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Grant PUD	**PROGRAM**	
Approved by: Senior Manager SSE Management		**Regulation:**
Content Owner: Power Production Electrical Safety Committee		**Category:** Safety

PP-HYD-SAF-100 – GCPUD Power Production Electrical Safety Program (ESP)

Contents

1. Scope

This document applies to all Power Production employees, GCPUD employees and contractors working in Power Production facilities.

2. Purpose

This document establishes the Electrical Safety Program (ESP), herein called the Program. The Program is applicable to Grant County power production facilities and provides the requirements for electrical safe work practices and electrical safety training. Compliance with this Program reduces exposure to electrical hazards for all employees of Grant County PUD, contractors, subcontractors, and vendors. This Program is also intended to minimize the risk to Grant County equipment and facilities.

NOTE: *This Program does not contain all requirements of the above documents, in the event of a conflict between this document and the requirements listed above, the conflict would be resolved by the ESP committee per their charter.*

This document does not cover any of the following:

1. Installations or work involving automotive, watercraft, and similar equipment
2. Installations under the exclusive control of NESC for the purpose of metering, transmission, and distribution of electrical energy
3. Clearance activities: *Lockout Tagout Clearance*
4. *Process HP-OPS-ADM-01* provides requirements for Clearance and shall take precedence over similar requirements in NFPA 70E if there is a conflict
5. Telecommunications workers performing work under WAC 296-32.
6. Grant County PUD will comply with the National Electric Safety Code (NESC) and WAC 296-45, Electric Power Generation, Transmission, and Distribution.

3. Program Requirements

3.1 General Requirements

1. Personnel shall be trained and qualified consistent with assigned tasks.
2. No electrical equipment will be installed, modified, or used until inspected by the Electrical Installation/Modification AHJ. With the exception of like for like replacements.
3. An incident energy analysis will be conducted on all AC 3-phase components that operate ≥ 208 volts and DC components that operate ≥ 150 volts.
4. An Electrical Risk Assessment (ERA) which includes both arc flash and shock risk assessment shall be performed and documented for all work containing electrical hazards.

5. An Energized Electrical Work Permit (EEWP) is required for all non-exempt work activities on or around exposed energized parts ≥ 50 volts.
6. The condition of maintenance shall be considered in the risk analysis of an electrical hazard.
7. Risks shall be reduced wherever possible using the hierarchy of risk control methods:
    a. Elimination – Establishing an electrically safe working condition.
    b. Substitution
    c. Engineering controls
    d. Awareness
    e. Administrative controls
    f. PPE
8. The Electrical Safety Program audit will not exceed 3 years and field work audit will not exceed 1 year.
9. Electrical incidents shall be investigated, including near misses that could have resulted in an injury, fatality, or damage to health. Findings will be communicated to the ESP Committee through the Corrective Action Program.
10. The ESP Committee shall act as the Electrical Safety (NFPA 70E) AHJ for the Program.

3.2 Electrical Safety Training and Qualifications

3.2.1 General Training Requirements

Personnel shall be trained and qualified to a level of proficiency consistent with their assigned tasks.

All training shall meet the minimum requirements of the Electrical Safety Program (ESP).

Training and/or retraining shall be commensurate with WAC.

1. Workers who face the risk of exposure to electrical hazards shall have electrical safety training commensurate with their assigned duties. The degree of training provided shall be determined by the risk to the employee.
2. Documentation of training shall be available to supervisors/managers.
3. Courses shall be made available for Continuing Education Units (CEU) that are certified by the State of Washington.

4. Personnel shall be instructed on the proper use and maintenance of PPE prior to use.

3.2.2 General Employees

General employees shall receive electrical training (initial and annual refresher) through completion of the Electrical Safety module of Grant County general employee training.

3.2.3 Non-qualified Electrical Workers

1. A non-qualified electrical worker is someone without the necessary training, knowledge, and experience to work on or near exposed live electrical parts. All non-qualified electrical workers shall:

   a. Attend a Basic Electrical Safety Training course.

   b. Receive refresher training on Basic Electrical Safety Training course every 36 months.

3.2.4 Qualified Electrical Workers (Electricians, I&C Technicians, and Power Plant Operators)

1. Qualified Electrical Workers shall have:

   a. Electricians and I&C Technicians, at a minimum, shall have a general journeyman electrician State license or they shall meet one of the following criteria:

   b. Be an established Electrician or I&C Technician working for Grant County PUD.

   c. Completed District approved apprenticeship program or equivalent.

2. Power Plant Operators shall meet at least one of the following criteria:

   a. Be an established Power Plant Operator working at Grant County.

   b. Completion of a Grant County PUD Operator apprenticeship program.

   c. Journeyman operator card/status recognized by the District and Union.

3. Qualified Electrical Workers shall attend the following training

   a. First Aid/CPR/AED every 2 years. Training certification shall be verified at least annually.

   b. NFPA 70E, *Standard for Electrical Safety in the Workplace*. Qualified Electrical Workers shall have refresher training to updated regulations and electrical safety criteria, at intervals not to exceed three years.

   c. Electrical Safety Program Training course at intervals not to exceed three years.

d. WAC Chapter 296-45 at intervals not to exceed three years.

4. Power Production Electricians shall maintain qualifications through continuing education:
   a. 24 hours per three-year cycle:
      i. at least eight (8) hours of NFPA 70 Code Update.
      ii. four (4) hours on currently adopted Revised Code of Washington (RCW) 19.28 and related Washington Administrative Codes (WAC); and
      iii. twelve (12) hours of additional State approved continuing education courses)
5. Qualified Electrical Workers shall also be familiar with the proper use of the special precautionary techniques, applicable policies and procedures, PPE (including arc flash, insulating, and shielding materials), and insulated tools and test equipment. A person may be considered qualified with respect to certain equipment and methods, but non-qualified for others.
6. Qualified Electrical Workers who are permitted to work within the Limited Approach Boundary (LAB)/Arc Flash Boundary (AFB) of exposed energized electrical conductors and circuit parts operating at 50 volts or more shall, at a minimum, be trained in all of the following:
   a. The skills and techniques necessary to distinguish exposed energized electrical conductors and circuit parts from other parts of electrical equipment.
   b. The skills and techniques necessary to determine the nominal voltage of exposed energized electrical conductors and circuit parts.
   c. The approach distances and the corresponding voltages to which the Qualified Electrical Worker will be exposed.
   d. The decision-making process necessary to be able to perform the job safety planning, identify electrical hazards, assess the associated risk, and select the appropriate risk control methods including PPE.
   e. Selecting an appropriate test instrument and shall demonstrate how to use a device to verify the absence of voltage, including interpreting the indications provided by the device, and understanding the limitations of each specific test instrument that may be used.
7. An Electrical Worker, who is undergoing on-the-job training under the direct oversight of a Qualified Electrical Worker, and who has demonstrated an ability to perform duties safely at his or her level of training, shall be considered qualified for the performance of those duties.
8. A vendor under the direct oversight of a Qualified Electrical Worker shall be considered qualified for the performance of their contracted duties.

3.2.5 Qualified Electrical Worker Supervisor

1. Qualified Electrical Worker Supervisors include, but is not limited to, Electrical Engineers, supervisors of Electricians, I&C Technicians, and Power Plant Operators. Operations Technical Advisors (OTA) will be included for technical purposes of training and SOP writing.
2. Qualified Electrical Worker Supervisors shall attend the following training:
   a. First Aid/CPR/AED training, at intervals not to exceed two years. Training certification shall be verified at least annually.
   b. NFPA 70E, *Standards for Electrical Safety in the Workplace*. Qualified Electrical Worker Supervisors shall have refresher training to updated regulations and electrical safety criteria, at intervals not to exceed three years.
   c. Electrical Safety Program Training course at intervals not to exceed three years.
   d. WAC Chapter 296-45 at intervals not to exceed three years.
3. A Qualified Electrical Worker Supervisor supervises or directs Qualified Electrical Workers conducting the technical aspects of electrical work. They shall have skills and knowledge related to the construction and operation of electrical equipment and installations that they supervise.
4. Qualified Electrical Worker Supervisors shall be qualified to supervise the work on the equipment and methods being used.
5. Qualified Electrical Worker Supervisors may be permitted to enter the LAB or AFB with proper PPE but are not permitted to perform work.

3.2.6 Battery Training

Personnel who install, maintain, or otherwise work directly with batteries that present a chemical or electrical hazard shall complete Battery Safety Training.

1. Battery Electrical Hazard Thresholds are:
   a. AC >50 volts and 5 milliamperes
   b. DC >100 volts and 40 milliamperes
   c. Thermal >1,000 watts short-circuit power

3.2.7 Capacitor Training

Personnel who install, maintain, remove, or dispose of capacitors or capacitor banks rated greater that pose an electrical hazard shall complete Capacitor Safety Training.

1. Capacitor Electrical Hazard Thresholds are:
   a. < 100 volts and > 100 joules of stored energy
   b. ≥ 100 volts and > 1.0 joule of stored energy

c. ≥ 400 volts and > 0.25 joules of stored energy

3.3 Electrical Equipment Listing, Labeling, and Approval Requirements

1. All electrical equipment installed or used at Grant County PUD Power Production facilities shall be approved by the Electrical Engineering Department.
   a. Electrical equipment shall be approved and acceptable for use if it has been accepted, certified, listed, labeled, or otherwise determined to be safe by an OSHA Nationally Recognized Testing Laboratory (NRTL) (as indicated by an NRTL label applied by the manufacturer).
   b. If 3.3.1.a is not met, and there is an Underwriters Laboratories (UL) standard for the piece of equipment, it shall be field evaluated and labeled by an OSHA recognized NRTL representative.
   c. For equipment that does not comply with 3.3.1. a or 3.3.1. b, inspection and/or testing shall be completed using the Non-NRTL Labeled Electrical Equipment Evaluation Form when required by the Electrical Installation/Modification AHJ.


AHJ APPROVAL FOR NON-NRTL EQUIPMENT

AHJ Report Number_____

Manufacturer_____

_____

Serial Number_____

Evaluated by (print/sign) Date:

_____

HY010100E-FRM

EXCEPTION: Non-NRTL certified equipment that operates at less than 50 volts (such as cable assemblies, instruments, security systems, low voltage lighting, communication systems, etc.) may be excluded from section 3.3.

NOTE 1: Condition 3.3.1.c is reserved for use in unique situations or for special needs that do not satisfy NRTL requirements.

NOTE 2: Legacy equipment and non-NRTL equipment in use prior to the implementation of this Program may remain in service and does not require reevaluation, so long as it has not been modified, found to be defective or damaged, and does not present a hazard to the workers.

NOTE 3: See the LnI website for a list of LnI recognized NRTLs.

WAC 296-155-444 electrical equipment approval

https://app.leg.wa.gov/WAC/default.aspx?cite=296-155-444?

NOTE 4: Equipment of the same manufacturer and model number that has been previously evaluated by an NRTL may be approved by the AHJ using the 3.3.1.c option.

2. Equipment shall be suitable for its intended purpose and location to be installed and used in accordance with the manufacturer's instructions and any instructions or requirements of the NRTL listing or labeling.

   Exception: AHJ may approve in-house made test leads as needed.

3. All electrical multi-meters, including the external test leads, used on electrical equipment that operates at 50 volts or more shall be approved per paragraph 3.3.1. The standard multi-meter will be rated Category III or higher. Category II or less rated test instruments shall be permitted only when no instrument with a higher rating is available for the purpose, and it can be assured the instrument will not be used outside the limits of its category rating.

3.4 Electrical Maintenance

Electrical equipment must be properly maintained in accordance with manufacturer's instructions or accepted industry standards (such as NFPA 70B) in order to ensure the accuracy of the arc flash calculations and survey, as well as to meet the requirements for Normal Operating Condition of equipment.

3.5 Electrical Safe Work Practices

1. An electrical hazard/risk evaluation, including both an arc flash and a shock risk assessment, shall be performed and documented for all work containing electrical hazard(s) in accordance with NFPA 70E and this Program. This assessment shall be documented on the Electrical Risk Assessment (ERA) Form (Appendix A) or Energized Electrical Work Permit (Appendix B).
2. All electrical equipment, circuit conductors, and circuit parts shall be considered energized until placed in an Electrically Safe Working Condition (ESWC) in accordance with, *PP-OPS-ADM-S-01, Lockout Tagout Clearance Process*.

3.6 Electrically Safe Working Condition:

1. Determine all possible sources of electrical supply to the specific equipment. Check applicable drawings, diagrams, and identification tags.
   a. After properly interrupting the load current, open the disconnecting device(s) for each source.
   b. Wherever possible, visually verify that all blades of the disconnecting devices are fully open or that draw out-type circuit breakers are withdrawn to the test or fully disconnected position.
   c. Release stored energy.

d. Apply lockout/tagout devices in accordance with the PP-OPS-ADM-S-01, Lockout Tagout Clearance Process

e. Use an adequately rated portable test instrument to test Utilizing zero energy check, "live, dead, live" method. Before and after each test, determine that the test instrument is operating satisfactorily through verification on any known voltage source or proving unit.

2. On electrical systems over 1,000 volts, non-contact capacitive test instruments shall be permitted to be used to test each phase conductor.

   a. Where the possibility of induced voltages or stored electric energy exists, ground all circuit conductors and circuit parts before touching them. Where it could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts, apply temporary protective grounding equipment in accordance with the Grant County PUD Grounding Procedure.

3. When work is in progress, covers are to be installed on all panels when leaving them unattended when possible. If unable to reinstall cover, place sign on equipment stating, "Contact Clearance Holder for Access" and provide contact information.

4. Normal operation of electric equipment shall be permitted where a normal operating condition exists. A normal operating condition exists when all the following conditions are satisfied:

   a. The equipment is properly installed.

   b. The equipment is properly maintained.

   c. The equipment is rated for the available fault current.

   d. The equipment is used in accordance with instructions included in the listing and labeling and in accordance with the manufacturer's instructions.

   e. The equipment doors are closed and secured.

   f. All equipment covers are in place and secured.

   g. There is no sign of impending failure.

   NOTE: To meet the requirements of "Normal Operation" it is the responsibility of the Electrical Engineering Depart to ensure the equipment is installed maintained, sized, and used in accordance with instructions included in the listing and labeling and in accordance with the manufacturer's instructions. If necessary, the AHJ will provide operating instruction in agreement with manufacturer's instructions for Operations.

5. Before starting work, match the equipment ID or description to the work order to confirm correct location.

6. Use visual indicators to verify equipment is in the expected position.

7. Test equipment to confirm it is in de-energized condition.
8. Where there is not an accessible exposed point to take contact voltage measurements to determine the absence of voltage at work locations, planning considerations shall include approval of alternate methods of verification (e.g., proximity probes, non-contact probes, circuit tracers, current sensing probes).
9. Appropriate signs, tags, barricades, or an attendant shall be used to warn and protect employees from hazards that may cause injury due to electric shock or arc flash.
10. Barricades, safety signs, or attendant(s) are required if work occurs inside the LAB or AFB of energized equipment.
11. If the attendant is required to be within the LAB or AFB, they shall be a Qualified Electrical Worker with appropriate PPE.
12. Insulated tools and equipment shall be used, stored, maintained, and tested per the manufacturer's instructions or industry standards.
13. Non-conductive ladders (i.e., fiberglass, wood) are to be used for electrical work or near electrical installations.
14. Electrical PPE and other protective equipment shall meet the requirements of Section 4.12, Electrical PPE.
15. All test instruments shall be visually inspected for external damage before each use. Damaged or defective equipment shall not be used.
16. Test instruments shall be designed, rated, and approved for their intended use.
17. For the performance of zero energy checks, test instruments on known voltages before and after zero voltage is verified (Live-Dead-Live).

3.7 Work Involving Electrical Hazards

All electrical hazards to which an employee may be exposed shall be put into an electrically safe work condition in conjunction with *PP-OPS-ADM-S-01, Lockout Tagout Clearance Process,* except where deenergizing would create additional hazards or increased risk or would be infeasible.

Each piece of equipment operating > 50 volts AC and not put into a de-energized state must be evaluated for shock risk by completing an ERA or EEWP.

Each piece of equipment operating ≥ 208 volt 3-phase AC or ≥ 150 volt DC and not put into a de-energized state must be evaluated for incident energy and arc flash boundary.

Electrical equipment that has exposed energized parts ≥50V, or where there is an increased risk of injury from an exposure to an arc flash hazard, or equipment that

operates at less than 50 volts where the capacity of the source and any overcurrent protection between the energy source and the worker are considered and it is determined that there will be increased exposure to electrical burns or to explosion due to electric arcs, may only be accessed under the following conditions:

1. Perform Work with an Energized Electrical Work Permit

   When working within the LAB or the AFB of energized electrical conductors or circuit parts that are not placed in an electrically safe work condition (e.g., for the reasons of increased or additional hazards, increased risk, infeasibility, or <50V per NFPA 70E), justification and authorization shall be documented on an approved Energized Electrical Work Permit (EEWP) (Appendix B) and shall require qualified management authorization. The EEWP shall be included in the work document (e.g., work package, technical procedure).

2. Perform Work with Exemptions to an EEWP

   The following exempted work requires a completed Electrical Risk Assessment (Appendix A) prior to starting work.

   a. An EEWP shall not be required when a Qualified Electrical Worker is working within the LAB of energized electrical conductors or circuit parts, or the AFB, and is performing the following tasks:

      i. Testing

      ii. Troubleshooting

      iii. Access to and egress from an area with energized electrical equipment if no electrical work is performed and the restricted approach boundary is not crossed, including:

      - Installing temporary protective measures, such as:
        - Voltage rated protective shields/barriers
        - Voltage rated rubber insulating equipment,
        - Voltage rated plastic guard equipment
      - When escorting a non-qualified person across the LAB
      - Thermography or Ultrasound
      - When crossing LAB for visual inspection only
      - Housekeeping and non-electrical tasks

iv. Safe condition/safe-to-work checks

v. Working on Class 2 circuits

vi. Removing/replacing electrical device covers, and enclosure covers

vii. Clearance activities

viii. When working on equipment that operates at less than 50 volts where the capacity of the source and any overcurrent protection between the energy source and the worker are considered and it is determined that there will be no increased exposure to electrical burns or to explosions due to electric arcs.

ix. An EEWP shall not be required when crossing the LAB only for visual inspection by a Qualified Electrical Worker or a non-qualified person escorted by a Qualified Electrical Worker, and the Restricted Approach Boundary will not be crossed.

x. An EEWP shall not be required when crossing the AFB only for visual inspection by a Qualified Electrical Worker.

xi. An EEWP shall not be required when working on equipment that operates at less than 50 volts where the capacity of the source and any overcurrent protection between the energy source and the worker are considered and it is determined that there will be increased exposure to electrical burns or to explosion due to electrical arcs. This assessment can be documented on the Electrical Risk Assessment (Appendix A).

3. Physical or mechanical barriers outside of the restricted approach boundary

   Use of temporary protective measures to prevent inadvertent contact with energized conductors or circuit parts shall have documentation of installation and removal. It is acceptable to allow temporary barriers to remain in place for the duration of the task with verification of adequacy by a Qualified Electrical Worker each day when work is being performed. Document on Job Brief or ABC form.

3.8 Working within the Limited Approach Boundary or Arc Flash Protection Boundary

1. Work within the LAB or the AFB shall be performed using appropriate PPE. The workers shall be provided an electrical hazards brief by a Qualified Electrical Worker.
2. A shock risk assessment shall be completed and documented on the Electrical Risk Assessment (Appendix A) to determine the voltage (AC and DC) to which personnel will be exposed, boundary requirements, and the PPE necessary to minimize the possibility of electric shock to personnel.
3. An arc flash risk assessment shall be performed and shall and determine if an arc flash hazard exists. If an arc flash hazard exists, the risk assessment shall determine the appropriate safety-related work practices, the AFB, and the PPE to

be used within the AFB. This assessment shall be documented on the Electrical Risk Assessment (Appendix A). The arc flash risk assessment shall be reviewed periodically, at intervals not to exceed 5 years.

The Grant County PUD Power Production approved method for performing an arc flash risk assessment is described below:

a. Incident Energy Analysis

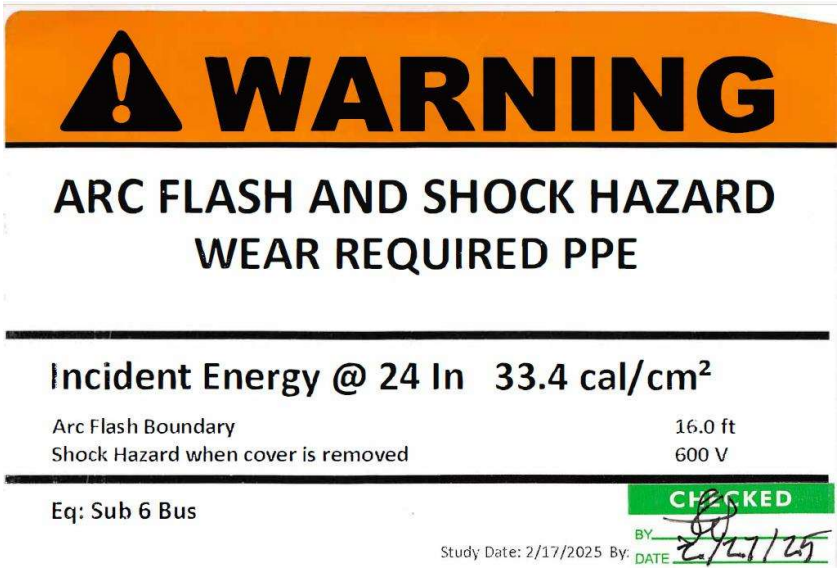
   Note: If incident energy analysis has not been performed, use NFPA 70 table 130.7(C)(15)(a) as a reference.

b. Power Production Engineering is responsible for conducting or overseeing incident energy analyses and tracking electrical equipment hazard label needs throughout Power Production facilities.

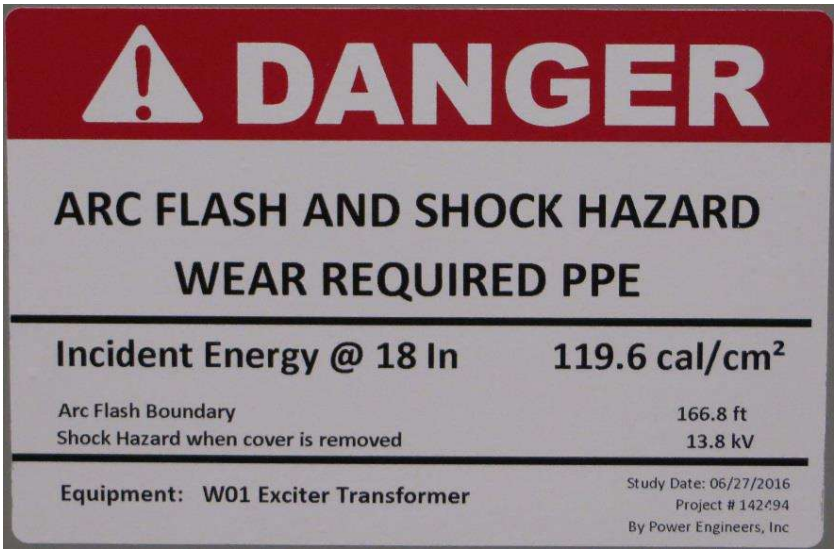
4. If an incident energy analysis has been performed, and an arc flash hazard exists, the equipment likely to be worked on while energized shall be field marked with a label containing the available incident energy prior to work being performed. The equipment marking shall contain, at a minimum, the following information:

   - AFB
   - Working Distance
   - Incident energy at the working distance
   - Nominal system voltage

Where the calculated incident energy is 40 cal/cm^2 or below, the label shall be an orange "WARNING" label; where the calculated incident energy exceeds 40 cal/cm^2, the label shall be a red "DANGER" label.



When calculated incident energy exceeds 40 cal/cm^2, and de-energizing is not feasible, alternate work methods and controls shall be documented and have been authorized by senior management.



5. Non-qualified persons who are not escorted by a Qualified Electrical Worker shall not be permitted to enter areas that are required to be accessible to Qualified Electrical Workers only, unless the electrical conductors and equipment involved are in an electrically safe work condition.
6. Where there is a specific need for a non-qualified person(s) to cross the LAB, a Qualified Electrical Worker shall advise the non-qualified person of the possible hazards, and continuously escort the qualified person(s) while inside the LAB. Under no circumstance shall the escorted non-qualified person(s) be permitted to cross the Restricted Approach Boundary.
7. Under no circumstances shall a non-qualified person(s) be permitted to cross the AFB unless escorted by a qualified electrical worker.
8. At least two Qualified Electrical Workers shall be assigned to any work occurring inside the AFB or the Restricted Approach Boundary of exposed parts operating at more than 300 volts phase-to-phase or phase-to-ground.
9. A Qualified Electrical Worker has the right to request an evaluation to determine if additional Qualified Electrical Worker(s) are needed when performing a task that presents a shock hazard or arc flash hazard to ensure employee protection.
10. Conductive articles of jewelry and clothing (e.g. watchbands, bracelets, rings, key chains, necklaces, metalized aprons, cloth with conductive thread, metal headgear, or metal frame glasses) shall not be worn where they present an electrical contact hazard with exposed energized conductors or circuit parts.

3.9 Over Current Protective Devices

3.9.1 Operating Circuit Breakers

An employee who operates a circuit breaker shall be authorized by their facility management and have knowledge in the safe operation of the equipment and the hazards involved (See paragraph 4.3.2 for required training for non-electrical workers and paragraph 5.9.9 for required PPE).

3.9.2 Reclosing (Re-Energizing) Circuits After Protective Device Operation

After a circuit is de-energized by an over current protective device (e.g., tripped circuit breaker, blown fuse), the circuit shall not be manually re-energized until it has been determined by a Power Plant Operator that the equipment and circuit can be re-energized safely.

NOTE 1: *Overcurrent protective devices may be, but are not limited to fuses, circuit breakers, and overloads.*

3.10 Blind Penetrations

1. This section addresses performing drilling, saw cutting and other blind penetrations greater than 1.5 inches, and excavations into surfaces containing concealed electrical conduits and cables.
2. If the presence and location of electrical circuits or conductors cannot be accurately identified and completely de-energized, appropriate mitigating controls shall be used for penetrations greater than 1.5 inches. At a minimum:
   b. All applicable drawings and documentation shall be reviewed. The job site shall be inspected to the maximum extent possible to determine if obstructions are present before starting the job.
   c. A scan shall be performed if penetrating into concrete or masonry surfaces.
   d. Circuits or conductors shall be deenergized to the maximum extent possible and placed in an electrically safe work condition.
   e. Workers shall use a drill stop.
   f. A risk assessment shall be completed for work requiring penetrations into or through walls, floors, or other surfaces that may contain concealed electrical systems.
   g. Workers performing blind penetrations shall use appropriate voltage rated gloves with protective outer leather gloves and nonconductive safety glasses with side shields.
3. When using water during drilling operations a GFCI shall be used.

3.11 Batteries or Battery Banks

1. Battery Electrical Hazard Thresholds are:
   a. AC >50 volts and 5 milliamperes
   b. DC >100 volts and 40 milliamperes

c. Thermal >1,000 watts short-circuit power

2. When working on equipment that exceeds battery electrical hazard thresholds, appropriate voltage rated PPE shall be worn.
3. When performing work on batteries where chemical exposures may exist, the following chemical resistant PPE shall be made available to employees.
   a. Goggles and face shield
   b. Gloves
   c. Protective apron
   d. Protective footwear
4. Portable or stationary water facilities shall be available for rinsing eyes and skin in accordance with American National Standards Institute (ANSI) Z358.1.
5. Do not use tools or conductive objects that may short circuit any battery components.
6. Before making or breaking connections within a group of cells, open the battery system disconnecting means to minimize the possibility of arcing.

3.12 Capacitors

1. Capacitor Electrical Hazard Thresholds are:
   a. < 100 volts and > 100 joules of stored energy
   b. ≥ 100 volts and > 1.0 joule of stored energy
   c. ≥ 400 volts and > 0.25 joules of stored energy
2. For the purpose of shock risk assessment, DC voltages shall be considered equivalent to AC voltages referenced in NFPA 70E and appropriate voltage rated PPE shall be worn.
3. Only Qualified Electrical Workers trained in the proper handling and storage of power capacitors and hazard recognition shall be assigned the task of removing/servicing/installing such units.
4. Access to capacitor areas shall be restricted until all capacitors have been discharged, shorted, and grounded or verified to be less than 50 volts.
5. Any residual charge from capacitors shall be removed by shorting the terminals before servicing or removing.
6. Capacitors shall be discharged using an appropriately voltage rated shorting probe. If capacitors have been removed from the circuit or are being transported, the terminals shall be continuously short circuited using no smaller than a #14 AWG conductor.
7. Automatic discharge and grounding devices shall not be relied upon.

8. Shorting probes shall be inspected before each use.
9. Capacitor terminals shall be considered "charged" until the terminals are shorted or verified to be less than 50 volts.

3.13 Electrical Personal Protective Equipment (PPE)

1. Electrical PPE includes, but is not limited to, the equipment and clothing necessary to protect personnel performing electrical work from hazards involving electrical shock, arc flash, batteries, and any other electrical hazards that may be encountered.

NOTE: *PPE for non-electrical hazards (e.g., battery acid) shall also be considered.*

2. Electrical PPE and other protective equipment that has an expired testing date or fails visual or functional inspection shall be removed from service.

3. Hot sticks shall be tested and labeled in accordance with manufacturer's instructions and reference manuals.

4. All electrical PPE items must conform to and be marked in accordance with NFPA 70E 130.7(C)(14).

5. PPE shall be:

a. Maintained in a safe, reliable condition.

b. Stored in a manner that protects against physical damage, moisture, dust, or other deteriorating agents.

c. Visually inspected before each use.

d. Periodically inspected or tested in accordance with manufacturer's instructions and/or the applicable ANSI or American Society for Testing and Materials (ASTM) standard(s).

6. All personnel are to be provided, and shall use, PPE appropriate for potential shock or arc flash hazards to which they may be exposed. All parts of the body inside the AFB shall be protected.

Arc-Rated PPE Table

Incident Energy Exposures equal to 1.2 cal/cm² up to an including 12 cal/cm²
• Arc-rated clothing with an arc rating equal to or greater than the estimated incident energy • Arc-rated long-sleeve shirt and pants or arc-rated coverall or arc flash suit • Arc-rated face shield and arc-rated balaclava or arc flash suit hood • Arc-rated outerwear as needed • Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with protectors • Hard hat • Safety glasses or safety goggles • Hearing protection • Leather footwear
Incident Energy Exposures greater than 12 cal/cm²
• Arc-rated clothing with an arc rating equal to or greater than the estimated incident energy • Arc-rated long-sleeve shirt and pants or arc-rated coverall or arc flash suit • Arc-rated arc flash suit hood • Arc-rated outerwear as needed • Arc-rated gloves, or rubber insulating gloves with protectors • Hard hat • Safety glasses or safety goggles • Hearing protection • Leather footwear

1. Personnel shall be instructed to the proper use and maintenance of PPE prior to use.
2. Voltage rated rubber-insulating equipment shall be marked with the issue date. The equipment shall not be used if the testing interval listed on the table below has expired. Equipment may be returned to service after satisfactory re-testing is complete.

Electrical PPE Testing Interval Table

Rubber-Insulating Equipment	Maximum Test Interval
Blankets	Before first issue; every 12 months thereafter
Covers	If insulating value is believed degraded
Gloves	Before first issue (up to 12 months); every 6 months thereafter
Line hose	If insulating value is believed degraded
Sleeves	Before first issue; every 12 months thereafter

3. Voltage rated gloves with leather protectors, shall be used when there is a danger of injury from electric shock due to contact with energized electrical conductors or circuit parts.
   a. An inspection shall be performed prior to using gloves and immediately following any incident that is suspected of having caused damage.
      i. Check date on gloves to verify it is within periodicity.
      ii. Visually inspect for cracks, holes, tears, foreign substances, and other visible defects.
      iii. Perform air leakage test on gloves.
      iv. Gloves found with any defects that may affect its insulating properties shall be removed from service.
   b. Voltage rated insulating sleeves shall also be used when there is an additional danger of arm injury from electric shock due to contact with energized electrical conductors or circuit parts.
   c. Gloves exposed to chemicals, damaged, or requiring periodic testing, cleaning and sanitizing shall be returned to the Tool man.

4. Personnel who operate circuit breakers, electrical disconnect switches, and similar switchgear equipment, under normal operation shall wear, at a minimum:
    - Minimum 8 cal/cm^2 arc-rated clothing
    - Hearing protection
    - Non-melting (untreated natural fiber) pants and long-sleeved shirt
    - Safety glasses (or equivalent)
    - Leather or insulating gloves
5. Personnel shall wear appropriate layers of arc-rated (AR) clothing wherever there is potential exposure to an arc flash above the threshold incident-energy level for a second-degree burn (1.2 cal/cm^2).

3.14 Portable Cord- and Plug-Connected Electric Equipment

This section also applies to cord sets (extension cords).

1. Handling and Storage
    a. Portable equipment shall be handled and stored in a manner that will not cause damage. Flexible electric cords connected to equipment shall not be used for raising or lowering the equipment.
    b. Flexible cords shall not be fastened with staples or hung in such a fashion as could damage the outer jacket or insulation.
2. Grounding-Type Equipment
    a. A flexible cord used with grounding-type utilization equipment shall contain an equipment grounding conductor.
    b. Attachment plugs and receptacles shall not be connected or altered in a manner that would interrupt continuity of the equipment grounding conductor. Additionally, these devices shall not be altered in order to allow use in a manner that was not intended by the manufacturer.
    c. Adapters that interrupt the continuity of the equipment grounding conductor shall not be used.

3. Visual Inspection and Repair
    a. Before each use, portable cord- and plug-connected equipment shall be visually inspected for external defects (such as loose parts or deformed and missing pins) and for evidence of possible internal damage (such as a pinched or crushed outer jacket).
    EXCEPTION: Stationary cord- and plug-connected equipment that remain connected once they are put in place and are installed such that the cord and plug are not subject to physical damage during normal use shall not be required to be visually inspected until they are relocated or repaired.
    b. 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. No employee shall use it until a person(s) qualified to perform the repairs and tests necessary to render the equipment safe has done so.
    c. When an attachment plug is to be connected to a receptacle, the relationship of the plug and receptacle contacts shall first be checked to ensure that they are of mating configurations.
4. Connecting Attachment Plugs
    a. Employee's hands shall not be wet when plugging and unplugging flexible cords and cord- and plug-connected equipment if energized equipment is involved.
    b. Energized plug and receptacle connections shall be handled only with insulating protective equipment if the condition of the connection could provide a conductive path to the employee's hand (e.g., if a cord connector is wet from being immersed in water).
    c. Locking-type connectors shall be secured after connection.
5. Manufacturer's Instructions. Portable equipment shall be used in accordance with manufacturer's instruction and safety warnings.
    a. Do not daisy chain 125 volt extension cords.
6. 600V Cable Connecting/Disconnecting PPE Requirements:
    a. Analysis has determined that while most 600V receptacles can source an incident energy of approximately 0.2 cal/cm^2, some may have incident energy as high as 2 cal/cm^2. With this in mind, connecting/disconnecting 600V cords must be performed by a QEW and the PPE required is daily arc rated wear plus a face shield and balaclava.

7. 600V Cable voltage drop calculations:
    a. Assumptions:
        i. 550V 3 phase with ground.
        ii. 60 Amp Breaker and receptacle.
        iii. 60A Maximum Load. (Worst Case; Circuit should only be loaded to 48A max)
        iv. 4 AGW Copper Minimum conductor size (NFPA 70 Table 400.5(A)(1), i.e. SO cord 75 deg C
        v. Maximum 3% allowed voltage drop.
        vi. 10% reduction in allowed length per each connection.
    b. Formula:
        i. $Vd = \frac{1.73xKxLxI}{Cm}$

        ii. $L = \frac{VdxCm}{1.73xKxI}$

            1. Vd = Voltage Drop (Volts)
            2. I = Max Current in conductor (Amps)
            3. L = One-way length of circuit (feet)
            4. Cm = Cross Sectional Area of Conductor (Circular Mils)
            5. K = Resistance of ohms of 1 circular mil foot of conductor

        iii. $L = \frac{16.5x41740}{1.732x12.9x60} = 514\ ft$

    c. Each extension connection would reduce the allowed length by 51.4 ft.
        i. For example, 3 extension cables daisy chained (4 connections between the receptacle and the load) would reduce the maximum allowed cable length to 308 ft.

        ii. $L2 = 514 - (51.4x4) = \mathbf{308\ ft}$

    d. Conclusion: To maintain sufficient voltage at rated current, length extensions for 600V cords shall be limited to no more than 4 – 50’ lengths connected in series (200’ max) or no more than 6 – 25’ lengths connected in series (150’ max).

3.15 Ground-Fault Circuit-Interrupter (GFCI) Protection

Employees shall be provided with ground-fault circuit-interrupter (GFCI) protection as described herein. Listed cord sets or devices incorporating GFCI protection for personnel identified for portable use shall be permitted.

GFCI protection shall be tested in accordance with manufacturer's instructions.

1. Maintenance and Construction or Outdoors
   GFCI protection shall be provided when an employee operates or uses cord sets (extension cords) or cord- and plug-connected tools related to maintenance and construction or outdoor activities supplied by 120-volt, 15-, 20-, or 30-ampere circuits.

   Where employees operate or use equipment supplied by greater than 120-volt, 15-, 20-, or 30-ampere circuits, GFCI protection or an assured equipment grounding conductor program shall be implemented.

3.16 Overcurrent Protection Devices

Overcurrent protection of circuits and conductors shall not be modified, even on a temporary basis, beyond what is permitted by applicable portions of electrical codes and standards dealing with overcurrent protection.

3.17 Program Audits

The ESP shall be audited to verify that the principles and procedures of the ESP are in compliance with the latest edition of NFPA 70E. Audits shall be performed at intervals not to exceed 3 years and shall be conducted by a delegate of the Electrical Safety Program Committee.

Field work shall be audited to verify that the requirements contained in the procedures of the Electrical Safety Program are being followed by personnel. Audits shall be performed at intervals not to exceed 1 year and shall be conducted by a delegate of the Electrical Safety Program Committee.

When the auditing determines that the principles and procedures of the Electrical Safety Program are not being followed, the ESP Committee, employee supervisor, and/or contractor project manager(s) shall be informed and shall take actions to correct any observations or findings, including appropriate revisions to the training program or revisions to the ESP.

4. Recordkeeping

Records and documentation generated by the Program shall be processed and maintained in accordance with appropriate district policies.

5. Appendices

5.1 Appendix A- Code References

5.2 Appendix B- Energized Electrical Work Boundaries

5.3 Appendix C- Roles and Responsibilities- Reference Charter

6. Attachment Links:

1. Electrical Safety Program (ESP) Committee Charter
2. Electrical Risk Assessment (ERA)
3. Energized Electrical Work Permit (EEWP)
4. ESP Terms and Definitions

7. Review/Revision History

Date	Description
3/9/2026	Full rewrite of program by ESP Committee. Renamed PP-HYD-SAF-100

Previous Version Revision History

HY010100 – Electrical Safety Program (ESP) Version History*			
Document #	**Ver.**	**Date**	**Revision**
HY010100 - ALL	0	6/1/17	Initial issue
HY010100-POL	1	6/27/17	>208V 3-Phase clarification added to statement #3.
	2	5/1/18	Rule #2 clarified; document titles changed in rule #3; 'Hazard' changed to 'Electrical' in rule #4; Text deleted from rule #5; New rule #6 – maintenance; new rule #7 – risk reduction; rule #8 – audit clarified; new rule #9 – investigations.
HY010100A-FRM	1	11/16/17	Sections 4, 5, & 7 heavily revised. Comments section added (new #8).
HY010100A-LST (Definitions)	1	5/1/18	Added definitions: Blind Penetration, Class 2 Circuits, Fault Current, Fault Current Available, Incident Energy, Maintenance (Condition of), Shock Hazard, Testing, and Working On. Definitions revised: Arc Flash Boundary, Arc Flash Hazard, AHJ, Electrical Hazard, Electrically Safe Work Condition, Qualified Person, Restricted Approach Boundary, and Working Distance.

HY010100A-PRO (Requesting Inspection of EE)	1	5/1/18	Retitled: Inspecting (instead of Reviewing) Electrical Equipment. Trigger revised; procedure modified throughout.
HY010100A-REF (ESP Description)	1	5/1/18	Normal Operation revised (Sections 1.0 & 7.1), AHJ duties revised (Section 2.4), LAB added (Section 2.6), Table citation revised (Sections 3.3 & 3.4), text deleted (Sections 4.1, 6.0.3, 6.1.2, 7.3, 7.4), Equipment maintenance section added (4.2), shock and arc flash requirements clarified (Section 6.0), Blind penetration (7.2) clarified; PPE standard amended and exception deleted (Section 8.0), New section 9.0: risk control; Section 10: ESP audits expanded; references added (Section 11.0).
HY010100A-STD (Committee Charter)	1	5/1/18	Electrical Engineering representative added as voting committee member.
HY010100A-TSK (Inspecting Electrical Equip. for use)	1	5/1/18	Retitled: Inspecting Electrical Equipment for Use, Trigger revised to include modifying electrical equipment. Reformatted with Pre-purchase/mod and new Post-purchase/mod sections. Supersedes HY010100F-TSKv0
HY010100B-JOB (PM Duties)	1	5/1/18	Training requirements increased for PM.
HY010100B-PRO (Working On/ Near Ener. Eq.)	1	5/1/18	Steps 8, 15, 16 text deleted. Additional job briefing required if changes occur during work which can affect safety, Step 16a.
HY010100B-STD (Arc Flash Risk Assessment)	1	5/1/18	Retitled. >208V 3-Phase added to Sections I & II. Section II 'analysis' replaces 'analyses'. Table citations revised. Section IV retitled; references amended in Section V.

Appendix A - Code References

29 CFR 1910, Subpart S, "Electrical."

29 CFR 1926, Subpart K, "Electrical."

29 CFR 1926, Subpart CC, "Cranes & Derricks in Construction."

29 CFR 1926, Subpart O, "Motor Vehicles, Motorized Equipment, and Marine Operations."

IEEE 2023, "National Electrical Safety Code (NESC)."

NFPA 70E-2024, "Standard for Electrical Safety in the Workplace."

Washington Administrative Code (WAC) 296-45, Electric Power Generation, Transmission, and Distribution

PP-OPS-ADM-S-01, Lockout Tagout Clearance Process
American National Standards Institute (ANSI) Z358.1, *Emergency Shower and Eye Wash Station Requirements*.

American National Standards Institute (ANSI) Z535, *Series of Standards for Safety Signs and Tags*.

Electrical Safety Program (ESP) Course Descriptions, Objectives, and Training Requirements.

IEEE 1584 – Guide for Performing Arc Flash Hazard Calculations.

Revised Code of Washington 19.28, Electricians and Electrical Installations.

- **Appendix B – Energized Electrical Work Boundaries**