



SAFE WORK PRACTICES MANUAL FOR LOW VOLTAGE ELECTRICIANS

Safety and Industrial Hygiene Unit

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1.0 Introduction.

1.1. Scope.

- 1.1.1. This Manual establishes Safe Work Practices for Low Voltage Electricians performing electrical work near, or with, electrical equipment that operates up to 1000 volts, in permanent or temporary shore installations or on floating equipment in areas under Panama Canal Authority jurisdiction. It covers work performed by qualified personnel as well as by unqualified personnel.
- 1.1.2. This Manual does not apply to work performed by qualified personnel in High Voltage operations in, near, or with, high voltage equipment in electrical power generation, transmission, and distribution installations (including communication and metering) located in buildings used for that purpose or outdoors.
 - 1.1.2.1. The activities of qualified personnel at these installations shall be governed by the provisions of this Manual, the High Voltage Operations Safety Manual and the criteria and regulations each Division generates.

1.2. General Requirements

- 1.2.1. Only PCA qualified and authorized personnel will be permitted to perform work in electrical conductors, circuit parts, or electrical equipment as provided in this Manual.

1.3. Definitions

- 1.3.1. Qualified persons are those who possess the knowledge, abilities, skills, and training to identify and minimize electrical hazards when working in or near exposed energized parts.
- 1.3.2. Unqualified personnel are persons who possess little or no training in avoiding electrical hazards when working in or near exposed energized parts.
- 1.3.3. Electrical arc is the flow of current between two points at different potentials through the open air. It is usually accompanied by a great release of energy, manifested in the form of a flash, explosion, and heat.

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- 1.3.4. Electrical shock is the discharge of electric energy through the body of a person when it completes a circuit of low resistance between two points of an electrical circuit.
- 1.3.5. Approach boundary is the distance to which an unqualified person may safely approach an exposed energized part of an electrical circuit. The objective is to protect an unqualified person against the danger of contact with an energized part, which may result in electrical shock.
- 1.3.6. Approach distance is the distance to which a qualified person may safely approach exposed energized parts or electrical circuits without the need to use personal protection equipment. The objective is to protect a qualified person against the danger of contact with an energized part, which may result in an electrical shock.
- 1.3.7. Selector switches are electrical equipment switches with several positions, such as on, off, or stand-by.
- 1.3.8. Interlocks are electrical safety switches that prevent activation of other circuits or their own activation by physical means.
- 1.3.9. Push buttons are button switches.

2.0 Training

2.1. Training Requirements.

- 2.1.1. Training requirements apply to all employees exposed to the hazards of electric shock or electric arc flash and explosion which cannot be reduced to a safe level with electrical installation requirements.
- 2.1.2. Employees exposed to such hazards who are required to be trained include: field supervisors, electrical and/or electronic engineers, electrical and/or electronic equipment installers, electrical and/or electronic workers or technicians, electricians, electrician assistants, industrial equipment mechanics and repairmen, painters, fitters, welders, and marine engineers.
- 2.1.3. When the activities of the employees listed in 2.1.2, or of the employees they



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supervise, do not bring them near exposed electrical circuit parts, it is not necessary to train them.

- 2.1.4. Other employees also expected to be exposed to a comparable risk of injury due to electrical shock or injury associated with the flash and explosion produced by an electric arc shall also be trained.
- 2.1.5. Unqualified personnel who are similarly exposed shall also be trained and familiarized with any safe electrical work practices not specifically included in this Manual, but which are necessary for their safety.

2.2. Training Content

- 2.2.1. Employees shall be trained in and familiarized with the safe work practices contained in this Manual and other safe work practices that apply to their respective work assignments.
- 2.2.2. Qualified personnel (e.g., those permitted to work in or near exposed energized parts) shall be, as a minimum, trained and familiarized with the following:
 - 2.2.2.1. The skills and techniques necessary to distinguish exposed energized parts from other parts of the electrical equipment.
 - 2.2.2.2. The skills and techniques necessary to determine the nominal voltage of exposed energized parts, and
 - 2.2.2.3. The clearance distances specified in table 3.3.4 and the voltage to which a qualified person may be exposed.
 - 2.2.2.4. First aid and cardiopulmonary resuscitation techniques.

Note 1: For the purpose of this Manual, a person must possess the training required by this Section to be considered as a qualified person.

Note 2: Qualified persons performing work on energized equipment, whether in direct contact or in contact through tools or materials, must also possess the required training to comply with Section 3.4 of this Manual.



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2.3. Type of Training.

2.3.1. The training required in this Section shall be of classroom or work site type. The extent of training provided shall be determined by the risk to the employee, and it shall be documented.

2.3.1.1. Contractor shall provide training for their own employees.

3.0. Selection and Use of Work Practices

3.1. General.

3.1.1. Safe work practices shall be used to prevent electric shock, injuries resulting from direct or indirect electrical contact, or injuries caused by electric arc flash or explosion, when work is performed near or on electrical equipment or circuits that are or may be energized.

3.1.2. Specified safe work practices shall be consistent with the nature and extent of the associated electrical hazards.

3.1.3. Energized parts to which an employee may be exposed shall be deenergized prior to performing work on or near them by the employee.

3.1.4. Exceptions:

3.1.4.1. Energized parts operating at less than 50 volts to ground and 1500 Va or less that do not need to be deenergized if there is no increased exposure to electrical arc burns or explosions.

3.1.4.2. Emergency alarm systems which are kept operational at all times as required for the safe operation of the installation.

3.1.4.3. Parts of the equipment and electrical circuits which, due to their unpractical design or operational limitations may only be worked on or tested with the circuit energized or because they are an integral part of a continuing industrial process.

3.1.4.4. Equipment or electrical circuits which, when energized, pose an added risk to workers who must perform the job, or to other exposed



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personnel.

3.2. Work in or Near Exposed Deenergized Parts

- 3.2.1. This paragraph applies to work performed on or near exposed deenergized parts that can expose employees to electrical hazards.
- 3.2.2. Conductors or parts of electrical equipment which have been deenergized but locked out or tagged in accordance to the provisions of this Section shall be treated as energized parts, and work practices for work performed on or near them shall apply.
- 3.2.3. In accordance with this Section, deenergized equipment shall be considered as placed in an electrically safe condition.
- 3.2.4. **Lockout and Tagging of Circuits and/or Electrical Equipment.**
 - 3.2.4.1. While any employee is exposed to contact with parts of electric equipment or circuits which have been deenergized, the circuits energizing the parts shall be locked out or tagged in accordance with the requirements of PCA Standard 2600SEG118, *Lockout and Tagging*.
- 3.2.5. **Deenergizing Equipment.**
 - 3.2.5.1. Safe procedures for deenergizing circuits and equipment shall be determined before circuits or equipment is deenergized.
 - 3.2.5.2. Circuits and equipment to be worked on shall be disconnected from all electric energy sources. For this purpose, all possible electric supply sources to the specific equipment shall be determined and all tags, cards, identification labels, and the applicable diagrams verified.
 - 3.2.5.3. Control circuit devices, such as push buttons, selector switches, and interlocks, may not be used as the sole means for deenergizing circuits or equipment. Interlocks for electric equipment may not be used as a substitute for lockout and tagging procedures.
 - 3.2.5.4. Stored electric energy which might endanger personnel shall be



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released. Condensers shall be discharged and high capacitance elements shall be short-circuited and grounded.

- 3.2.5.5. Stored non-electrical energy in devices that could reenergize electric circuit parts shall be blocked or relieved to the extent that the circuit parts could not be accidentally energized by the device.
- 3.2.5.6. Wherever possible, it shall be visually verified that all contacts of the disconnecting devices are completely open or that the removable switches are completely separated.
- 3.2.5.7. Lockout and tagging devices shall be placed in accordance with the Lockout and Tagging Standard and established procedures.
- 3.2.5.8. Whenever the possibility for induced voltage or stored electrical energy exists, phase conductors or circuit parts shall be grounded prior to touching them. When it can be reasonably expected that conductors or deenergized circuit parts may make contact with other exposed conductors or energized circuit parts, grounding devices appropriate to support the release of energy available from an electrical fault shall be installed.
- 3.2.5.9. Tags without locks may be used, provided the following requirements are met:
 - 3.2.5.9.1. The tag shall be supplemented by at least one additional safety measure that provides a level of safety equivalent to that obtained by use of a lock. Examples of additional safety measures include the removal of an isolating circuit element, blocking of a controlling switch, or opening of an extra disconnecting device, and
 - 3.2.5.9.2. Only one circuit or equipment part is deenergized, and
 - 3.2.5.9.3. The lockout period does not extend beyond the work shift, and
 - 3.2.5.9.4. Employees exposed to the hazards associated with reenergizing the circuit or the equipment are familiar with

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this procedure.

3.2.5.10. Verification of deenergized condition. The requirements of this paragraph shall be met before any circuits or equipment can be considered and worked as deenergized. For such purpose,

3.2.5.10.1. A qualified person shall operate the equipment operating controls or otherwise verify that the equipment cannot be restarted.

3.2.5.10.2. A qualified person shall use test equipment to test the circuit elements and electrical parts of equipment to which employees will be exposed and shall verify that the circuit elements and equipment parts are deenergized.

3.2.5.10.3. A qualified person will use test equipment to determine if any energized condition exists as a result of inadvertently induced voltage or unrelated voltage backfeed even though specific parts of the circuit have been deenergized and presumed to be safe.

3.2.5.10.4. Test equipment shall be checked for proper operation before and immediately after performing this test with a known electric power supply source.

3.2.6. Reenergized Equipment.

3.2.6.1. These requirements shall be met, in the order given, before the circuit or the equipment is reenergized, even temporarily.

3.2.6.1.1. A qualified person shall conduct tests and visual inspections, as necessary, to verify that all tools, electrical jumpers, shorts, grounds, and other such devices have been removed, so that the circuits and equipment can be safely energized.

3.2.6.1.2. Employees exposed to the hazards associated with reenergizing the circuit or equipment shall be warned to stay clear of circuits and equipment.



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3.2.6.1.3. Each lock and tag shall be removed as established in the Lockout and Tagging Standard and applicable procedures.

3.2.6.1.4. There shall be a visual determination that all employees are clear of the circuits and equipment.

3.3. Working in or Near exposed Energized Parts.

3.3.1. General.

3.3.1.1. This paragraph applies to work performed on exposed live parts (involving either direct contact or by means of tools or materials) or near enough to them for employees to be exposed to any hazard they present.

3.3.1.2. Only qualified persons may work on electric circuit parts or equipment that has not been deenergized under the procedures of Section 3.2 of this Manual.

3.3.1.3. Such persons shall be capable of working safely on energized circuits and shall be familiar with the proper use of special precautionary techniques, personal protection equipment, insulating and shielding materials, and insulated tools.

3.3.1.4. All work with energized parts which involves the possibility of contact with energized parts shall be authorized by the Manager of the Division to which the performer of the job or his assistant belongs.

3.3.2. Work Procedures

3.3.2.1. If the exposed live parts are not deenergized (i.e., for reasons of increased or additional hazards or infeasibility), other safety-related work practices shall be used to protect employees who may be exposed to the electrical hazards involved.

3.3.2.2. Such work practices shall protect employees against contact with



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energized circuit parts directly with any part of their body or indirectly through some other conductive object.

3.3.2.3. The work practices that are used shall be suitable for the conditions under which the work is to be performed and for the voltage level of the exposed electric conductors or circuit parts.

3.3.2.4. The work practices shall be documented.

3.3.3. Electric Arc Flash Hazard Analysis.

3.3.3.1. A flash hazard analysis shall be done before a person approaches any exposed electrical conductor or circuit part that has not been placed in an electrically safe work condition as established in Section 3.2.

3.3.3.2. For 600 Volts or more, in certain instances, the flash protection boundary might be a greater distance than the distances listed in Table 3.3.4. In such cases, the greater distance will be utilized to trigger the need for using adequate personal protection equipment.

3.3.3.3. For systems operating at 600 volts and below, the flash protection boundary shall be a minimum of 4.0 ft, unless it is calculated using some recognized and accepted method.

Note: To calculate the flash protection boundary in a 600 volt system, see code *NFPA 70E, Part II, Paragraph 2-1.3.3.2.*

3.3.4. Safe Distances for Qualified Personnel.

3.3.4.1. Qualified personnel may not approach or take any conductive object closer to exposed energized parts than the established approach distances in Table 3.3.4, unless:

3.3.4.2. The qualified person is insulated or protected from the energized parts, and the non-insulated parts of the body do not come within the minimum approach distance established in Table 3.3.4, or

3.3.4.3. The energized parts are insulated from the qualified person and from any other conductive object at a different potential, or

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3.3.4.4. The qualified person is insulated from any other exposed conductive object, as during live-line bare-hand work.

Note: Insulating gloves, or insulating gloves and sleeves are considered as such only with respect to the energized parts on which work is being performed, and not with respect to other parts, equipment and/or energized conductors in the proximity of the employee.

Table 3.3.4. - Table of Electrical Shock Protection Approach Distances - Alternate Current

Voltage Range (phase to phase)	Minimum Approach Distance (Qualified personnel)	Approach Boundaries (Unqualified personnel)	
		Exposed moving parts	Exposed fixed parts.
300V or less	Avoid Contact	10 feet 0 inches	3 feet 6 inches
Over 300V, not over 750V	1 foot 0 inches (30.5 cm).	10 feet 0 inches	3 feet 6 inches
Over 750V, not over 15kV	2 feet 2 inches (66 cm)	10 feet 0 inches	5 feet 0 inches

(Taken from Standard for Electrical Safety Requirements for Employee Workplaces, NFPA 70E, 2000 Edition, Table 2-1.3.4)

3.3.5. Safe Distances for Unqualified Personnel.

3.3.5.1. Unqualified personnel shall not be permitted to get closer than the approach boundary established in Table 3.3.4, unless electrical conductors and the equipment involved are in an electrically safe working condition.

3.3.5.2. Whenever an unqualified person is working in or near an approach boundary, the designated person in charge of the work area where an electrical danger exists shall cooperate with the designated person in charge of the unqualified personnel, to ensure that all work is performed safely. This includes warning unqualified personnel about the electrical danger and alerting them to stay away from the approach boundaries.



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3.4. Special Working Conditions.

3.4.1 Work Near Exposed Aerial Lines.

- 3.4.1.1. When a qualified person is working in an elevated position near overhead lines, the location shall be such that the person and the longest conductive object he or she may contact cannot come closer to less than the approach distances established in Table 3.3.4.
- 3.4.1.2. When an unqualified person is working in an elevated position near overhead lines, the location shall be such that the person and the longest conductive object he or she may contact cannot come closer than 10 feet (305 cm) to any unguarded, energized line or exposed energized equipment.
- 3.4.1.3. If overhead energized lines carry over 1000 volts, the established requirements of the High Voltage Operations safety standards shall apply.
- 3.4.1.4. Any vehicle or mechanical equipment having parts of its structure elevated near overhead energized lines shall be operated in compliance with the established requirements of High Voltage Operations safety standards.

3.4.2. Illumination.

- 3.4.2.1. Employees may not enter spaces containing exposed energized parts, unless illumination is provided that enables the employees to perform the work safely.
- 3.4.2.2. Where lack of illumination or an obstruction precludes observation of the work to be performed, employees may not perform tasks near exposed energized parts. Employees may not reach blindly into areas which may contain energized parts.

3.4.3. Work in Restricted or Confined Spaces.

- 3.4.3.1. When an employee works in a confined or enclosed space (such as a

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manhole or vault) that contains exposed energized parts, protective shields, protective barriers, or insulating materials shall be used as necessary to avoid inadvertent contact with these parts. Doors, hinged panels, and the like shall be secured to prevent their swinging into an employee and causing the employee to contact exposed energized parts.

3.4.4. Housekeeping.

- 3.4.4.1. Where live parts present an electrical contact hazard, employees may not perform housekeeping duties at such close distances to the parts that there is a possibility of contact, unless adequate safeguards (such as insulating equipment or barriers) are provided.
- 3.4.4.2. Electrically conductive cleaning materials (including conductive solids such as steel wool, metalized cloth, and silicon carbide, as well as conductive liquid solutions) may not be used in proximity to energized parts unless procedures are followed which will prevent electrical contact.

3.4.5. Disconnecting Interlocks.

- 3.4.5.1. Only a qualified person following the requirements of Section 3.3 of this Manual may defeat an electrical safety interlock, and then only temporarily while he or she is working on the equipment.
- 3.4.5.2. The interlock system shall be returned to its operating condition when the job is completed.

3.4.6. Replacing and Charging Batteries.

- 3.4.6.1. Battery charges and changes shall be done according to *2600SEG220, Replacing, Charging, and Storing PCA Batteries.*

3.4.7. Conductive Work Sites.

- 3.4.7.1. Portable electric equipment used in highly conductive work locations (such as those inundated with water or other conductive liquids), or in job locations where employees are likely to contact water or



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conductive liquids, shall have double insulation and be approved for such locations.

- 3.4.7.2. The extension cords shall be equipped with ground fault protection interrupters (GFCI) and be approved for their use in such locations.

3.4.8. Occasional Use of Flammable or Ignitable Materials.

- 3.4.8.1. Where flammable materials are present only occasionally, electric equipment capable of igniting them shall not be used, unless measures are taken to prevent hazardous conditions from developing. Such materials include, but are not limited to: flammable gases, vapors, or liquids; combustible dust; and ignitable fibers or flyings.
- 3.4.8.2. The requirements for installations where flammable or ignitable materials are established in the current Code of Electrical Installations.

3.4.9. Fuse Replacement.

- 3.4.9.1. Prior to installing and/or removing fuses, the circuit where the fuses are connected shall be deenergized.
- 3.4.9.2. If deenergizing the circuit is not practical, or its deenergization increases or creates additional risks, the load must be disconnected.
- 3.4.9.3. If the fuse must be replaced with the circuit energized and/or loaded, then tools for the removal of fuses must be provided with insulation adequate for the existing voltage and electrical protection gloves, and the procedures set out in Section 3.3 of this Manual shall be followed.

3.4.10. Work While Standing on Conductive Surfaces not Properly Grounded.

- 3.4.10.1. When work is to be performed in or near conductive surfaces while standing on conductive surfaces that are not properly grounded:
- 3.4.10.1.1. All requirements in Section 3.3 shall be followed, and

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3.4.10.1.2. Insulating surfaces (such as rubber mats, insulating railings, or equal) shall be provided for employees to stand on.

4.0. Tools and Equipment

4.1. Portable Electrical Equipment.

4.1.1. This paragraph applies to the use of equipment connected with flexible electrical cords and plugs, including electrical extension cords.

4.1.2. Unless it is certified to be double insulated, portable electrical equipment shall have a grounding conductor connected to metallic parts that could come in contact with the user,

4.1.3. All tools and portable electrical equipment shall be certified by a recognized laboratory. (UL, CSA or equal).

4.1.4. Extension Cords.

4.1.4.1. An electrical extension cord connected to grounded equipment shall have a conductor to ground the equipment.

4.1.4.2. If used outdoors, extension cords shall be equipped with ground fault protection interrupters (GFCIs) and humidity-resistant outside insulation, and be certified for heavy use.

4.1.4.3. Electrical extension cords fabricated at the shop shall comply with all the requirements in force.

4.1.4.4. The following precautions shall be followed when handling electrical extensions:

4.1.4.4.1. Do not place them where someone may trip over them.

4.1.4.4.2. Do not place them where they are exposed to mechanical damage such as pinching by passing vehicles, cuts with sharp surfaces, abrasions, nicks, etc.



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4.1.4.4.3. Do not place them where they are exposed to excessive heat and/or aggressive chemical substances (solvents, oil, caustics, etc.).

4.1.5. Handling.

4.1.5.1. Portable equipment shall be handled in a manner which will not cause damage.

4.1.5.2. Flexible electric cords connected to equipment may not be used for lifting or lowering equipment.

4.1.5.3. Flexible cords may not be fastened with staples or otherwise hung in such a fashion as could damage the outer jacket or insulation, or the connection.

4.1.6. Visual Inspection.

4.1.6.1. Portable cord and plug connected equipment and flexible cord sets (extension cords) shall be visually inspected before use on any shift for external defects (such as loose parts, deformed and missing pins, or damage to outer jacket or insulation) and for evidence of possible internal damage (such as pinched or crushed outer jacket).

4.1.6.2. Cord and plug connected equipment and flexible cord sets (extension cords) which remain connected once they are put in place and are not exposed to damage need not be visually inspected until they are relocated.

4.1.6.3. If there is a defect or evidence of damage that might expose an employee to injury, the defective or damaged item shall be removed from service, and no employee may use it until repairs and tests necessary to render the equipment safe have been made.

4.1.6.4. A log shall be kept of all inspections and repairs to portable electrical equipment.

4.1.7. Connecting Attachment Plugs.



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- 4.1.7.1. Employees' hands may not be wet when plugging and unplugging flexible cords and cord and plug connected equipment, if energized equipment is involved.
- 4.1.7.2. Energized plug and receptacle connections may be handled only with insulating protective equipment if the condition of the connection could provide a conducting path to the employee's hand (if, for example, a cord connector is wet from being immersed in water).
- 4.1.7.3. Locking type connectors shall be properly secured after connection.
- 4.1.7.4. When an attachment plug is to be connected to a receptacle (including a cord set), the relationship of the plug and receptacle contacts shall first be checked to ensure that they are of proper mating configurations.
- 4.1.7.5. Attachment plugs and receptacles may not be connected or altered in a manner which would prevent proper continuity of the equipment grounding conductor at the point where plugs are attached to receptacles. Additionally, these devices may not be altered to allow the grounding pole of a plug to be inserted into slots intended for connection to the current-carrying conductors.
- 4.1.7.6. Plugs shall be disconnected by holding the connector, and never by pulling on the cord.
- 4.1.7.7. All plugs shall provide a mechanism to secure the cord at the inlet and/or a strain relief.
- 4.1.7.8. Adapters which interrupt the continuity of the equipment grounding connection may not be used.

4.2. Electric Power and Lighting Circuits.

4.2.1. Routine Opening and Closing of Circuits.

- 4.2.1.1. Load rated switches, thermomagnetic circuit breakers, or other devices specifically designed as disconnecting means shall be used

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for the opening, reversing, or closing of circuits under load conditions.

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

4.2.2. Reclosing Circuits after Protective Device Operation.

- 4.2.2.1. After a circuit is deenergized by a circuit protective device, the circuit may not be manually reenergized until it has been determined that the equipment and circuit can be safely energized.
- 4.2.2.2. The repetitive manual reclosing of circuit breakers or reenergizing circuits through replaced fuses without identifying and correcting the cause of failure is prohibited.

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

4.2.3. Overcurrent Protection Modification.

- 4.2.3.1. Overcurrent protection of circuits and conductors may not be modified, even on a temporary basis, beyond that allowed by the Electrical Installation regulations in force, and the installation safety requirements for overcurrent protection.

4.3. Test Instruments and Equipment.

- 4.3.1. Only qualified personnel may perform testing work on electric circuits or equipment.
- 4.3.2. Test instruments and equipment and all associated test leads, cables, power cords, probes, and connectors shall be visually inspected for external defects and damage before the equipment is used. If there is a defect or evidence of damage that might expose an employee to injury, the defective or damaged



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item shall be removed from service, and no employee may use it until repairs and tests necessary to render the equipment safe have been made.

4.3.2.1. This includes the verification of the proper operation of the equipment.

4.3.3. Test instruments and equipment and their accessories shall be rated for the circuits and equipment to which they will be connected and shall be designed for the environment in which they will be used.

4.4. Portable Ladders.

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

4.5. Conductive Materials and Equipment.

4.5.1. Conductive material and equipment that are in contact with any part of the body of the employee will be handled in such a way as to avoid making contact with exposed energized conductors or circuit parts.

4.5.2. If an employee must handle long dimensional conductive objects (such as ducts and pipes) in areas with exposed live parts, and work practices shall be instituted (such as the use of insulation, safety and material handling techniques) which will minimize the hazard of contact with energized parts.

5.0. Safeguards for Personnel Protection.

5.1. Use of Personal Protection Equipment.

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

5.1.2. Personal protective equipment requirements shall be determined on the basis of employee exposure to voltage and short circuit currents.

5.1.3. Protective equipment shall be maintained in a safe, reliable condition and shall



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be periodically inspected or tested.

- 5.1.4. If the insulating capability of protective equipment may be subject to damage during use, the insulating material shall be protected.
 - 5.1.5. Employees shall wear nonconductive head protection wherever there is a danger of head injury from electric shock or burns due to contact with exposed energized parts.
 - 5.1.6. Employees shall wear protective equipment for the eyes or face wherever there is danger of injury to the eyes or face from electric arcs or flashes or from flying objects resulting from electrical explosion.
 - 5.1.7. When work is performed at a less than a safe distance to minimize arc flash hazards, a flash hazard analysis must be done to determine the use of fire resistant protective clothing and personal protection equipment.
- 5.2. Protective Rubber Gloves and Equipment.**
- 5.2.1. Rubber electrical protection equipment is classified according to specific voltage classes. Employees must ensure the use of equipment or the proper or higher classification than the voltage to be withstood.
 - 5.2.2. **Rubber Gloves.**
 - 5.2.2.1. Rubber gloves for electrical protection from the Storehouse Section shall be requested through the Interior Electrical Section and tested by the latter Section prior to issuing them to the requesting unit.
 - 5.2.2.2. All electrical protection gloves requested other than through the Storehouse Section shall be approved by the Manager, Safety Division, and later tested by the Interior Electrical Section prior to their use.
 - 5.2.2.3. The Interior Electrical Section shall ensure that all rubber gloves for electrical protection are inspected, tested, numbered, and stamped in accordance with Standard ASTM DI20-84A. Test results shall be logged on form 2209-S, "Work Glove Test Report" and placed in the glove compartment.



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- 5.2.2.4. Any gloves rejected after testing shall be immediately destroyed and this fact shall be reported to the owning unit.
- 5.2.2.5. Gloves removed from their sealed containers shall be tested within 30 days from their previous test date, as logged on form 2209-S.
- 5.2.2.6. Gloves that have remained in sealed bags or containers may be used at any time up to 60 days after their last test date as logged on form 2209-S. However, they must be tested again after only one use within a period of 30 to 60 days after the previous test.
- 5.2.2.7. Personnel working on circuits of 600 volts or more shall use the proper protective gloves with leather protectors.
- 5.2.2.8. Electrical protection rubber gloves shall be only for their intended use, and may not be used to handle solvents. Any damage observed by a user shall be considered, and gloves shall not be used if it can affect his integrity and protection.
- 5.2.2.9. Gloves must be visually inspected for cracks, tears, holes, or cuts and an air test must be performed before each day's use. If defects are found, the gloves shall be returned to the Interior Electrical Section for testing.
- 5.2.2.10. When not in use, electrical protection gloves shall be kept inside a plastic bag stored in an appropriate container specifically for such purpose, and placed in a location where gloves are protected from damage. The date they were first used and their next test date shall be noted on Form 2209-S, and this form shall be stored with the gloves for their proper control.

5.2.3. Other Rubber Protection Equipment.

- 5.2.3.1. Other rubber protection equipment such as mats shall be visually inspected for cracks, tears, holes, and cuts before each day's use.
- 5.2.3.2. If defects are found on protection equipment, it shall be returned to the Interior Electrical Section to be tested.

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5.2.3.3. All rubber protection equipment shall be tested periodically, but not less than annually, to verify their integrity and insulating properties.

5.2.3.3.1. A log shall be kept of test dates.

5.2.3.3.2. This log shall be on a tag placed on the equipment or a log book, with the equipment clearly identified with its corresponding test date.

5.3. Apparel and Jewelry.

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

5.3.2. Garments and synthetic material accessories, (such as rayon, polyester, acetate, and synthetic-cotton blends) that may burn or/melt into the skin as the result of arc flash shall not be used when there is the possibility of such exposure.

5.4. General Protective Equipment and Tools.

5.4.1. When working near exposed energized conductors or circuit parts, each employee shall use insulated tools or handling equipment if the tools or handling equipment might make contact with such conductors or parts. If the insulating capability of insulated tools or handling equipment is subject to damage, the insulating material shall be protected.

5.4.2. Ropes and handlines used near exposed energized parts shall be nonconductive.

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



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5.4.4. When normally enclosed live parts are exposed for maintenance or repair, they shall be guarded to protect unqualified persons from contact with the live parts.

5.5. Alerting Techniques.

5.5.1. Alerting techniques shall be used to warn and protect employees about hazards which may cause them injury due to electrical shock, burns, or breakdown of electrical equipment parts, according to PCA *Standard 2600SEG121, Signs and Barricades*:

5.5.2. Safety Signs and Tags.

5.5.2.1. Safety signs, safety symbols, or accident prevention tags shall be used where necessary to warn employees about electrical hazards which may endanger them.

5.5.3. Barricades.

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

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

5.5.4. Attendants.

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

5.5.4.2. The attendant shall be knowledgeable in first aid techniques, cardiopulmonary resuscitation, and the electrical hazards in the area.