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ENVIRONMENTAL HEALTH AND SAFETY

<http://www.dartmouth.edu/~ehs/>

Electrical Safe Work Practice

June 2017 Revision

Prepared in compliance with 29 CFR 1910.301-305 & NFPA 70E-2015

ELECTRICAL SAFETY-RELATED WORK PRACTICES PROGRAM

I. Purpose

This document establishes the safety-related work requirements adopted by Dartmouth College to insure the safety of its employees when exposed to the hazards of electricity. This policy is compliant with Occupational Safety and Health Administration (OSHA) standard 29 CFR 1910.331 through 1910.335 and OSHA reference document National Fire Prevention Association (NFPA) 70E-2015, titled: "Standard for Electrical Safety in the Workplace."

Outlined in this policy are the safety-related work practices adopted by Dartmouth College to prevent electric shock injuries or potential injuries from an arc flash incident stemming from either direct or indirect contact with electrical energy sources.

II. Scope and Application

This program covers electrical safety-related work practices for both **Authorized**¹ and **Unauthorized** persons and provides the requirements for protecting personnel who are exposed to electrical hazards while working on or near energized circuits and equipment. Hazardous electrical exposures may be present in the following installations:

- (a) **Premises wiring.** Installations of electrical conductors and equipment within (or on) buildings or other structures, outdoor lighting, public address systems, stadium events, parking areas, etc.
- (b) **Wiring for connection to supply.** Installations of conductors that connect to the supply of electricity.
- (c) **Other wiring.** Installations of other outside conductors on the premises
- (d) **Optical fiber cable.** Installations of optical fiber cable where such installations are made along with electrical conductors.

¹ In order to eliminate confusion between different regulatory documents that use the term Qualified Worker in different manners, for the purpose of this document, Dartmouth College has substituted the work Authorized for the term Qualified as used in NFPA-70E.

This program does **not** apply to:

- (a) Communication equipment covered under the OSHA standard in 29 CFR 1910.268 (Telecommunications), however where transmitters are located, hazardous radio frequency (RF) hazards may exist and shall be considered as part of the daily job briefing.

III. Authorized Electrical Workers:

At Dartmouth College, the following FO&M job classifications are included in the safe electrical work practice program and are expected to have the technical skills required to perform any related electrical work required of their position AND to be able to identify the hazards associated with the electrical work and take appropriate action to protect themselves from those hazards.

• Electrician: Master, A & B	• Automation Control Tech.
• Building Maintenance Worker	• Fire Safety Technician: Master, A & B
• Electronic Technician	• Oil Burner Technician
• Heating Plant Operator	• Instrument Technician
• Heat Plant Mechanic	• Troubleshooter
• Access Control Technician	• Generator Technician
• Plumber	• Welder
• Control System Technician	• Refrigeration Technician

Supervisors are expected to ensure that Authorized Employees have the knowledge, technical skill and experience necessary to safely perform any work that may expose the employee to energized electrical circuits or conductors including testing, troubleshooting and de-energizing of equipment required of their position.

IV. Selected Definitions

Authorized Person.

For the purpose of this policy an **Authorized** electrical worker **does not** represent an individual's knowledge, skill or ability regarding installation and maintenance of electrical equipment. For the purpose of this policy, the term Authorized Person only refers to the individual's ability to take action to protect themselves against the hazards of any electrical exposure related to their work.

An authorized electrical worker is one who has demonstrated the skills and knowledge related to the construction and operation of the electrical equipment and installations that they may work on and has received safety training on the hazards involved and the actions necessary to avoid the hazards or protect themselves from those hazards. Authorized workers must be competent in the following:

1. The methods and techniques necessary to distinguish exposed energized parts from other parts of electric equipment. This is done by examining equipment to identify exposed parts that are isolated from grounded parts through some insulated part of the equipment. After determination is made what parts are, or could be energized, the parts shall be tested to determine if energized.
2. The methods and techniques necessary to determine the nominal voltage of live parts. This may be done by examining labels, nameplates, schematics, tape color, or the construction of the equipment.
 - This mandates that all employees whose job titles consider them as authorized electrical workers for the purposes of this program must demonstrate the ability to operate a voltage meter to determine the absence or presence of electrical voltage.
3. Understand the minimum approach boundaries. (NFPA 70E Limited Approach Boundary, Restricted Approach Boundary and Arc Flash Boundary): Only authorized workers may enter inside these boundaries and only if adequately protected from shock and/or arc flash using proper personal protective equipment. Also, the clearance distances for work performed near overhead lines that are specified in this policy (Section VI., 7. Power Lines). This may be correlated with the NFPA 70E limited approach boundary.
4. The use of special precautions including draining capacitors for 5 minutes before working on them, not approaching open secondary conductors on current transformers, working with adequate lighting, personal protective equipment, insulating and shielding materials and insulated tools.

An **unauthorized person** is someone with little or no training in avoiding the electrical hazards and does not work on or near exposed energized parts.

Arc Rating. The maximum incident energy resistance demonstrated by a material (or a layered system of materials) prior to break open or at the onset of a second-degree skin burn. Arc rating is normally expressed in calories per centimeter squared. (cal/cm²)

Electrical Hazard. A dangerous condition such that contact or equipment failure can result in electric shock, arc-flash burn, thermal burn or blast.

Energized (Live) Electrical Work: Energized electrical work is any electrical work on energized electrical equipment, other than testing or troubleshooting and requires the use of an Energized Electrical Work Permit. Energized electrical work is permitted when:

- It can be demonstrated that de-energizing introduces additional hazards or increased risk.
- When it can be demonstrated that the task to be performed is infeasible in a de-energized state due to equipment design or operational limitations. **(Infeasible does NOT mean impractical)**²
- Less than 50 volts

Energized Electrical Work Permit: An energized electrical work permit is required any time work on energized electrical parts is being performed with the following exceptions:

- Testing, Troubleshooting and Voltage Measuring
- Thermography and visual inspection if the restricted boundary is not crossed.
- Access to and egress from an area with energized electrical equipment if no electrical work is being performed and the restricted approach boundary is not crossed.
- General housekeeping and other non-electrical tasks if the restricted approach boundary is not crossed.

Incident Energy. The amount of energy impressed on a surface, a certain distance from the source, generated during an electric arc event. One of the units used to measure incident energy is calories per centimeter squared (cal/cm²).

Limited Approach Boundary. An approach limit at a distance from an exposed energized part within which a shock hazard exists. Personnel must be an

² Note: Examples of increased or additional hazards include interruption of life support equipment, deactivation of emergency alarm systems, shutdown of hazardous location ventilation equipment, or removal of illumination for an area. Examples of work that may be performed on or near energized circuit parts because of infeasibility due to equipment design or operational limitations include: testing of electric circuits that can only be performed with the circuit energized, work on circuits that form an integral part of a continuous process that would otherwise need to be completely shut down in order to permit work on one circuit or piece of equipment.

Authorized Worker to enter this boundary. The Authorized Worker must set this boundary to prevent unauthorized workers from entering within the limited approach boundary.

Restricted Approach Boundary The restricted approach boundary is the distance from an energized electric part or conductor where the authorized worker MUST use Shock Protection PPE or other means to prevent shock in accordance with NFPA-70E Table 130.4(D)(a).

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

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

Arc Flash Protection Boundary. An approach limit at a distance from exposed live parts within which a person could receive a second degree burn if an electrical arc-flash were to occur. This limit is the distance from the arcing source where incident energy is 1.2 cal/cm^2

Flame-Resistant (FR). The property of a material whereby combustion is prevented, terminated or inhibited following the application of a flaming or non-flaming source of ignition, with or without subsequent removal of the ignition source. **Arc Rated (AR) clothing has an arc thermal performance value (ATPV) in cal/cm^2 and must be labeled with this rating for the hazard level identified for the work to be performed.**

Personal Protective Equipment (PPE). Arc rated clothing/shields/hood and electrical insulating equipment such as EH rated hardhats, rubber gloves, safety glasses, hearing protection and other devices worn and used by workers exposed to electrical hazards for the purpose of preventing serious injury or death.

Personal Protective Equipment Category (PPE Category): PPE Categories are used to select proper levels of PPE for a task when the arc flash incident energy of a task is determined using Tables 130.7(C)(15)(A)(b) of NFPA 70E or the condensed tables derived from NFPA 70E in Table II of this policy.

Testing/Troubleshooting: Testing and troubleshooting is the process used by an authorized worker to determine if a piece of equipment is operating properly or, if not, to diagnose the problem so that repairs can be made.

When testing and troubleshooting equipment, the equipment is considered energized electrical work. The authorized employees performing this work must wear proper personal protective equipment.

V. Responsibilities

Manager, Director, Executive Level Responsibilities:

College Managers, Directors and Executives are jointly responsible for ensuring that all supervisors and employees included in the safe electrical work practice program adhere to and follow the work practice requirements set forth in this policy.

College Managers, Directors and Executives will delegate the necessary authority to each supervisor to ensure that all affected employees follow safe electrical work practices. As required, College Managers, Directors and Executives will take steps to ensure compliance.

Supervisor

Each supervisor is responsible for ensuring that each employee is aware of and follows the electrical safety related work practices outlined in this policy. Each supervisor is expected to set a positive example by modeling safe work practices and considering safety in the assignment and planning of electrically related tasks.

Each supervisor is responsible for reporting problems with implementing this program in their shop to their direct supervisor and EHS to help ensure continual program improvement.

Supervisors are responsible for ensuring that all employees in the Safe Electrical Work Practice Program are provided with the Personal Protective Equipment required for Arc Flash PPE Category 2. This includes:

- Arc Rated clothing with a Minimum Arc Flash Rating of 8 cal/cm² .
- Class II E Hard Hat (20,000 volts protection)
- Face shield with wrap around guarding to protect forehead, ears & neck.
- Non metallic ANSI Rated safety glasses
- Arc Rated Balaclava Hood with a minimum arc flash rating of of 8 cal/cm²
- Hearing Protection Ear Canal Inserts
- Rubber insulating gloves rated for the tasks required with leather protection
- All Leather, EH Rated footwear with protective toe
- A Class III or IV, U.L. Listed Voltage meter

The Heating Plant Supervisor and the Supervisor of the “High Voltage Electricians” must ensure employees are provided with:

- Arc rated clothing, hard hat, face shield, balaclava hood, nonconductive eye protection, rubber insulating gloves, leather protectors and footwear that meets a minimum arc rating of 40 cal/cm².

Supervisors are responsible for verifying that all employees who are included in the safe electrical work practice program demonstrate the ability to properly use a voltage meter for the purpose of identifying the absence or presence of electricity and if present being capable of identifying the voltage in order to determine the proper personal protective equipment required.

Employee

At all times, each employee must use care, consideration and respect for electricity and its hazards for their safety and that of others.

Each employee covered under this policy is responsible for following the electrical safety related work practices outlined in this policy.

Each employee shall report problems with implementation of this program to their supervisor and EHS to help ensure continual program improvement.

Employees are responsible for maintaining all issued PPE in accordance with the manufacturers requirements. This includes storage, cleaning and maintenance of equipment and clothing.

Director of Environmental Health and Safety (EHS)

The Director of EHS is responsible for ensuring institutional compliance with this policy and the overall effectiveness of adherence to the electrical safety requirements set forth by OSHA. On behalf of the College, the Director of EHS evaluates and makes recommendations for improvements based on observed and reported discrepancies between actual practice and the intent of OSHA requirements.

VI. Electrical Work: General Requirements

All work on electrical systems and electrical equipment shall be done with the system or equipment in a de-energized state utilizing proper lock out procedures.

If the determination is made that the work must be done in an energized state (other than for testing and trouble shooting), an Energized (Live) Electrical Work Permit is required.

Energized (Live) work, other than testing and troubleshooting, is prohibited at Dartmouth College unless specifically authorized via the use of an Energized Electrical Work Permit. The Energized Electrical Work Permit is completed by the employee and is approved by at least two of the following people:

- The employee's FO&M Direct Supervisor
- The FO&M Electrical Shop Supervisor
- The FO&M Service Manager
- The FO&M Science Facilities Manager
- The Associate Vice President of FO&M

Energized electrical work requiring an energized electrical work permit, (that is any energized electrical work other than testing or troubleshooting) will only be performed by licensed electricians authorized by Dartmouth College. Employees of Dartmouth College authorized to perform energized work will be established by job description but as a rule, will be limited to:

- Licensed Electricians working in the electrical shop
- Building Service Workers holding electrical license

Energized (Live) work inside distribution panels, switchboards, MCC's, bus ducts, and other higher amperage electrical equipment may only be completed by a licensed electrician authorized by Dartmouth College.

Only licensed electricians authorized by Dartmouth College may remove the cover from any distribution panel on campus.

Appropriate electrical safety-related work practices and procedures shall be followed by employees who work on or near exposed energized conductors or circuit parts that constitute a hazard as identified within the scope of this document.

- Employees shall be provided with safety-related work practices and shall be trained to implement them. The specific work practices used must be consistent with the nature and extent of the electrical hazard.
- In the case where on-site contractors may be used, the supervisor of the FO&M electrical shop and the on-site contractor shall inform each other of existing hazards, personal protective equipment/clothing requirements, safe work practice procedures, and emergency/evacuation procedures applicable to the work to be performed. This coordination shall include a meeting, which shall be documented.

- There are two hazards to consider before starting work on any electrical equipment. These hazards are electrical shock and arc flash when work is being performed on or near exposed energized parts.
- The arc flash PPE categories for the tasks and PPE requirements are given in Table 1. Also, a shock hazard and an arc-flash hazard exist for operations being performed on control circuits greater than 120 volts, motor control centers (MCC's), breaker panels, control circuits, chillers, bus ducts, rtu's, disconnect switches and switchgear. The arc flash PPE category for these tasks is given in Table 2 and the PPE requirements are given in Table 1. Table 2 may only be used where an arc flash analysis has not been conducted and fault current is known to be less than 25,000 amps and clearing time less than requirements listed in NFPA 70E.
- Electrical hazard warning labels shall be affixed in accordance with the National Electrical Code, Section 116.16 Flash Protection as quoted below:

Electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers, that are in other than dwelling occupancies, and are likely to require examination, adjustment, servicing, or maintenance while energized shall be field marked to warn qualified persons of potential electric arc flash hazards. The marking shall be located so as to be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

Distribution panels, switchboards, MCC's, bus ducts, other higher amperage electrical equipment, or major disconnecting means shall have a label affixed indicating the arc flash boundary and ppe requirements in accordance with NFPA 70E-2015.

FPN No. 1: NFPA 70E, Standard for Electrical Safety in the Workplace, provides assistance in determining severity of potential exposure, planning safe work practices, and selecting personal protective equipment.

FPN No. 2: ANSI Z535.4, Product Safety Signs and Labels, provides guidelines for the design of safety signs and labels for application to products.

The warning labels shall be printed in accordance with the above ANSI Z535.4 product safety signs and labels standard and shall as a minimum provide information identifying the following:

Flash Hazard Protection

Flash Protection Boundary (inches)

PPE Requirements

Flash Hazard at 18 inches (cal/cm²) or 36 inches > 600 V

Shock Hazard Protection

Voltage Level of Exposure (volts)

Limited Approach Boundary

Rubber Gloves (class)

- When work is being performed on or near exposed energized conductors and circuit parts the arc flash PPE category for these tasks is given in Table 2 and the PPE requirements for the given categories are listed in Table 1. Table 2 also contains Arc Flash Boundaries for each Category.
- For employees who may be exposed to a shock hazard, the approach boundaries given in Table 3 apply. Unauthorized employees are not permitted inside the Limited Approach Boundary unless escorted by a qualified employee, who becomes responsible for their safety. In no case is an unauthorized person allowed inside the Restricted Approach Boundaries unless the circuits and equipment have been placed in an electrically safe work condition (lockout/tagout) and verified de-energized by a qualified worker
- The specific work practices used must be consistent with the nature and extent of the electrical hazard.
- All authorized employees referenced in this policy shall be CPR trained. CPR and AED training is required in accordance with the standards set forth by the certifying agency.

Please refer to the flow chart found in Attachment 2 for additional information.

VII. General Requirements: Work On or Near Exposed De-Energized Circuits/Parts

As a general rule, employees, supervisors, and managers shall make every effort to ensure all electrical work is performed in a zero energy or de-energized state.

Energized (live) circuits or parts must be de-energized before beginning work unless de-energizing will introduce additional (or increased) hazards or is infeasible due to equipment design or operational limitations. Specific guidelines allowing for energized work are described in footnote 2 of this policy.

Energized circuits/parts that operate at less than 50 volts to ground do not need to be de-energized if there will be no increased risk for injury or mishap.

If the exposed energized circuits/parts are not de-energized, then other safety-related work practices must be used to protect employees. *For example*, the use of PPE, insulating and shielding materials and insulated tools.

VIII. Auditing Compliance:

Dartmouth College Executives, Directors, Managers and Supervisors will conduct periodic audits of employees with a representative from EHS. Attachment 4 "Workplace Safety Observation" form will be used to document these periodic observations.

Attachment 1

The NFPA 70E requires a shock hazard analysis and an arc flash hazard analysis to be conducted under article 130.2(A) and Article 130.3 respectively for work being performed on energized circuits of 50 volts or more. The approach boundaries given in Table 130.4(D)(a) define the limits of approach for AC shock hazards for both qualified and unqualified employees. (Note: Use Table 130.4(D)(b) for DC limits of approach). For qualified employees, the shock hazard may be mitigated by the proper selection and use of insulating PPE or materials and tools. On the other hand, performing an arc flash hazard analysis is much more complicated and involves calculations of incident energy at each location in the system where an arc flash event may occur. However, in lieu of an arc-flash analysis the NFPA 70E standard permits the employer to use Table 130.7(C)(15)(A) to assess the arc flash hazard identification for under a set of limited working conditions particularly related to condition and maintenance. And then determine the arc flash hazard PPE category on table 130.7(C)(15)(B) along with the associated arc-flash boundary.¹ The conditions that lie within the scope of this electrical safety program are given in Table II. Table I specifies the PPE requirement for those tasks identified in Table II. Work to be performed that lies outside of the tasks identified in Table II require an arc flash analysis and the proper selection of PPE before it may be performed safely.

¹ Note: To use the tables, the fault current and clearing time must be less than the parameters outlined in table I

**Personal Protective Equipment Selection Matrix
for work on Energized Electrical Components or Systems**

(Tables are based on the NFPA 70E-2015)

Table I

Arc Flash Hazard PPE Category	Protective Clothing and PPE Required	Required Minimum Arc Rating of PPE (cal/cm²)
1	<p>Clothing AR long sleeve shirt and long pants or AR coveralls over cotton shirt and pants.</p> <p>Protective Equipment Hard hat (ANSI Z89.1) Safety glasses (ANSI Z87.2) Face protection (arc-rated face shield complying with ANSI Z87.2) Rubber gloves* (ASTM D120, Type 1) Leather protectors (ASTM F686-02) Ear protection (ear canal inserts) Insulated tools (ASTM F1505) Leather work shoes</p>	4.0

* For circuit voltage up to 500V, use class 00 rated rubber gloves, for circuit voltage between 501 volts and 750 volts AC (1000 volts DC), use class 0 rated rubber gloves.

Table I (Cont)

Arc Flash Hazard PPE Category	Protective Clothing and PPE Required	Required Minimum Arc Rating of PPE (cal/cm²)
2	<p>Clothing Cotton undergarments, AR long sleeve shirt and long pants An alternate is to use AR coveralls (minimum arc rating of 8 cal/cm² over non-melting or untreated natural fiber pants and T-shirt.</p> <p>Protective Equipment Hard hat (ANSI Z89.1) Safety glasses (ANSI Z87.1) Face protection (arc-rated face shield or double-layer switch hood with shield Complying with ANSI Z87.2) Balaclava hood min. 8 cal/cm² Ear protection (ear canal inserts) Rubber gloves* (ASTM D120, Type 1) Leather protectors (ASTM F696-02) Insulated tools (ASTM F1505) Leather work shoes</p>	8.0

* For circuit voltage up to 500V, use class 00 rated rubber gloves, for circuit voltage between 501 volts and 750 volts AC (1000 volts DC), use class 0 rated rubber gloves.

Table I (Cont)

Arc Flash Hazard PPE Category	Protective Clothing and PPE Required	Required Minimum Arc Rating of PPE (cal/cm²)
3	<p>Clothing Cotton underwear, long sleeve shirt and long pants plus AR suit</p> <p>Protective Equipment Hard hat (ANSI Z89.1) Safety glasses (ANSI Z87.1) Face protection (rated flash suit hood with shield complying with ANSI Z87.2) Ear protection (ear canal inserts) Rubber gloves* (ASTM D120, Type 1) Leather protectors (ASTM F696-02) Insulated tools (ASTM F1505) Leather work shoes</p>	25.0
4	<p>Clothing Cotton underwear shirt and pants plus multilayer flash suit</p> <p>Protective Equipment Hard hat (ANSI Z89.1) Safety glasses (ANSI Z87.1) Face protection (rated flash suit hood with shield complying with ANSI Z87.2) Ear protection (ear canal inserts) Rubber gloves* (ASTM D120, Type 1) Leather protectors (ASTM F696-02) Insulated tools (ASTM F1505) Leather work shoes</p>	40

* For circuit voltage up to 500V, use class 00 rated rubber gloves, for circuit voltage between 501 volts and 750 volts AC (1000 volts DC), use class 0 rated rubber gloves. Class 1 rated gloves for work on 4160 volt equipment and class 2 rated gloves for voltages over 5 kV but less than 15 kV.

Table II

This arc flash PPE table is based on NFPA 70E tables in a condensed format. It is based on equipment in good condition, secured, and regularly maintained as per manufacturer or NFPA 70B recommendations. If parameters are met, this table may be used for PPE category and arc flash boundary.

Note: For arc flash boundary, see Arc Flash label on equipment or use Table II

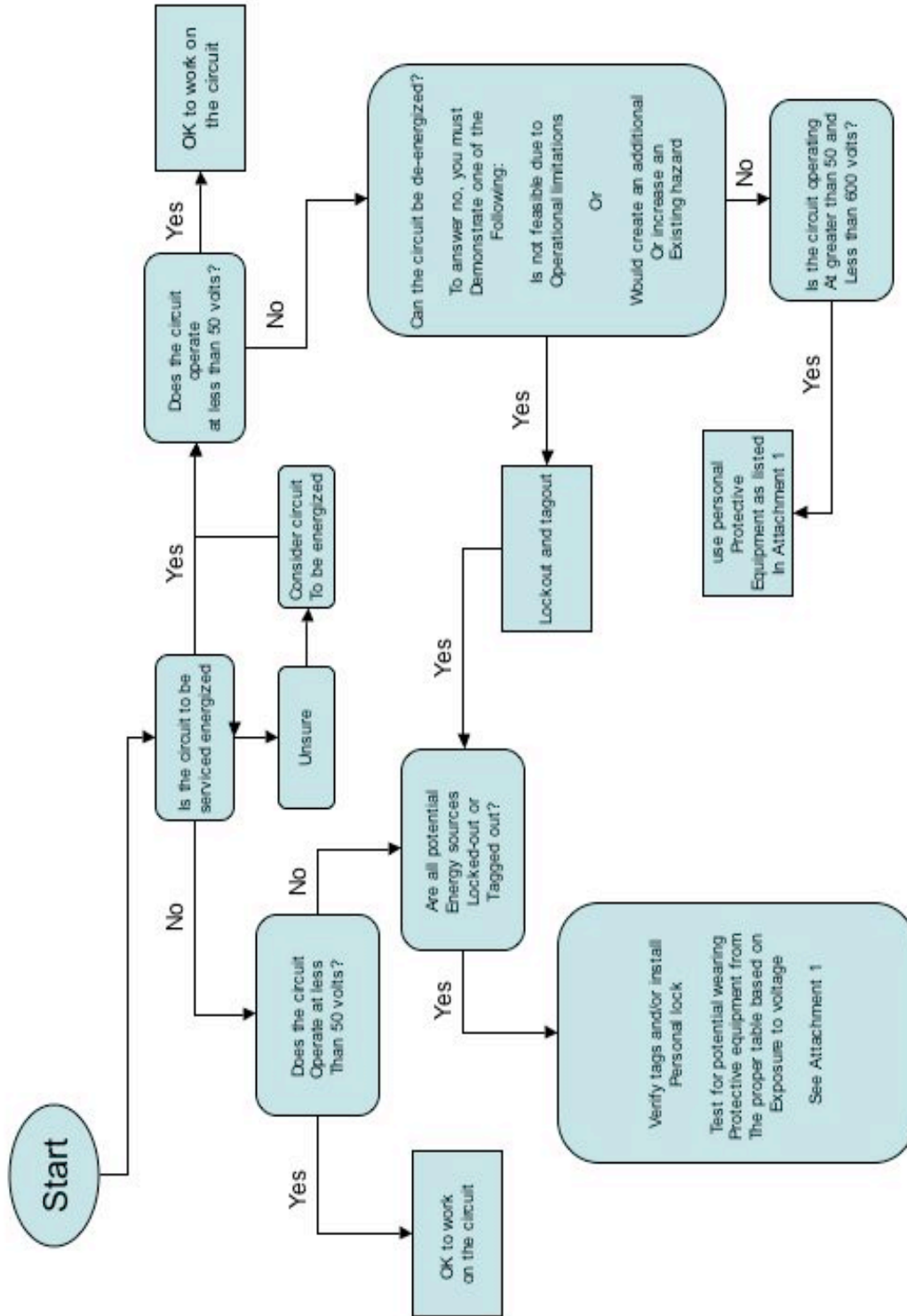
TASK	PARAMETERS Fault Current Clearing Time	ARC FLASH PPE CATEGORY	ARC FLASH BOUNDARY and WORK DISTANCE
Electrical work on systems rated 240 volts or less including: operate single phase circuit breakers if maintained, or fused switches and disconnects with doors closed, cable trough or tray cover removal, work on control circuits 50 volts or less, meggar testing or similar diagnostics, and 12 VDC battery maintenance (less than 1 kA).	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
Working on electrical systems rated at 240 volts or less including: opening hinged covers on control circuit enclosures and voltage testing, work on DC systems up to 250 volts with less than 4 kA.	≤25 kA & Max 2 cycles	1	19 in. Work 18 in.
Working on or near exposed energized parts rated at 600 volts or less where exposed to electrical parts, but no physical work is performed that may cause a serious arc flash and that is not listed in PPE 3 category. Work on DC Systems up to 250 VDC with 4-7 kA.	≤65 kA & Max 2 cycles or ≤42 kA & Max 30 cycles	2	5 ft. Work 18 in.
Working on or near exposed energized parts rated at 600 volts or less including removing bolted covers on exposed 480 volt cabinets with generator running, open cover to exposed parts of an ATS or UPS enclosure, racking in or out 480 volt breakers on an energized bus or working on a 480 volt MCC, Work on DC Systems up to 250 VDC with 7-15 kA	≤35 kA & Max 30 cycles	3	AC - 20 ft. DC – 6 ft. Work 18 in.
Exposing energized parts rated at <u>greater than 600</u> volts nominal including main switchgear, racking in/out breakers, and opening doors to check phasing or other energized work, or testing and grounding with a hot stick.	≤35 kA & Max 15 cycles	4	40 ft. Work 36 in.

Table III

Approach Boundaries to Live Parts for Shock Protection
(All dimensions are distance from live part to employee measured in feet)

(1)	(2)	(3)	(4)
	LIMITED APPROACH BOUNDARY		RESTRICTED APPROACH BOUNDARY
Nominal System Voltage Range Phase to Phase	Exposed Movable Conductor	Exposed Fixed Circuit Part	
50 to 150	(10 ft. 0 in.)	(3 ft. 6 in.)	Avoid Contact
150 to 600	(10 ft. 0 in.)	(3 ft. 0 in.)	(1 ft. 0 in.)
601 to 15,000	(10 ft. 0 in.)	(5 ft. 0 in.)	(2 ft. 2 in.)

Attachment 2



Energized Electrical Work Permit

(For work under 750 volts)

To be completed by the electrically qualified persons doing the work		
Building:	Room/Area:	Work Order # <i>(if applicable)</i>
Description of work to be done:		
Description of Circuit/Equipment:		
Justification for why equipment cannot be de-energized:		
Results of Shock Hazard Analysis Category (NFPA 70E-2015 Table 130.7(C)(15)(A)(a) & 130.7(c)(15)(A)(b))		Results of Arc Flash Hazard Analysis (From Label on electrical panel)
Maximum Voltage: _____ Arc Flash Boundary _____ (ft.) Limited Approach Boundary: _____(ft.) Restricted Approach Boundary: _____(ft.)		Flash Hazard at 18 inches (cal/cm2) _____ Flash Protection Boundary: _____(ft.) Limited Approach Boundary: _____(ft.) Restricted Approach Boundary: _____(ft.)
PPE: Rated Gloves: ____ Safety Glasses: ____ Rated Face Shield: ____ Hard Hat: ____ Hearing Prot: ____ Footwear: Leather: ____ EH Rated: ____ Dielectric (wet environment): ____ Non Conductive Mat: ____		
Safety Checklist & Job Briefing (Verify that proper controls are in place):		
<input type="checkbox"/> Workers must be trained, qualified, and have full knowledge of equipment. <input type="checkbox"/> Insulated tools and equipment required. <input type="checkbox"/> Remove all jewelry and metal apparel <input type="checkbox"/> Accessed restricted to unqualified persons from the work area. (Highest Approach Boundary + 3 feet) <input type="checkbox"/> Documented job briefing including discussion of job-specific hazards with electrically qualified person <input type="checkbox"/> Additional information, special requirements, procedures, or written work plans reviewed		
Electrically Qualified Persons performing the work understand and agree to the above:		
Printed or typed name(s):	Signature(s)	Date(s)
APPROVALS TO PERFORM THE WORK WHILE ELECTRICALLY ENERGIZED (2 signatures required)		
Printed or typed name(s):	Signature(s)	Date(s)
FO&M Supervisor:		
FO&M Electrical Shop Supervisor:		
FO&M Shop Service Manager		
FO&M Science Facility Manager		
FO&M Associate Vice President		

SHOCK HAZARD

(Limit Approach & Restricted Approach Boundaries)

Voltage Range	Limited Approach		Restricted Approach
	Movable	Fixed	
< 50 Volts	NS	NS	NS
50 V – 150 V	10 feet	3 ft 6 in	Avoid Contact
151 V – 750 V	10 Feet	3 ft 6 in	1 foot
Over 750 V	Consult NFPA 70E-2015 Table 130.4(D)(a)		

PPE Category & Arc Flash Boundary

Equipment	PPE Cat.	Arc Flash Bound.
Panel boards or other equipment rated 240 V or less	1	19 in
Panel boards or other equipment between 240 V and 600 V	2	3 feet
600 V Class (277 V – 600 V Nominal)	2	5 feet
600 V class motor control centers	2	5 feet

PPE Requirements

CATEGORY 1	CATEGORY 2
Arc Rated Clothing 4 cal/cm ² Arc rated face shield or arc flash hood Non conductive safety glasses Hearing protections inserts Rubber insulating gloved w/leather Leather, non conductive (EH) rated footwear	Arc Rated Clothing 8 cal/cm ² Arc rated face shield or arc flash hood and arc rated balaclava Non conductive safety glasses Hearing protections inserts Rubber insulating gloved w/leather Leather, non conductive (EH) rated footwear
Type II Class E hard Hat w/face shield, Arc Rated outer wear to be used as needed	

Definitions

Arc Flash Boundary:	When an arc flash hazard exists, the arc flash boundary is the approach distance that a person could reason a second-degree burn to unprotected skin. (1.2 cal/cm ²)
Limited Approach Boundary	An approach distance from an exposed energized electrical conductor or circuit where a shock hazard exists.
Restricted Approach Boundary	An approach distance from an exposed energized electrical conductor or circuit where there is an increased likelihood of electric shock due to electrical arc over combined with inadvertent movement.

Sample Arc Flash Analysis Label

WARNING

Arc Flash and Shock Hazard

Appropriate PPE Required

186 inch 37.4 Class 4	Flash Hazard Boundary cal/cm ² Flash Hazard at 18 inches FR Shirt & Pant + Multi Layer Flash Suit + Cotton Underwear
208 VAC 00 Rated 42 inch 0 inch 0 inch	Shock Hazard When Covers are Removed Glove Class Limited Approach Restricted Approach Prohibited Approach
Equipment Name: BUS-XFMR208V	

Attachment 4

Workplace Safety Observation Form

Name of Observer: _____ Time: _____ AM/PM Date: _____

Worker 1 Observed: _____

Worker 2 Observed: _____

Please check the boxes below including a brief description of the discrepancy related to each "No" checked. in the comment section or back side of form.

Job and Location: _____

I. PERSONAL SAFETY

	OSHA Ref. 29 CFR 1910	Worker 1			Worker 2			Specify
		Yes	No	NA	Yes	No	NA	
Clothing (FR-Rated) On	.132/.335							
Eye Protection Used (Specify)	.133							
Hard Hat Used	.135							
Arc Shield Used	.132/.335							
Hearing Protection Used	.95							
Rubber Gloves Tested and Used	.137							
Leather Gloves Used	.138							
Insulated Tools Used	.335							
GFCI Portable Device Used	.305							

II. PROPER WORK METHODS

	NFPA 70E			
Job Briefing Conducted (or if alone, all 6 topics considered)				
Can Identify Potentially Energized Parts, Nominal Voltage _____ Volts	.335			
Can State Shock Approach Boundaries: Limited: _____ in. Restricted: _____ in.	.335			
Lockout/Tagout Equipment and Procedures Used Properly	.147			
Fire Extinguisher Available and Charged	.157			
First Aid Kit Available; Full/Current	.151			
Proper Illumination Available (minimum 10 ft candles)	.333			
Testing with CAT III Meter to Determine De-energized. Test Before and After?	.335			
Ladder Safety Practices Used	.25			
Barricade or Barriers Installed if Working Near Exposed Energized Parts	.333			
Housekeeping Clean and Neat on Job Site	.333			
Visually Inspect Cords and Test Leads, GFCI Equipment Used	.334			
Precautions Used for Working Near Ignitable Material	.334			
Demonstrate Knowledge of Construction and Operation of Equipment	.335			

Comments: