insulating hand tools are not required in all cases. Rubber insulating gloves and insulated and insulating hand tools may be required by 130.4, 130.8 (C) (7), and 130.8 (D).
4) For equipment protected by upstream current limiting fuses with arcing fault current in their current limiting range (1/2 cycle fault clearing time or less), the Hazard/Risk Category required may be reduced by one number.
5) For power systems up to 600 V the arc flash boundary was determined by using the following information: When 0.03 second trip time was used, that indicated MCC or panelboard equipment protected by a molded-case circuit breaker. Working distance used was 18 in. (455 mm). arc gap used was 32 mm for switchgear and 25 mm for MCC and protective device type 0 for all. When 0.33 or 0.5 second trip time was used, that indicated a LVPCB (drawout circuit breaker) in switchgear. Working distance was 24 in. (610 mm). Arc gap used was 32 mm and protective device type 0 for all. All numbers were rounded up or down depending on closest multiple of 5.
6) For power systems from 1kV to 38 kV the arc flash boundary was determined by using the following information: No maximum values were given in the 2009 edition of NFPA 70E for short-circuit current or operating time. Two sets of equations were performed: 35kA AIC and 0.2 second operating time and 26 kA AIC and 0.2 second operating time. 0.2 seconds was used by adding the typical maximum total clearing time of the circuit breaker to an estimated value for relay operation. This coincides with the IEEE 1584 values of 0.18 second operating time and 0.08 tripping time rounded off. A short-circuit current of 35 kA was used as a maximum (HRC-4 @ ~ 40 cal/cm^2). Working distance used was 36 in. (909 mm), arc gap was 6 in. (455 mm), and protective device type 0 for all.

Specific Notes (as referenced in the table):

1. Maximum of 25 kA short circuit current available; maximum of 0.03 sec (2 cycle) fault clearing time; minimum 18 in. working distance.
2. Maximum of 65 kA short circuit current available; maximum of 0.03 sec (2 cycle) fault clearing time; minimum 18 in. working distance.
3. Maximum of 42 kA short circuit current available; maximum of 0.33 sec. (20 cycle) fault clearing time; minimum 18 in. working distance.
4. Maximum of 35 kA short circuit current available; maximum of up to 0.5 sec. (30 cycle) fault clearing time; minimum 18 in. working distance.

TASKS (Direct Current) (Assumes equipment is energized, and work is done within the flash protection boundary)	Hazard/Risk Category[a]	Rubber Insulating Gloves[b]	Insulated and Insulating Hand Tools
Storage batteries, direct-current switchboards and other direct-current supply sources >100 V <250V			
Parameters: Voltage: 250V Maximum arc duration and working distance: 2 sec @ 18in.			
Work on energized electrical conductors and circuit parts, including voltage testing where arcing current is ≥1 kA and <4 kA Potential arc flash boundary using above parameters at 4 kA: 36 in.	1	Y	Y
Work on energized electrical conductors and circuit parts, including voltage testing where arcing current is ≥4 kA and <7 kA Potential arc flash boundary using above parameters at 7 kA: 48 in.	2	Y	Y
Work on energized electrical conductors and circuit parts, including voltage testing where arcing current is ≥7 kA and <15 kA Potential arc flash boundary using above parameters at 15 kA: 72 in.	3	Y	Y
Storage batteries, direct-current switchboards and other direct-current supply sources ≥250 V ≤600V Parameters: Voltage: 600V Maximum arc duration and working distance: 2sec @ 18in.			
Work on energized electrical conductors and circuit parts, including voltage testing where arcing current is ≥1 kA and <1.5 kA Potential arc flash boundary using above parameters at 1.5 kA: 36 in.	1	Y	Y
Work on energized electrical conductors and circuit parts, including voltage testing where arcing current is ≥1.5 kA and <3 kA Potential arc flash boundary using above parameters at 3kA: 48 in.	2	Y	Y
Work on energized electrical conductors and circuit parts, including voltage testing where arcing current is ≥3 kA and <7 kA Potential arc flash boundary using above parameters at 7kA: 72 in.	3	Y	Y
Work on energized electrical conductors and circuit parts, including voltage testing where arcing current is ≥7 kA and <10 kA Potential arc flash boundary using above parameters at 10 kA: 96 in.	4	Y	Y

Y: Yes (required)

[a]If acid exposure is possible, the clothing is required to be protected from acid and arc rated to the hazard according to ASTM F 1891 or equivalent and evaluated by ASTM F 1296 for acid protection.

[b]In clean rooms or other electrical installations, that do not permit leather protectors for arc flash exposure, ASTM F-496 is required to be followed for use of rubber insulating gloves without leather protectors, and the rubber gloves chosen are required to be arc rated to the potential exposure level of the hazard/risk category.

Hazard/Risk Category Classification Tables

ELECTRICAL SAFE WORK PRACTICE PROGRAM – 70E TABLES

Protective Clothing and Personal Protective Equipment (PPE)		
Hazard/Risk Category	Clothing Description (Typical number of clothing layers is given in parentheses)	PPE
0	**Protective Clothing Non-melting or untreated natural fiber (i.e., untreated cotton, wool, rayon, or silk, or blends of these materials) with a Fabric Weight of at Least 4.5 oz/yd^2 .** Shirt (long sleeve) Pants (long)	**Protective Equipment** Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Heavy duty leather gloves (AN) (See Note 1)
1	**Arc-Rating Clothing, Minimum Arc Rating of 4 cal/cm^2** (See Note 3) Arc-rated long-sleeve shirt and pants or arc-rated coverall **(Note: 8 cal/cm^2 coverall provided by KSU will meet this requirement)** Arc-rated face shield (see Note 2) or arc flash suit hood Arc-rated jacket, parka, rainwear, or hard hat liner (AN)	**Protective Equipment** Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Heavy duty leather gloves (See Note 1) Leather work shoes (AN)
2	**Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm^2** (See Note 3) Arc-rated long-sleeve shirt and pants or arc-rated coverall **(Note: 8 cal/cm^2 coverall provided by KSU will meet this requirement)** Arc-rated flash suit hood or arc-rated face shield (See Note 2) and arc-rated balaclava Arc-rated jacket, parka, rainwear, or hard hat liner (AN)	**Protective Equipment** Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Heavy duty leather gloves (See Note 1) Leather work shoes
3	**Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 25 cal/cm^2** (See Note 3) Arc-rated long-sleeve shirt (AR), Arc-rated pants (AR), Arc-rated coverall (AR), Arc-rated arc flash suit jacket (AR), Arc-rated arc flash suit pants (AR) **(Note: 40 cal/cm^2 suit provided by KSU will meet this requirement)** Arc-rated arc flash suit hood Arc-rated gloves (See Note 1) Arc-rated jacket, parka, rainwear, or hard hat liner (AN)	**Protective Equipment** Hard Hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather work shoes
4	**Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 40 cal/cm^2** (See Note 3) Arc-rated long sleeve shirt (AR), Arc-rated pants (AR), Arc-rated coverall (AR), Arc-rated arc flash suit jacket (AR), Arc-rated arc flash suit pants (AR) **(Note: 40 cal/cm^2 suit provided by KSU will meet this requirement)** Arc-rated arc flash suit hood Arc-rated gloves (See Note 1) Arc-rated jacket, parka, rainwear, or hard hat liner (AN)	**Protective Equipment** Hard Hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather work shoes

AN = As Needed (optional)
AR = As required
SR = Selection required

NOTES:

1) If rubber insulating gloves with leather protectors are required by Table 130.7(C)(9), additional leather or arc-rated gloves are not required. The combination of rubber insulating gloves with leather protectors satisfies the arc flash protection requirement.

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

3) *Arc rating* is defined in Article 100 and can be either the arc thermal performance value (ATPV) or energy of break open threshold (E_{bt}), ATPV is defined in ASTM F 1959, *Standard Test Method for Determining the Arc Thermal Performance Value of Materials for Clothing*, as the incident energy on a material, or a multilayer system of materials, that results in a 50 percent probability that sufficient heat transfer through the tested specimen is predicted to cause the onset of a second-degree skin burn injury based on the Stoll curve, in cal/cm^2. E_{bt} is defined in ASTM F 1959 as the incident energy on a material or material system that results in a 50 percent probability of breakopen. Arc rating is reported as either ATPV or EBT, whichever is the lower value.