ANTIOCH COLLEGE

Electrical Safe Work Practices

I. PURPOSE

To establish minimum acceptable standards for AC and DC electrical safe work practices. The program includes requirements for the training of qualified and unqualified employees relating to the use of personal protective equipment, proper use of tools while working near electrical apparatus, testing procedures, working with specialized fixed equipment for various job functions, understanding approach boundaries, determining nominal voltages and identifying exposed energized parts. Detailed information for site or job-specific procedures is provided to employees through formal and informal education.

References: National Fire Protection Association (NFPA) 70E, OSHA Title 29 CFR 1910 Subpart S.

II. OBJECTIVES

- Avoid injuries related to electrical contacts.
- Provide guidance in determining the level of protection needed for various electrical exposures.
- Determine and address training needs of employees in production and maintenance.

III. SCOPE

This program applies to all employees with exposure to electricity through a variety of tasks including, but not limited to the operation of switches, controllers, troubleshooting DC components, lockout procedures or maintenance with direct exposure to energized parts. It is not the intent of this program to detail procedures required to protect equipment, apparatus or wiring systems.

Employees who work on exposed energized equipment rated at over 600 volts shall be specifically trained. Work on medium and high voltage equipment will be performed by a qualified contractor or utility company personnel only.

IV. RESPONSIBILITY

a. Safety Program Administrator
   1. Assure the requirements of this policy are followed throughout their areas of responsibility.

2. Annual review, and, if necessary, revise the Pentair Water Electrical Safety Policy.
3. Insure training and retraining is made available to employees performing electrical maintenance.

b. Maintenance Supervisor
   1. Conduct periodic inspection to insure safe work practices are being followed.
   2. Any questions or uncertainty must be addressed and cleared up by the appropriate line leader.

V. DEFINITIONS

a. Approach Distances – Must be established whenever work is to be conducted on electrical systems or components not in an electrically safe condition.

   1. Flash Protection Boundary – Distance beyond which appropriate flash protection equipment is required to prevent incurable 2nd degree burns.

   2. Limited Approach Boundary – Shock protection boundary designed to keep nonqualified persons at a safe distance away from exposed electrical components. A barricade with attached cautionary language shall be placed at this boundary as a warning of potential electrical hazard.

   3. Restricted Approach Boundary – Secondary shock protection measure whereby accidental movement can put a body part or conductive object in contact with live parts. Approach distances listed in Table 1 represent minimum distances required between energized parts to an unprotected person or conductive equipment. Only qualified persons with appropriate protection are allowed within this boundary.

   4. Prohibited Approach Boundary – Proximity to exposed parts where only qualified workers may work and are deemed to be making contact with the exposed parts. Working within this boundary requires an Energized Work Permit unless troubleshooting or voltage testing. Appropriate protection shall be utilized.

b. Disconnecting means – A device by which the conductors of a circuit can be disconnected from their source of electrical supply. As an energy isolation control, it shall have the capability of being locked out.

c. Enclosure – A case or housing of apparatus surrounding an installation to prevent personnel from accidentally contacting energized parts. If the enclosure is conductive it must be grounded or bonded to a grounding system.

d. Exposed – Capable of being inadvertently touched or approached nearer than a safe distance by a person. Not insulated.

e. Ground – A conducting connection to the earth.

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

g. Isolated – Not readily accessible to persons unless special means are used.

h. Non-qualified Employee – One who is not exposed to hazards or approaches exposed parts of electric circuits operating at 50 volts or more to ground.

i. Outlet – A point on the wiring system at which the current is taken to supply utilization equipment.

j. Qualified Employee – One familiar with the construction and operation of the equipment and the hazards involved.

VI. PROCEDURES

The following procedures apply to both qualified and unqualified employee unless specifically referenced to qualified employees.

a. Job Briefing – Before starting each job, a qualified person shall conduct a job briefing with the employees involved. The briefing shall cover the following:

- Hazards associated with the job includes, but is not limited to all energy sources, environmental factors, motion potential, falling, or falling objects.
- Work procedures associated with the job or task at hand.
- Special precautions including discharging capacitors, maintaining current path on current transformer secondary conductors, or DC positive grounding.
- Energy source controls to isolate all sources of energy.
- Personal protective equipment includes rubber goods to prevent shock and Specific clothing for arc flash protection.

Additional job briefings shall be conducted if significant changes, that might affect the safety of the employee, occur during the course of the work. If a qualified worker is working alone, he/she shall consider the items listed and take precautions accordingly.

b. Selection and Use of Safe Work Practices – Safety-related work practices shall be employed to prevent electric shock or injuries resulting from electrical contacts.

1) Live parts to which an employee may be exposed shall be de-energized by a qualified employee using lockout/tagout techniques as specified in the

lockout/tagout Program before the employee works on or near them unless a greater hazard is introduced. The qualified employee shall test to ensure that the previously energized part is de-energized. Using an appropriate tester rated for the voltage. Where more than one employee works on de-energized equipment, group lockout must be used; the designated authorized employee shall coordinate affected workgroups and ensure continuity of protection.

2) If it is not feasible to de-energize exposed live parts, other safety-related work practices shall be used to protect the exposed employees. Only qualified maintenance employees are allowed to work where exposed to energized equipment. Procedures utilized to perform this work shall include special precautionary techniques such as use of personal protective equipment, insulating and shielding material and insulated tools. Special precautions are important when working with DC positive grounded systems. An ***Energized Work Permit*** shall be completed and authorized prior to working on energized parts over 250 volts with the exception of troubleshooting or voltage testing.

3) Work on or near exposed live parts is not permitted without proper illumination.

4) Employees working in confined or enclosed spaces shall de-energize or effectively barricade with protective shields or barriers any exposed live parts. Doors or hinged panels shall be secured to prevent swinging freely.

5) Conductive materials shall be handled in such a manner that will prevent them from encroaching approach boundaries as specified in Table 1. Only non-conductive ladders are allowed for use near energized parts.

6) Conductive apparel such as chains, watches, rings or necklaces shall not be worn while working on or near exposed electrical parts.

7) Interlocks shall not be bypassed unless a qualified person is temporarily working on the equipment and alternative safe procedures are in place. Equipment rated at more than 600 volts, interlocks shall NEVER be bypassed. Arc rated ports may be installed on medium voltage equipment to avoid removing covers for infrared testing.

8) Electrical disconnect switches and breakers shall be labeled including the voltage, name of device controlled and other pertinent information i.e. main disconnect, motor control switch etc.

9) Access to electrical switches, control devices and meters shall be kept free of obstructions with a minimum of 3 feet clear.

Table 1. Approach Boundary to Live Parts for Shock Protection

VOLTAGE RANGE (Phase to Phase)	Restricted Approach Boundary	Limited Approach Boundary	Prohibited Approach Boundary
250 volts and less	Avoid Contact	Avoid Contact	Avoid Contact
250 to 750 volts	1 ft. 0 in.	3 ft. 6 in.	1 in
750 to 15,000 volts	2 ft. 2 in.	10 ft.	7 in.

c. **Use of Portable Electric Equipment** – Includes cord & plug connected equipment.

1) Ground Fault Circuit Interrupter (GFCI) devices shall be used for all temporary maintenance or construction activities. Devices may include GFCI receptacles, receptacles protected by GFCI breakers, or a portable cord-connected GFCI. GFCI equipment shall be tested periodically to ensure that it functions properly. Permanent GFCI equipment shall be available in all damp locations or any outdoor receptacles.

2) Avoid raising and lowering the equipment using flexible cords. Do not fasten cords with staples or other fasteners that may damage the outer jacket. Handle portable electric equipment in a manner which will not cause damage.

3) Portable cord and plug equipment shall be inspected before use. Ensure test cables are not placed in a coil and twist-lock connectors are verified fully locked before energizing.

4) Extension cords shall be given a continuity test with the initial inspection before use and periodically thereafter to determine open points or short circuits (test for full continuity on each wire and zero continuity from wire to wire). If damage is detected on cord and plug equipment it shall be immediately removed from service and repaired or discarded.

4) Grounded type tools or equipment shall have a grounded-type plug and shall be inspected to ensure compatibility with the receptacle. Adapters may not be used. This requirement does not include double insulated tools.

d. **Power and Lighting Circuits** – Includes use of circuit breakers and fuses.

1) Load rated circuit breakers shall be used for opening and closing circuits. Fuses, terminal lugs and cable splice connections shall not be used to make or break load.

2) Circuit breakers, motor control switches and other electrical disconnects should be operated by standing to the side. Keep your body away from the front of breakers, switches and disconnects when energizing and de-energizing.

3) After a faulted circuit has been de-energized by a circuit protective device, the circuit shall not be reenergized until it has been determined safe to do so by a qualified employee.

4) Only qualified employees may perform testing work on electrical circuits. Test equipment shall be rated for the voltage to which they will be connected. Work on or near exposed energized shall only be conducted by qualified electrical personnel. Technicians working on DC cells may be qualified for that function but not qualified for other AC applications.

5) Electrical equipment capable of igniting a spark shall not be used near flammable, combustible or ignitable material.

6) Flexible cable may not be used for permanent installations unless allowed by OSHA and NEC, i.e. hanging fixtures, pendant controls temporary or vibrating equipment provided proper strain relief connectors are utilized.

e. <u>Safeguards for Personal Protection</u> - Includes Personal Protective Equipment

1) PPE is made available to all employees and shall be used when appropriate. The level of PPE used is determined by conducting a hazard assessment and choosing a protection level that significantly reduces or eliminates the risk of injury. Conduct job briefings before performing any work to determine the job hazards. This process, in conjunction with the PPE Requirements below, will determine the level of protection needed to work with or near electrical apparatus.

2) If an arc flash analysis has been conducted for the facility, consult the label to determine the hazard and appropriate level of personal protective equipment. The following list of PPE is a guide where the analysis has not been performed.

a. <u>Eye Protection</u> – Safety Glasses with side shields shall be used at all times while working on or near exposed live parts. Metal-rimmed prescription glasses shall not be used while exposed to energized parts. (Hazard Risk Category 0-4)

b. <u>Face Protection</u> – Tinted arc shields shall be worn when working on exposed energized systems with a hazard risk category of 2 or more.

c. <u>Head Protection</u> – Non-conductive hard hats shall be worn where employees are working on or near exposed energized electrical conductors that could contact the head. (Hazard Risk Category 1-4)

d. <u>Shock Protection</u> – Rubber gloves rated for the voltage shall be worn when avoiding contact for voltages over 50 volts, or for any work on voltages over 250 where boundary distances are encroached (refer to Table 1). Rubber gloves shall be air tested before each days use and dielectrically tested every 6 months. Rubber barrier material approved for use on energized equipment may be used to isolate the employee from the energized parts in lieu of using rubber gloves. (Hazard Risk Category 1-4)

Table 2. Minimum PPE requirements when working on or near exposed energized parts

Task	Rubber Gloves	Minimum Clothing	Tools	Head/Face Protection	Comments
HRC 0 **Work on energized systems where barriers ARE in place**	Not Applicable	Natural Fiber underwear, shirt, pants and socks (cotton, wool)	Insulated Tools Voltage Tester	Safety Glasses No additional equipment required.	Includes: circuit breaker operation, opening hinged covers to non-exposed electrical parts, operating equipment with door closed, reading panel meters. Testing insulated parts
HRC 1-2 **Work on exposed energized systems (barriers ARE NOT in place) Up to 480 volts AC or 600 volt DC; not including main switchgea**r	Class 00 or 0 for up to 750 volts	Cotton garments for HRC 0 arc flash hazard or Fire Resistant-Rated Coverall with a minimum rating of 8 cal/cm² over cotton if HRC unknown.	Insulated Tools Voltage Tester Insulated barrier material	Safety Glasses Hardhat where head may contact exposed energize parts. Arc shield for all 480 volt work.	Includes: voltage tests, remove & install or operate circuit breakers or fused switches with door open. Troubleshooting controls, or work on energized DC equipment up to 600 volts.
HRC 3-4 **Work on exposed energized systems (barriers ARE NOT in place) in 480 volt main switchgear or transfer switch.**	Class 00 or 0 for up to 480 volts Class 1 or 2 for 4160 volts and Class 2 in 13,800v switchyard	Cotton garments for HRC 0 arc flash hazard or Fire Resistant-Rated Suit and Hood with a minimum rating of 40 cal/cm² over cotton if HRC is unknown	Insulated Tools Voltage Tester Insulated barrier material	Safety Glasses Hardhat where head may contact exposed energize parts. Arc Flash Hood	Includes: voltage tests, remove & install (rack) or operate circuit breakers or fused switches with door open on customer's main switchgear or transfer switch.

Note: Table used where no labels are present to indicate the arc flash hazard.

e. Insulated Equipment - Insulated tools are required for all electrical work where contact with energized parts could occur. (Hazard Risk Category 1-4)

f. Insulated Rubber Barriers - approved for use on energized equipment, may be used to isolate the employee from the energized parts in lieu of using rubber gloves to avoid contact on lower voltages. For voltages over 600 volts, insulated barricades shall cover energized parts by using a hotstick in conjunction with rubber gloves. Rubber blankets shall be dielectrically tested at least once annually. (Hazard Rating 1-4)

g. Clothing – A minimum of natural fiber clothing (cotton or wool) shall be worn by employees who are exposed to energized electrical systems or equipment. Clothing includes undergarments, socks, shirts, pants, hats, baseball caps, etc. If

conditions dictate that a significant flash may result due to high fault currents, a flame-resistant (FR Rated) switching coat or FR Rated coveralls is required. All FR clothing shall have a label stating the cal/cm² rating. See table 2 or labels for guidance. Equipment downstream from the Feeder disconnecting means with HRC 0 may also be considered HRC 0 after verification by examination or consulting one-line arc flash records where available. (Hazard Risk Category 1-4)

f. **Additional Safety Requirements** – Includes the use of signs and barriers.

1) Safety symbols or signs shall be prominently displayed to warn employees about electrical hazards – including warning signs on panel doors, doors to electrical rooms or any hazardous location which may endanger employees.

2) Barricade red danger tape (or equivalent) shall be placed at the limited approach boundary to prevent non-qualified workers from approaching energized parts. A qualified attendant may be used in place of a physical barricade.

3) Protective shields, protective barriers, or insulating material shall be used to protect employees from shock, burns or electrically related injuries while the employee is working near exposed energized live parts. Conductive barricades shall not be used. Barriers or other means (locked doors, cabinets, etc.) shall be used to prevent unqualified employees from entering an electrical exposure boundary (refer to Table 1).

VII. TRAINING

Training requirements apply to employees at risk of electric shock that is not reduced to a safe level by electrical installation requirements. Employees at risk are required to be trained. Other employees who may reasonably be expected to face comparable risk of injury due to electric shock or other electrical hazards must also be trained. The degree of training provided shall be determined by the risk to the employee. The engineering manager and/or safety manager determine training needs.

a. **Type of training** – The training required by this section may be of the classroom or on-the-job type. The degree of training provided must be determined by the risk to the employee.

b. **Content of Training** – Employees shall be trained in and familiar with the safety-related work practices that pertain to their respective job assignments. Employees who are not qualified persons shall also be trained in and familiar with any electrically related safety practices not specifically addressed in this document but which are necessary for their safety. Qualified persons (i.e., those permitted to work on or near exposed energized parts) shall, at a minimum, be trained in and familiar with the following:

1) The skills and techniques necessary to distinguish exposed live parts from other parts of electric equipment by determining the exposed parts that are isolated from grounded parts.

2) The skills and techniques necessary to determine the nominal voltage of exposed live parts by examining labels, nameplates, one-line diagrams or schematics; or by testing.

3) The approach boundaries specified in Table 1 and the corresponding voltages to which the qualified person will be exposed.

4) Where, when and how to use appropriate personal protective equipment.

5) Emergency response techniques including CPR, First Aid and releasing a victim.

c. Frequency of Training

New Hires - initial training is required prior to working on energized electrical components. The degree of training provided must be determined by the risk to the employee

Reviews/Refresher – annually, reviews/refreshers on electrical safety shall be conducted by a qualified person and documented.

Comprehensive Education – every 3 years a comprehensive education session shall be conducted by a qualified person and documented.

Electrical Contact Incident (i.e. shock) – regardless of injury, retraining shall be conducted for injured and affected employees (i.e. those who perform similar tasks) by a qualified person and documented.

A person must have the above training in order to be considered qualified. Qualified persons whose work on energized equipment involves either direct contact or contact by means of tools or materials shall be capable of working safely on energized circuits and shall be familiar with the proper use of special precautionary techniques, personal protective equipment, insulating and shielding materials and insulated tools.

VIII. COMPLIANCE:

All electrical work shall be completed to N.E.C. (National Electrical Code) standards. Variations are not permitted, unless approved by the authority having jurisdiction (electrical inspector, etc.). Electrical installation work will be performed by qualified employees only. On-site training will be conducted by qualified personnel. Each qualified electrical person shall demonstrate their abilities to perform the work outlined in this program on an annual basis. The attached ***Worksite Observation Form*** shall be used to document the assessment.

Proper work habits and observance of electrical safe work procedures is expected of all qualified and unqualified employees. Negligence may subject the individual and others to serious injury. Failure to follow these procedures will result in progressive disciplinary action up to and including termination.

Energized Electrical Work Permit

Person Requesting the Work: _____ Date: _____

Circuit/Equipment/Job Location: _____

Description of Work: _____ Voltage: _____

Justification for Working Energized: _____

_____

Qualified Person(s) Assigned to Energized Work: _____

☐ **Job Briefing included: _____**

☐ **Describe Safe Work Practices: _____**

☐ **Approach Boundaries: Restricted: _____ Limited: _____ Flash: _____**

☐ **Personal Protective Equipment: ☐ Rubber Gloves ☐ Insulated Tools ☐ 100% cotton clothing ☐ FR Clothing _____ cal/cm² ☐ Arc Shield ☐ Arc Hood ☐ Safety Glasses ☐ Hearing Protection ☐ Rubber Mat ☐ Rubber Barrier Material ☐ Barricade Tape ☐ Lockout-Tagout Equipment ☐ Insulated Tools ☐ Voltage Tester**

☐ **Provisions to Restrict Access of Unqualified Persons: _____**

☐ **Safe Work Procedures: _____**

_____

☐ **I believe the work can be performed safely. If not, return to requester.**

Electrically Qualified Person other than requester: _____

Sign: _____ Date: _____

Approvals to Proceed With Work

_____ _____

Supervisor or Designee Qualified Worker in Charge

_____Date

Workplace Electrical Safety Observation Form

Time of Observation: _____ AM/PM **Date of Observation: _____**

Worker 1 Observed: _____

Worker 2 Observed: _____

Worker 3 Observed: _____

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

Job and Location: _____

I. PERSONAL SAFETY

	OSHA Ref.	Worker 1			Worker 2			Worker 3		
	29 CFR 1910	Yes	No	NA	Yes	No	NA	Yes	No	NA
Clothing (FR-Rated) On	5A/ 70E									
Eye Protection Used	.133									
Face and Neck Protection Used	70E									
EH Hard Hat Used	.135									
Hearing Protection Used	.95									
Rubber Gloves Used	.137									
Leather Gloves Used	.138									
Lockout/Tagout Kit Used	.147									
Proper Tester Used	.333									
Insulated Tools	.333									
Rubber Mats/Barrier Material	NEC									

1. PROPER WORK METHODS

	OSHA Ref	Yes	No	NA
Job Briefing Conducted (or if alone, all topics considered)	.269			
Lockout/Tagout Procedures Used Properly	.147			
Proper Illumination Available	.333			
Testing Done to Determine That All Parts Are De-energized	.334/.147			
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	.334			
GFCI Equipment Used	.334			
Precautions Used for Working Near Ignitable Material	.334			

III. COMMENTS BY: _____