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ELECTRICAL SAFETY

1. PURPOSE & SCOPE

This procedure outlines the **Company Name** Electrical Safety program and defines the requirements and procedures for safeguarding **COMPANY NAME** associates who work near, with or on electrical equipment. This procedure applies to all electrical work at **COMPANY NAME** sites, including work under **COMPANY NAME** scope at customer sites.

2. HOW TO USE THIS PROCEDURE:

2.1. Become familiar with the sections on:

- General Procedures,
- Personnel Work Authorization,
- Personal Protective Equipment (PPE),
- Warning Signs, Barricades, and Watches,
- Requirements & Procedures for Tools & Equipment
- Responsibilities
- Training

2.2. Become familiar with the sections on specific work practices:

- Work at Customer Sites
- Testing
- Working on De-Energized Equipment
- Working on or Near Energized Equipment
- Energized Equipment
- Energized Electrical Work Permits and Pre-Job Briefing

2.3. Utilize the Appendices as referred to in the procedure sections.

3. DEFINITIONS - SEE APPENDIX A – DEFINITIONS.

4. GENERAL PROCEDURES

4.1. Overall Electrical Safety Guidelines

- 4.1.1. Switches, junction boxes, pull boxes, panel boards, and conduit fittings that are in service shall have appropriate covers on all outlets, even if some or all of the associated wiring is temporary.
- 4.1.2. Breaker-panel switches and/or main disconnect switches shall not be used for routine on/off control of electrical equipment (e.g., facility lighting) unless designed for such purpose.
- 4.1.3. Work shall not be performed in wet, damp, or other hazardous environments, unless equipment is rated for use in such environments and with proper hazard mitigation.
- 4.1.4. As a general rule, electrical work must be performed on de-energized, isolated, Locked Out and Tagged Out (LOTO) and grounded equipment only. If work must be done with

equipment energized, the proper procedures must be followed. See the sections on *Energized Equipment* and *Energized Electrical Work Permits and Pre-Job Briefing* below.

- 4.1.5. After a protective device has been activated, circuits must not be re-energized until an authorized individual has evaluated the cause of the activation and determined that the system is safe to re-energize.
- 4.1.6. Personnel shall not perform electrical work until specific safety precautions have been identified. These precautions shall be identified in the Pre-Job Briefing. Personnel shall not perform work on equipment until they fully understand the electrical equipment operation and have verified that adequate safety precautions are in place.
- 4.1.7. Personnel shall comply with all safety procedures provided with manufacturers' instruction books, Product Department instructions or other applicable safety procedures, including testing equipment.
- 4.1.8. Materials or equipment shall be not placed near energized lines, or exposed energized parts of equipment, closer than the following distances plus an amount providing for the maximum sag and side swing of all conductors and providing for the height and movement of material handling equipment:
 - 10 feet (305 cm) for lines and equipment energized at 50 kV or less.
 - 10 feet (305 cm) plus 4 inches (10 cm) for every 10 kV over 50 kV for lines and equipment energized at more than 50 kV.
- 4.1.9. Housekeeping and other related cleaning activities shall not be performed near exposed energized equipment or parts.
- 4.1.10. Non-current carrying metal parts of electrical equipment or devices, such as transformer cases and circuit breaker housings, shall be treated as energized at the highest voltage to which they are exposed, unless an authorized associate inspects the installation and determines that these parts are properly grounded.
- 4.1.11. All taped or compound insulated bus, connections, terminations, non-shielded cable in non-metallic duct or shielded cable where the ground attachment is not visible shall be considered as un-insulated or exposed.
- 4.1.12. At least one entrance, not less than 24 inches wide and 6 feet 6 inches high shall be provided to give access to the working space around electric equipment. On switchboard and control panels exceeding 48 inches in width, there shall be one entrance at each end of such board where practicable. Where bare energized parts at any voltage or insulated energized parts above 600 volts are located adjacent to such entrance, they shall be suitably guarded.

4.2. Personnel Work Authorization

- 4.2.1. Only Authorized Personnel shall use this procedure. Unauthorized personnel shall not perform work on equipment covered by this procedure except as specified herein.
- 4.2.2. Unauthorized, personnel who meet the definition of a Competent Person (see Appendix A), may perform work on de-energized electrical equipment less than 50 volts.
- 4.2.3. Unauthorized personnel must not perform electrical switching or other work on electrical equipment where they may be exposed to unguarded or uninsulated electrical conductors, even if the equipment is de-energized state.
- 4.2.4. Authorized Personnel **may** perform electrical switching, Lockout/Tagout, and selected testing or inspection of selected electrical equipment in accordance with this procedure.

- 4.2.5. **COMPANY NAME** personnel **may not** perform work on energized components except as specifically authorized by this procedure.
- 4.2.6. **COMPANY NAME** personnel shall not perform work on equipment or circuits rated greater than 600 volts, even when de-energized.
- 4.2.7. Authorized Personnel must have a current authorization on file relative to the specific activities and electrical equipment with which they are involved.
- 4.2.8. For maintenance electrical work, authorization shall be a valid Electrician's License.
- 4.2.9. When issuing authorizations, the associate's manager must determine that the associate is authorized by education, training, and experience to carry out the specific work activity safely. Consider whether the associate is:
- 4.2.9.1. Knowledgeable on related **COMPANY NAME** EHS policies such as: Confined Space Entry, Lockout/Tagout Procedures, Temporary Barricades for Hazardous Areas, and Electrical Safety.
 - 4.2.9.2. Current with all prescribed technical and safety training.
 - 4.2.9.3. Knowledgeable on equipment to be worked on.
 - 4.2.9.4. Knowledgeable about proper methods of equipment testing and troubleshooting.
 - 4.2.9.5. Able to direct others in the proper procedures required for the work.
- 4.2.10. Personnel-in-training may work on electrical equipment if they have completed the mandatory classroom training, but only under direct supervision of an authorized person and within the scope of their training.
- 4.2.11. Unauthorized personnel may assist authorized personnel in performing work, provided that the work is performed only under the direct personal supervision of and in the presence of an authorized **COMPANY NAME** associate.

4.3. Personal Protective Equipment (PPE)

- 4.3.1. Personal Protective Equipment, including clothing, shall comply with the requirements of NFPA70E (see Appendix B) and the Job Hazard Analysis/Risk Assessment applicable for the work to be performed. In addition:
- 4.3.1.1. Non-conductive safety glasses, which meet ANSI Z87.1, with permanent side shields shall be worn at all times when working on electrical equipment, except where more robust PPE is required.
 - 4.3.1.2. Electrical Safety Gloves shall be worn when working around energized electrical equipment. Gloves must be selected based on the work being done and level of risk. Selection and care of electrical safety gloves shall be done in accordance with Appendix B.
 - 4.3.1.3. If the insulating capability of protective equipment may be subject to damage during use, the insulating material shall be protected, for example, an outer covering of leather to protect rubber insulating gloves.
 - 4.3.1.4. Conductive articles of jewelry and clothing, such as watch bands, bracelets, rings, key chains, necklaces, cloth with conductive thread, or metal headgear shall not be worn when performing electrical work.

4.4. Warning Signs, Barricades, and Watches

- 4.4.1. One or more of the following alerting techniques shall be used to warn and protect associates from hazards which could cause injury due to electric shock, burns, or failure of electrical equipment and associated components; and to keep unauthorized associates a safe distance from the equipment to be worked on:

- 4.4.1.1. Approach and Flash Protection Boundaries shall be determined in accordance with Appendix H of this document.
- 4.4.1.2. Use safety signs, safety symbols, safety barricade tape or accident prevention tags to warn associates about electrical hazards which may endanger them. Safety Signs and Tags must meet the requirements of ANSI Z535, Series of Standards for Safety Signs and Tags, or applicable local sign requirements. See below for examples of signs. At a minimum, the signs must approximate a standard 8.5 X 11 inch document page. Use the first sign for high and low voltage situations. Use the



second figure for high voltage applications only.

- 4.4.1.3. Use barricades with safety signs where it is necessary to prevent or limit associate access to work areas that expose associates to un-insulated energized conductors or circuit parts. Barricades shall not be constructed (either partially or in total) of conductive materials where they might cause an electrical contact hazard.
- 4.4.1.4. If signs and barricades do not provide sufficient warning and protection from electrical hazards, station a Safety Watch to warn and protect associates.

4.5. Work at Customer Sites

- 4.5.1. Arrangement shall be made for a customer-designated representative to operate the switches, disconnects, or circuit breakers required to de-energize and re-energize the equipment to be worked on.
- 4.5.2. All connections to electrical power sources, other than cord-and-plug connections, shall be made by a customer-designated representative.
- 4.5.3. Any required de-energization/isolation and re-connection/re-energization shall be observed by **COMPANY NAME** Associates.
- 4.5.4. **COMPANY NAME** Associates, or other personnel under **COMPANY NAME** control, must not operate such devices unless prior customer or contractor authorization has been provided in writing.
- 4.5.5. In the event the **COMPANY NAME** personnel have to operate such devices and have been granted authorization, then **COMPANY NAME** personnel must adhere to all **COMPANY NAME** policies when performing any switching operations.
- 4.5.6. **COMPANY NAME** customers shall perform all grounding at customer sites. If **COMPANY NAME** customers are unable or unwilling to perform grounding, **COMPANY NAME** Associates may perform grounding following procedures outlined in **Working on De-Energized Equipment**, below.

4.6. Testing

- 4.6.1. 3.2.1 Authorized personnel may perform testing with appropriate local reading test equipment, such as VOMs or clamp on ammeters, or minor electrical equipment adjustments, such as potentiometer, rheostat, or relay adjustments, per Original Equipment Manufacturer (OEM) instructions on energized low voltage conductors as described in this procedure.
- 4.6.2. Authorized personnel shall use appropriately rated VOMs and other direct reading instruments only on Low Voltage (LV) circuits. Personnel shall not use them when the voltage range is unknown. These limitations supersede contrary information provided by the OEM for the device.
- 4.6.3. Personnel must wear PPE complying with NFPA70E during testing.
- 4.6.4. **COMPANY NAME** personnel shall not use phasing sticks.

4.7. Working on De-Energized Equipment

- 4.7.1. **COMPANY NAME** personnel shall not perform work on equipment or circuits rated greater than 600 volts, even when de-energized.
- 4.7.2. Work on electrical equipment must be performed in an electrically safe work condition and only by personnel authorized to do so. Any departure from this rule is cause for disciplinary action up to and including dismissal from **COMPANY NAME** employment. Unless justified per the **Energized Equipment** section of this document below, associates shall not perform work on energized equipment or parts above 50 volts.
- 4.7.2.1. Electrically safe work conditions include the following:
- 4.7.2.1.1. Equipment that is not physically connected to a means of input energy.
- 4.7.2.1.1.1. Exceptions: Although such equipment is without a source of external energy, an electrical danger could still be present such as:
- 4.7.2.1.1.1.1. An oil-filled power transformer can possess a lethal DC electrical charge on one or more of its windings built up by circulating oil.
- 4.7.2.1.1.1.2. An electrical device that, although disconnected from any source of external energy, may contain charged capacitors or batteries.
- 4.7.2.1.1.1.3. Recently de-energized equipment that many contain residual charges.
- 4.7.2.1.2. Equipment and circuits LOTO'd per **COMPANY NAME** Procedure EHS-XX.XX.

4.8. Working on or Near Energized Equipment

- 4.8.1. Work shall not be performed on or near energized equipment or parts operated at or above 50 volts except for testing by authorized personnel.
- 4.8.2. Personnel shall not attach clips or clamps to energized buses.
- 4.8.3. Personnel shall not modify or defeat over-current protection of circuits and conductors.
- 4.8.4. Personnel shall not replace fuses when either side or both sides are energized.
- 4.8.5. Authorized personnel may perform work on energized circuits operated at less than 50 volts, provided there is no potential for electrical burns or explosion from electric arcs.

4.9. Requirements & Procedures for Tools & Equipment

4.9.1. General

- 4.9.1.1. Electrical equipment must be rated and designed for the environment in which it will be used. Examples include: explosive or damp conditions, proper voltage rating, or intrinsically safe for potential explosive environments.

4.9.1.2. Ladders must have non-conductive side rails and be constructed of non-conducting material such as fiberglass.

4.9.2. **Portable Electric Power Tools & Equipment**

4.9.2.1. Personnel shall ensure that all tools and instruments are proper for the work to be performed, in good repair and calibration and are capable of performing their function safely. Where appropriate, verify function on a known source before use.

4.9.2.2. All equipment and extension cords shall be visually inspected for defects, wear, deformities, damage and verification of dryness prior to each use. Equipment exhibiting evidence of damage, defect or being waterlogged shall be removed from service and discarded or have a yellow CAUTION tag attached until necessary repairs are completed.

4.9.2.3. When using grounded equipment, attachment plugs and cords must be compatible with the grounded equipment, for example 3-prong receptacles and extension cords. Personnel shall not alter or remove the grounding prong on a plug. Double-insulated tools need not be grounded. Adapters which interrupt the continuity of equipment grounding are prohibited.

4.9.2.4. The non-current carrying metal parts of portable or plug-connected equipment, such as welders, blowers, generators, and test instruments shall be grounded.

4.9.2.5. Ground Fault Circuit Interrupters (GFCI) shall be used with all cord and plug equipment, including double insulated tools and extension cords. Sites may use an assured equipment grounding conductor program in place of a GFCI, but the use of GFCIs is recommended. The GFCI must be located at the outlet end and not the equipment end. This GFCI requirement does NOT apply to standard office equipment.

4.9.2.6. Temporary lights must have guards to prevent accidental contact with the bulb. Lights shall not be suspended by their electric cords. Hand lamps must be of molded composition or other type approved for the purpose. Do not use brass-shell or paper-lined lamp-holders. Hand lamps must have a handle, a substantial guard over the bulb, and be attached to the lamp-holder or the handle.

4.9.2.7. Portable electric lighting in damp locations shall be operated at a maximum of 12 vDC. However, 120-volt lights may be used if protected by a GFCI.

4.9.2.8. Insulated hand tools must meet requirements of ASTM F1505, Specification for Insulated Hand Tools, and 1994 ANSI -American National Standards Institute ASTM - American Society for Testing and Materials (70E-129), or equivalent standard.

4.9.2.9. Electrical equipment may not be used unless the manufacturer's identification is on the equipment. Other markings shall be provided giving voltage, current, wattage, or other ratings as necessary. The marking shall be of sufficient durability to withstand the environment involved.

4.9.3. **Requirements for flexible electric cords including extension cords:**

4.9.3.1. Use only three-wire extension cords with appropriate voltage, amperage and wattage ratings for the loads to be applied.

4.9.3.2. Extension cords must be approved as an assembly by a nationally recognized testing laboratory

5. RESPONSIBILITIES

5.1. **COMPANY NAME EHS HQ:**

Reviews this policy annually and communicates changes to affected operations.

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Effective Date:

Approved:

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5.2. Operations Manager:

- 5.2.1. Implements this procedure at their facility or service operation,
- 5.2.2. Ensures that all required training is completed, and
- 5.2.3. Ensures that all facility and service equipment meet the guidelines stated in this procedure.

5.3. EHS Representative:

- 5.3.1. Ensures that PPE for electrical tasks is incorporated into operation's PPE Matrix, and
- 5.3.2. Posts warning signs and institutes watches as needed.

5.4. Authorized Associates:

- 5.4.1. Complete all required training, and
- 5.4.2. Follow this procedure when working on or near energized electrical equipment.

6. TRAINING

- 6.1. Training shall be provided to associates who work with or around electrical equipment that presents potential hazards. Training shall be based upon the type of work and potential exposure as required to protect employees from specific hazards associated with electrical energy. Training may be conducted using classroom, online, and/or on-the-job or a combination.
- 6.2. Unauthorized associates shall be provided with Lockout/Tagout Awareness and Electrical Safety Awareness level training. If unauthorized associates are required to assist authorized associates in specific tasks, they must be briefed on the hazards of the specific task and the actions to be taken prior to starting work.
- 6.3. Authorized associates shall be provided with Lockout/Tagout Authorized and Electrical Safety Authorized Training. In addition, they must be trained and knowledgeable in the equipment and work methods necessary for their assigned work.

7. AUDITING AND REVIEW

- 7.1. **COMPANY NAME** EHS Headquarters personnel shall review this procedure annually. Any changes to the procedures shall be communicated to **COMPANY NAME** EHS personnel for inclusion in site/business specific procedures.
- 7.2. Periodic audits (at a minimum annually) of electrical work shall be conducted to ensure that the specific work practices covered in the **COMPANY NAME** Electrical Safety Program are being followed. These periodic audits shall take place when work is actively being done on electrical systems and shall including the following:
 - 7.2.1. Review of Energized Equipment Work Permit and Pre-job Briefing documentation.
 - 7.2.2. Use of PPE and appropriate tools.
 - 7.2.3. Establishment of boundaries and barricades.
 - 7.2.4. Implementation of specific safe work practices for the job.

8. APPENDICES

- 8.1. Appendix A – Definitions
- 8.2. Appendix B – Selection of PPE and Electrical Safety Gloves for Work on Energized Equipment
- 8.3. Appendix G – Guidelines for Approach Distances
- 8.4. Appendix H – Flash Protection Boundary Radius Determination Graph
- 8.5. Appendix I – Hazard/Risk Category Classification Table

9. REFERENCE DOCUMENTS AND LINKS

- NFPA 70E Standard for Electrical Safety in the Workplace
- ANSI C84.1 "Electric Power Systems and Equipment Voltage Ratings [60Hz]"

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ASTM F1505 "Specification for Insulated Hand Tools"
ES EHS-XX.XX Lockout/Tagout
ES EHS-XX.XX Restricted Work Authorizations

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APPENDIX A - DEFINITIONS

- 1) AC (*ac*) - Alternating current, or electrical parameter characterized by an associated current that reverses direction at regular intervals of magnitude that varies continuously in a sinusoidal manner.
- 2) ANSI - American National Standards Institute.
- 3) ASTM - American Society for Testing & Materials.
- 4) ATPV: Each FR garment is assigned an ATPV rating by the manufacturer. The ATPV value represents the amount of incident energy that would cause the onset of second-degree burns. Expressed in **cal/cm²**.
- 5) Authorized Person - Any associate, including contractors who have acquired skills and training and has been approved or assigned by their supervisor to perform specific work or tasks. Approval shall be documented. For maintenance work at **COMPANY NAME**, an authorized person is a person who is licensed by a governmental board to test and install electrical wiring and devices, i.e., a **licensed electrician**.
- 6) Bonding - The permanent joining of metallic parts to form an electrically conductive path that ensures electrical continuity and the capacity to safely conduct any current likely to be imposed.
- 7) Calibrated - Documented status of an instrument that indicates that the instrument has been tested to confirm accuracy of readings indicated by same, on an annual basis by a laboratory that complies with ASTM or ANSI standards.
- 8) Competent Person - A person who is (1) capable of identifying existing and predictable hazards in work places; and (2) authorized and qualified by management to take prompt corrective measures to eliminate hazards and notify the appropriate personnel when an accident or incident occurs.
- 9) CPR - Cardiopulmonary Resuscitation.
- 10) Dead-front construction - Electrical distribution equipment with no live parts exposed to a person on the operating side of the equipment.
- 11) DC (*dc*) - Direct current, or electrical parameter characterized by an associated current that remains constant in magnitude and direction.
- 12) Electrical Equipment - A general term for material, fittings, devices, appliances, fixtures, and apparatus that are used as a part of or in connection with an electrical installation. The term applies to power-generation, distribution and electronics equipment.
- 13) Electrical Hazard - Any situation in which an associate or conductive tool or object in contact with the associate could contact or approach closer than the safe clearance distance of any live part or other energized conductor. Any situation in which electrical equipment is likely to cause a fire because of defective components or design. Examples of electrical hazards include inadequate working clearance while working on energized circuits, exposed energized parts, electrical equipment inadequately guarded or enclosed, electrical equipment in an unsafe environment, and unsafe electrical equipment. Generally, electrical equipment that is not in compliance with OSHA regulations or NEC standards presents a potential hazard.
- 14) Electrical Switching - Operation of all High Voltage and selected Low Voltage electrical equipment, for equipment shutdown or isolation purposes, that inherently requires the use of

special electrical safety Personal Protective Equipment (*PPE*) or remote operating tools such as switching sticks.

- 15) Electrical Work - Electrical work is any work on or near energized conductors or equipment where the employee is exposed to the energized conductors, where there are no panels or barriers in between conductors and associate.
- 16) Equipotential points – Points that are of the same potential. Typically used in a grounding situation where all points to be worked on are brought to the same potential as the workers, which is usually ground. Also used for high line work where the worker and the ladder and/or bucket is brought to the same potential as the energized line.
- 17) Exposed - Physically accessible to any part of the body or hand held tool.
- 18) GFCI - Ground-Fault Circuit Interrupter.
- 19) Grounded - Physically and intentionally connected to the earth, or to some conducting body that serves in place of the earth, through a ground connection of sufficiently low impedance and with sufficient current-carrying capacity to prevent the buildup of voltages that may result in undue hazard to connected equipment or persons.
- 20) High Voltage (HV) - Greater than 600 Vac or 750 Vdc.
- 21) Kilovolt-ampere (kVA) - The unit of apparent power in the International System; it is equal to the apparent power in a circuit when the product of the root-mean-square value of the voltage, expressed in volts, and the root-mean-square value of the current, expressed in amperes, equals 1,000.
- 22) Live/Energized Parts - An electrically conducting part carrying more than 35 Vac or 50 Vdc or that must be assumed to be at such a voltage range, by virtue of its design, until proven otherwise by LOTO procedures.
- 23) Live-Line Tools – Tools specifically designed to permit working on electrical conducting parts in a live/energized condition.
- 24) Lockout/Tagout Procedure - Procedure for affixing appropriate locks and tags to energy-isolating devices to prevent inadvertent energizing or start-up of machines or equipment while service or maintenance is being performed.
- 25) Low Voltage (LV) - Greater than 35 Vac or 50 Vdc but less than High Voltage.
- 26) Minimum Work Distance/Clearance - A minimum separation distance between a authorized electrical worker or any conducting object touching the worker and any energized component. Also, a mandatory separation distance between any energized component and vehicles or machinery.
- 27) NEC - National Electrical Code.
- 28) NEMA - National Electrical Manufacturers Association.
- 29) NFPA - National Fire Protection Association.
- 30) Nationally Recognized Testing Laboratory (NRTL) - An organization, per 29 CFR 1910.7, that is concerned with product evaluation and maintains periodic inspection of listed equipment and materials. The "NRTL" certification ensures that the equipment or materials meet appropriate

designated standards and that they have been tested and found to be suitable for use in a specified manner.

- 31) Nominal System Voltage - A nominal value assigned to a circuit or system to conveniently designate its voltage class, for example, 120/240 V, 480Y/277 V, 600 V, which is equivalent to phase to phase voltage for multiphase circuits and phase to ground voltage for single phase circuits. The actual voltage at which a circuit operates can vary from the nominal within a range that permits satisfactory operation of the equipment. Refer to ANSI C84.1, "Electric Power Systems and Equipment-Voltage Ratings [60 Hz]".
- 32) OJT - On-The-Job training.
- 33) PPE - Personal Protective Equipment.
- 34) Safety Watch - A person specifically assigned to stand by, within visible and audible range of workers, and continually monitor equipment and personnel for safety.
- 35) Strain Relief - A mechanical device that prevents force from being transmitted to the connections or terminals of a cable.
- 36) Sunday Feeder - Undisclosed use of portable generator(s) to the secondary side of a radial or networked transformer(s), thereby energizing primary or other secondary circuits.
- 37) Temporary Wiring - Electrical wiring that is temporarily installed for a limited time to complete a specific task, such as construction of a new facility or performance of R&D work. Temporary wiring methods must apply sound engineering practices to ensure adequate electrical safety of temporary wiring installations. Temporary wiring shall conform to the requirements in Article 305 of the NEC and the respective subparts of 29 CFR 1910 and 1926.
- 38) Ungrounded - A condition having no physical connection or continuity with earth ground. A condition of insulation or isolation.
- 39) Unauthorized Personnel - Personnel that can reasonably be expected, on a continuous basis, to avoid exposure to exposed energized conductors above 50 Vdc or 35 Vac and additionally can reasonably be expected to avoid blast or arc exposure, but that may operate selected Low Voltage electrical equipment such as electrically powered hand tools (drills, skill saws, and cut off wheels), floor mounted electrically powered equipment (lathes and milling machines) and office equipment (overhead projectors and computers).
- 40) VOM - Volt-Ohm-Meter, a direct reading Voltage Sensing Device for use only on Low Voltage circuits.
- 41) Voltage Sensing Device - Any of a variety of NRTL certified devices (Fluke VOM, Triplett VOM, Tic Tracer, ESP Hot-liner, Magnascope, Statische, Salisbury, and Hubbell-Chance Super Tester Voltage Detector) designed to detect the presence of voltage on a circuit in either a direct reading or an inductive "go / no-go" manner

APPENDIX B - SELECTION OF PPE AND ELECTRICAL SAFETY GLOVES FOR WORK ON ENERGIZED EQUIPMENT

1. Determine the Hazard/Risk Category number based on the work to be performed (Appendix I).
2. Determine the protective clothing and PPE required using the matrix below.
3. For each Hazard/Risk Category number in row 1 in the matrix, the minimum ATPV for the FR clothing required is shown in row 2.
4. PPE Requirements are indicated in the corresponding column for each Hazard/Risk Category.

Protective Clothing Selection Matrix

	Hazard/Risk Category Number (see note 5)	-1	0	1	2	2*	3	4
(note 4)	Required ATPV rating of FR clothing (cal/cm ²)	n/a	n/a	4	8	8	25	40
Untreated Natural Fiber	Cotton, silk or wool underwear	X			x	x	x	x
	Long sleeve shirt		x					
	Long pants, including jeans	X	x	x	x	x	x	x
FR Clothing	Long sleeve shirt and pants or coverall			x	x	x		
	Jacket, parka, or rainwear			AN	AN	AN	AN	AN
FR Protective Equipment	Flash suit jacket and pants						x	x
	Arc-rated face shield (ATPV => 8) ATPV 8				x	x		
	Flash suit hood						x	x
	Sock hood or hard hat liner					x		
	Class E hard hat			x	x	x	x	x
	Safety glasses with permanent side shields	X	x	x	x	x	x	x
	Ear canal inserts				x	x	x	x
	Leather gloves (note 2)			AN	x	x	x	x
	Leather safety shoes rated EH			AN	x	x	x	x

NOTES

- 1) AN = As needed.
- 2) If High voltage gloves are worn, the leather protectors outside the gloves satisfy this requirement.
- 3) The “-1” Hazard/Risk Category is only defined if determined by notes 3 or 6 in the Hazard/Risk Category Classification Table in Appendix E.
- 4) In row 2, the Required ATPV rating listed is the minimum required for the respective Hazard/Risk Category in row 1.
- 5) Tasks that fall into Hazard/Risk categories above 2* are prohibited.

Example: For a job determined to have a Hazard/Risk category of 2, the following PPE would be required using the matrix:

- a. Cotton underwear
- b. Long pants or jeans

- c. Fire retardant shirt and pants (or coverall) with a minimum ATPV rating of 8
- d. An arc-rated face shield with a minimum ATPV rating of 8
- e. Hard hat (Class E).
- f. Non-conductive safety glasses with permanent side shields
- g. Hearing protection (canal inserts)
- h. Leather gloves or high-voltage glove protectors (Kevlar)
- i. Safety shoes (leather with an EH rating)

Selection and Care of Electrical Safety Gloves

Selection of Gloves

1. Wear Class 0 gloves, at a minimum, when working on or near energized low voltage electrical equipment, unless other precautions eliminate all shock hazards to the associate.
2. Except for Class 00 gloves as discussed in this procedure, always wear protective gloves over rubber gloves. Any direct contact of a rubber glove with sharp or pointed objects may cut, snag or puncture the glove and reduce the protective qualities.
3. Rubber insulating gloves worn during electrical work must comply with ANSI/ASTM D 120/77, or equivalent standard. Gloves covered under this specification are designated Type I or Type II: Class 00, Class 0, Class 1, Class 2, Class 3, or Class 4. The type refers to the characteristics of the material from which the glove is made, and the Class refers to certain electrical properties, as follows:
 - Type I: Non-resistant to ozone. Made from a high-grade cis-1.4-polyisoprene rubber compound of natural or synthetic origin and properly vulcanized. Do not purchase Type I gloves in the future.
 - Type II: Ozone-resistant. Made of any elastomer or combination of elastomeric compounds. All new rubber insulating gloves purchased shall be Type II.

Classes:

GLOVE CLASS	MAXIMUM USE VOLTAGE
00	500
0	1,000
1	7,500
2	17,500
3	26,000
4	36,000

Notes

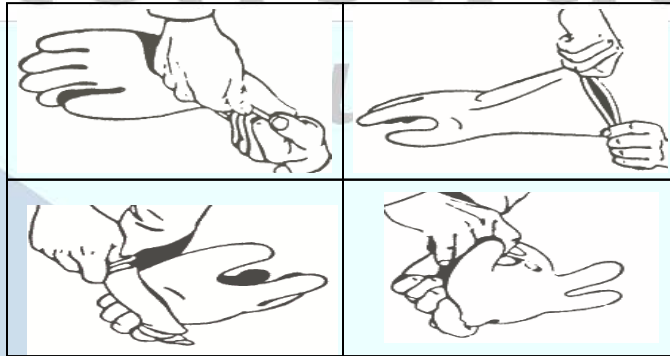
Maximum use voltage is the classification of the protective equipment that designates the maximum nominal design voltage of the energized system on which work may be safely performed.

Protector gloves need not be used with Class 00 gloves, during LV testing, or where instrument/tool manipulation necessitates high finger dexterity as long as the requirements of Appendix A and B are maintained.

The minimum under-lap of the protector gloves must be the glove class in inches or one (1) inch, which ever is greater.

Inspection and Care of Gloves

1. Before wearing rubber gloves, inspect them visually and perform a field air test at least once every day and during the progress of the job.
2. To inspect the gloves, stretch a small area at a time, checking that no defects exist such as: embedded foreign material, deep scratches, pin holes, cuts or punctures. Also, look for signs of deterioration caused by oil, tar, grease, insulating compounds, or any other substances that may injure rubber.
3. Inspect the entire glove including the cuff, thoroughly. Check the inside of the protectors for any bits of metal or short pieces of wire that may have fallen into them
4. After visually inspecting the glove, observe other defects with an air test, by holding the glove cuff with both thumbs and forefingers, twirling the glove around quickly to fill it with air and trapping the air by squeezing the cuff with one hand. Use the other hand to squeeze the palm, fingers, and thumb of the inflated glove while looking and listening for weaknesses and escaping air per the illustration below.



5. Test rubber insulating gloves with a dielectric test at least every six months, or more often if appropriate, by a nationally recognized testing lab. Do not use gloves that have not been tested within six months. Track test schedules and records with the facility or service operation's Compliance Calendar.
6. Destroy gloves or other equipment that is defective.
7. Wear rubber gloves right side out with the serial number and size on the outside. Turning gloves inside out places a stress on the preformed rubber.
8. Keep the cuffs fully extended. Rolling them down sacrifices protection.
9. Store gloves in a protective case, typically a canvas bag, where they cannot come in contact with sharp or pointed tools that may cut or puncture them.

APPENDIX C: ENERGIZED ELECTRICAL WORK PERMIT

Issue Date:		Site Location:	
Description of circuit/equipment/job location			
Description of work to be done			
Justification of why the circuit/equipment cannot be de-energized:			
Project Manager (Print Name)		Project Manager (Signature)	Date
Section B - Completed by the authorized persons <i>doing</i> the work:			Check when complete
1. Detailed job description procedure to be used in performing the above detailed work:			Yes ___ No ___
2. Description of the Safe Work Practices to be employed:			Yes ___ No ___
3. Results of the Shock Hazard Analysis:			Yes ___ No ___
4. Determination of Shock Protection Boundaries:			Yes ___ No ___
5. Results of Flash Hazard Analysis:			Yes ___ No ___
6. Determination of the Flash Protection Boundary:			Yes ___ No ___
7. Necessary personal protective equipment (PPE) to safely perform the task:			Yes ___ No ___
8. Means employed to restrict the access of unauthorized persons from the work area:			Yes ___ No ___
9. Evidence of completion of Job Briefing including discussion of any job-related hazards:			Yes ___ No ___
10. Do you agree the above-described work can be done safely? If no, return permit to Project Manager?			Yes ___ No ___
Authorized Person (Print Name)		Authorized Person (Signature)	Date
Authorized Person (Print Name)		Authorized Person (Signature)	Date
Authorized Person (Print Name)		Authorized Person (Signature)	Date
Authorized Person (Print Name)		Authorized Person (Signature)	Date
Project Manager (Print Name)		Project Manager (Signature)	Date

APPENDIX D: JOB BRIEFING & PLANNING CHECKLIST

A. Identify

Voltage levels involved

- Hazards
- Skills required
- Foreign (secondary sources) of voltages

B. Ask

Shock protection boundaries, off limit areas or hazardous areas

Flash protection boundary

Potential for arc flash (Conduct/Review arc flash hazard analysis)

Any unusual work conditions

Number of people needed to do the job

Can the equipment be de-energized?

Are backfeeds of the circuits to be worked on possible?

Is a "stand-by person" required?

C. Check

Safety Plan

Review plan with customer contact that is familiar with the equipment (as applicable)

Condition of Work Area – Access and Egress

D. Know

Who else needs to know – communicate

- Who will perform each task

- What the specific job is

Emergency Procedures

- Who is available to provide CPR/First Aid? Is there a rescue team on site?

- Is emergency equipment available? Where is it located?

- Where is the nearest telephone? What emergency number do you dial?

- Where is the fire alarm? Fire extinguishers?

- Can the equipment be shut-off in an emergency? How?

Which tools you need to use?

- PPE: FR clothing, gloves, arc-rated face shield, and switching hood

- Insulated tools

- Voltage testers

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APPENDIX E - GUIDELINE FOR APPROACH DISTANCES

Implement Approach Boundaries around live parts for shock protection. All data indicates the distance from the energized conductor to the respective approach boundary (the radius of the boundary).

Nominal System Phase-to-Phase Voltage	Approach Boundaries listed as distance (ft-in) from energized fixed conductors			
	Limited Approach Boundary exposed movable conductor	exposed fixed conductor	Restricted Approach Boundary	Prohibited Approach Boundary
< 50v	Not specified	Not specified	Not specified	Not specified
50 to 300v	10' 0"	3' 6"	Avoid Contact	Avoid Contact
301 to 750v	10' 0"	3' 6"	1' 0"	0' 1"
751 to 15kv	10' 0"	5' 0"	2' 2"	0' 7"
15.1 to 36kv	10' 0"	6' 0"	2' 7"	0' 10"
36.1 to 46kv	10' 0"	8' 0"	2' 9"	1' 5"
46.1 to 72.5kv	10' 0"	8' 0"	3' 2"	2' 1"
72.6 to 121kv	10' 8"	8' 0"	3' 3"	2' 8"
138 to 145kv	11' 0"	10' 0"	3' 7"	3' 1"
161 to 169kv	11' 8"	11' 8"	4' 0"	3' 6"
230 to 242kv	13' 0"	13' 0"	5' 3"	4' 9"
345 to 362kv	15' 4"	15' 4"	8' 6"	8' 0"
500 to 550kv	19' 0"	19' 0"	11' 3"	10' 9"
765 to 800kv	23' 9"	23' 9"	14' 11"	14' 5"

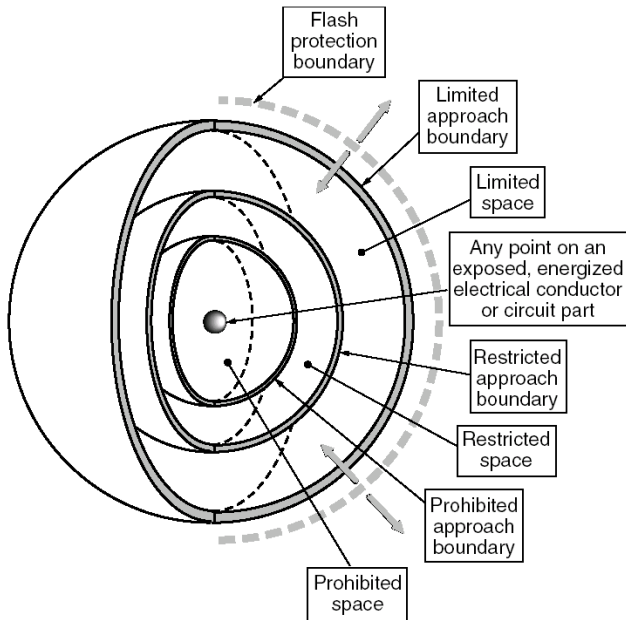
Altitude Correction Factors

FEET / METERS	Correction Factor
3000 / 914	1.00
4000 / 1219	1.02
5000 / 1524	1.05
6000 / 1828	1.08
7000 / 2133	1.11
8000 / 2438	1.14
9000 / 2743	1.17
10000 / 3048	1.20
12000 / 3657	1.25
14000 / 4267	1.30
16000 / 4877	1.35
18000 / 5486	1.39
20000 / 6096	1.44

***WHEN PERFORMING WORK AT ELEVATIONS GREATER THAN 3000 FT (900M) ABOVE MEAN SEA LEVEL, DETERMINE THE MINIMUM APPROACH DISTANCE BY MULTIPLYING THE DISTANCE BY THE ABOVE CORRECTION FACTOR CORRESPONDING TO THE ALTITUDE. FOR EXAMPLE, IF A PERSON WERE WORKING AT 4300 FEET (1310 METERS) THE CORRECTION FACTOR WOULD BE 1.05.**

APPENDIX F - SHOCK HAZARD ANALYSIS – LIMITS OF APPROACH

1. Around any exposed energized conductor there exist three approach boundaries as depicted below.



2. Limited Approach Boundary. The outer approach boundary is the Limited Approach Boundary. Unauthorized associates including any conductive object they carry must not cross this boundary unless they are wearing appropriate personal protective clothing and are supervised by an authorized person.

3. Restricted Approach Boundary. Authorized personnel must never cross or take any conductive object closer to an exposed energized conductor than the Restricted Approach boundary. Unless one of the following conditions exist:

4. The authorized person is insulated from the energized conductor by electrical safety gloves and other PPE as specified in Appendix B.

5. The energized conductor is insulated from the authorized person and from any other conductive object at a different potential, such as an energized shielded cable.

6. The authorized person is at the same potential as the energized conductor. An example would be live line work where the associate is in a lift bucket or cherry picker that is connected to the energized conductor.

7. Unauthorized associates must never cross the Restricted Approach Boundary.

8. Prohibited Approach Boundary. Crossing the prohibited approach boundary is the same as touching the energized part. This is commonly described as “live line work”. In general, **COMPANY NAME** associates are not authorized to do live line work.

- a) To cross the Prohibited Approach Boundary the authorized person must:
- b) Complete training to work on energized parts.
- c) Have a documented plan to do such work.
- d) Perform a risk analysis.

e) Have the plan and analysis approved by operational management and the responsible EHS manager.

9. The radii of the approach boundaries for specified voltage ranges are delineated in Appendix G along with altitude correction factors.

10. For moveable conductors such as suspended power lines, follow the "10 foot rule", which states for moveable conductors energized at 50 kV or less, the minimum approach distance is 10 feet (305 cm). For moveable conductors energized at more than 50 kV, the distance is 10 feet (305 cm) plus 4 inches (10 cm) for every 10 kV over 50 kV.

11. For verification of LOTO, follow the guidelines for the Restricted Approach Boundary.

12. Once boundaries have been defined they must be indicated using signs, barriers, or watches to ensure that unauthorized associates do not enter boundary.

B. Flash Hazard Analysis

1. Associates working on or around energized electrical equipment are in constant danger of injuries resulting from electrical arcs. These injuries fall into two categories: 1) Burns and 2) Physical injury from explosive forces and the accompanying molten metal and shrapnel. The extent of these injuries is determined by: 1) The duration of the electrical arc, 2) The magnitude of the arc, and, 3) The distance the employee is from the arc.

2. Because of these dangers, a Flash Hazard Analysis shall be conducted. The result of this analysis determines the Flash Protection Boundary. The Flash Protection Boundary is defined as the minimum distance from a defined arc where an associate can work without fire protective equipment and receive no worse than a second-degree burn. This is defined as 1.2cal/cm² lasting 0.1 sec. or for 6 cycles.

3. The Flash Hazard Analysis consists of the following steps:

- a) Determine the Flash Protection Boundary.
- b) Determine the Hazard Risk Category from the task(s) to be performed.
- c) Select PPE as governed by the Hazard Risk Category.

4. **Flash Protection Boundary Determination** – This determination may be conducted either by calculation or graphical means.

a) For low voltage (less than 600 volts) energized conductors that have a bolted fault current clearing (BFCC) time of 300 ka cycles or less, use a Flash Protection Boundary of 4 feet. A conductor with a short circuit current rating of 50 ka and a clearing time of 6 cycles would have a BFCC of 300 ka (50 ka X 6 cycles).

b) For Conductors with a BFCC over 300 ka or over 600 volts, use the following formula:

$$Dc = [53 \times MVA \times t]^{1/2}$$

Where:

Dc = Radius of the Flash Protection Boundary

MVA = Transformer size in mega-volt-amperes of the transformer feeding the conductor. For transformers below 0.75 MVA, multiply the transformer MVA rating by 1.25. If there is more than one source (transformer) feeding the conductor, the total MVA rating must be used.

t = time of arc in seconds. (6 cycles = 0.1 seconds)

The Flash Protection Boundary can also be determined by using the **Flash Protection Boundary Radius Determination Graph** below.

- c) NOTE: In most cases where **COMPANY NAME** associates will be working on energized equipment, they must be inside the Flash Protection Boundary hence the calculation of the Flash Protection Boundary may be unnecessary.
- d) Flash Protection Boundary Determinations shall be analyzed and calculated by a authorized employee.

5. Hazard Risk Category Determination

- a) Once it has been determined that the Flash Protection Boundary will be entered, determine the Hazard Risk Category from the Hazard/Risk Category Classification Table. See Appendix I.

(1) Select one of the 8 sections as the closest match to the equipment to be worked on.

(2) Panelboards rated 240 v and below.

(3) Panelboards or switchboards rated 240 V and up to 600 V (with molded case or insulated case circuit breakers.

(4) 600 V Class Motor Control Centers (MCCs).

(5) 600 V Class switchgear (with power circuit breakers or fused switches).

(6) Other 600 V Class (277 V through 600 V, nominal) Equipment

(7) NEMA E@ (fused contactor) Motor Starters, 2.3 kV through 7.2 kV.

(8) Metal Clad Switchgear, 1 kV and above.

(9) Other Equipment 1 kV and above.

- b) Within each section, select the closest match to the task to be performed.

c) For the task selected, a Hazard/Risk Category is listed in the first column to the right. The category listed will be either: 0, 1, 2, 2*, 3, or 4.

d) Table will specify if V-rated gloves and tools are required.

e) Be sure to pay attention to any notes indicated for the equipment being worked on.

f) For some types of equipment, a one step Hazard/Risk Category reduction may be possible. These are notated in the table in note 3 or 6.

(1) In the case of note 3, which applies to sections 1, 2, 3, and 5, a category reduction of 1 can be applied if the short circuit current available is less than 10 kA.

(2) In the case of note 6, which applies to section 4, a category reduction of 1 can be applied if the short circuit current available is less than 25 kA. The short circuit current available can be estimated from the following formula:

$$I_{sc} = \frac{KVA \times 10^5}{(V)(\% Z) \sqrt{3}}$$

Where:

KVA = Total KVA rating of all transformers feeding the equipment

V = Transformer secondary voltage

Z = Transformer % Impedance

Example: A 1 MVA transformer with a 15 kV secondary and 5.7% impedance would have a secondary short circuit value of 675 amps that would be allowed a category reduction of 1 in sections 1, 2, 3, 4, and 5 per notes 3 and 6.

Taking into account a possible Hazard/Risk Category reduction of 1, the resulting possible 7 categories are: -1, 0, 1, 2, 2*, 3 and 4.

C. Once the Hazard/Risk category number is determined, the PPE selection matrix provided in Appendix B shall be used to select required PPE for the task.

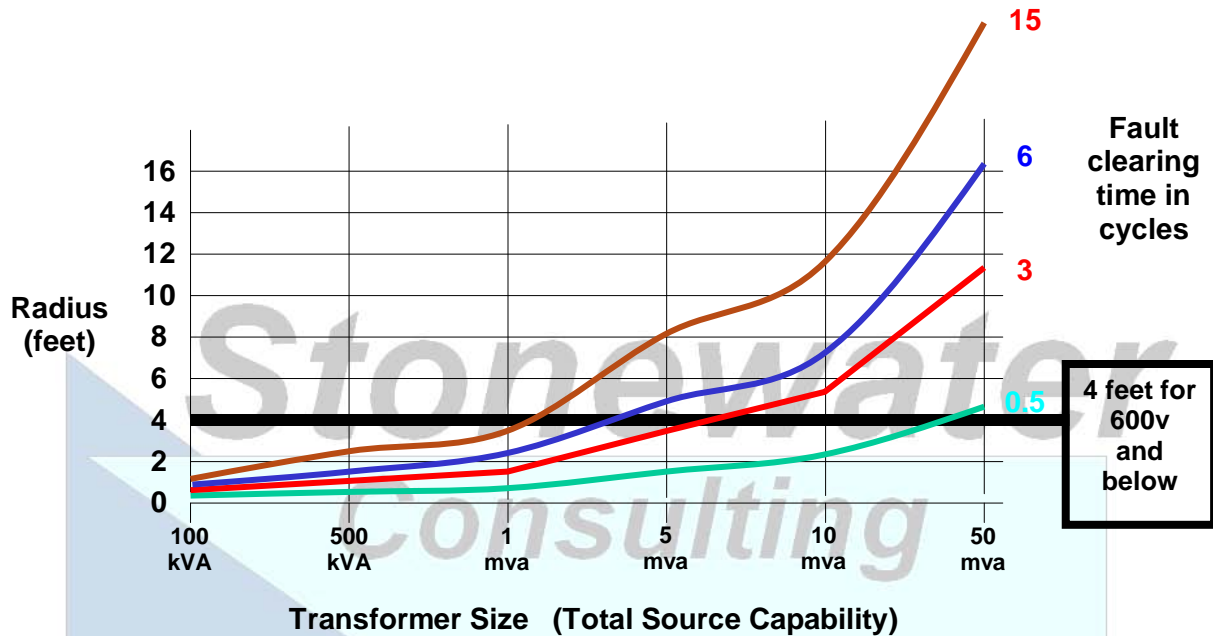
D. Testing on Low Voltage Equipment

1. All work, including inspection, testing, and adjustment on energized Low Voltage equipment shall meet the following requirements:

- a) A Pre-Job Briefing and Energized Equipment Work Permit shall be completed.
- b) All OEM requirements for the accomplishment of the involved testing/trouble-shooting and an evaluation of the job to be performed to identify all potential hazards such as energized parts, confined spaces, rotating parts, voltage of lines and equipment.
- c) Selection of the safety equipment and PPE necessary to safely perform the work. Selection of PPE shall be done by determining the Hazard/Risk category applicable to equipment and activity.
- d) Class 00 or higher electrical Safety gloves shall be worn.
- e) Temporary electrical barriers shall be used to protect each associate 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. Approach boundaries shall be determined in accordance with Section 5 of this program.
- f) The identification/selection of appropriate test instruments and electrical equipment that is rated for the equipment to be tested for example, proper voltage rating, and designed for the environment, such as hazardous or damp conditions, and intrinsically safe for potential explosive environments, in which they will be used, including all insulated tools (rated for the equipment voltage) that are required.
- g) The review of equipment for hazards in the placement of test leads and the positioning of test instruments. Leads must be proper for the involved voltage level and existing physical constraints.

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FLASH PROTECTION BOUNDARY RADIUS DETERMINATION GRAPH



Example: For a conductor fed from a 5MVA transformer through a circuit breaker with a total fault clearing time of 6 cycles, the Flash Protection Boundary Radius would be approximately 5 feet.

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APPENDIX G - HAZARD/RISK CATEGORY CLASSIFICATION TABLE

Task (Assumes Equipment is Energized, and Work is done within the Flash Protection Boundary)

Hazard/Risk Category

V-rated Gloves

V-rated Tools

(1) Panelboards rated 240 V and below – Notes 1 and 3

Circuit breaker (CB) or fused switch operation with covers on	0	N	N
CB or fused switch operation with covers off	0	N	N
Work on energized parts, including voltage testing	1	Y	Y
Remove/install CBs or fused switches	1	Y	Y
Removal of bolted covers (to expose bare, energized parts)	1	N	N
Opening hinged covers (to expose bare, energized parts)	0	N	N

(2) Panelboards or Switchboards rated >240 V and up to 600V (with molded case or insulated case circuit breakers) – Notes 1 and 3

CB or fused switch operation with covers on	0	N	N
CB or fused switch operation with covers off	1	N	N
Work on energized parts, including voltage testing	2*	Y	Y

(3) 600 V Class Motor Control Center (MCCs) Notes 2 (except as indicated) and 3

CB or fused switch or starter operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB or fused switch or starter operation with enclosure doors open	1	N	N
Work on energized parts, including voltage testing	2*	Y	Y
Work on control circuits with energized parts 120V or below, exposed	0	Y	Y
Work on control circuits with energized part >120V exposed	2*	Y	Y
Insertion or removal of individual starter “buckets” from MCC - Note 4	3	Y	N
Application of safety grounds, after voltage test	2*	Y	N
Removal of bolted covers (to expose bare, energized parts)	2*	N	N
Opening hinged covers (to expose bare, energized parts)	1	N	N

(4, 5, 6, 7, 8) PROHIBITED

KEY:

V-rated Gloves are gloves rated and tested for the maximum line-to-line voltage upon which work will be done

V-rated Tools are tools rated and tested for the maximum line-to-line voltage upon which work will be done

2* means that a double layer switching hood and hearing protection are required for this task in addition to the other Hazard/Risk Category 2 requirements


Y – yes (required)

N – no (not required)

Notes:

1. 25 kA short circuit current available, 0.03 second (2 cycle) fault clearing time
2. 64 kA short circuit current available, 0.03 second (2 cycle) fault clearing time
3. For < 10 KA short circuit current available, the Hazard/Risk Category required may be reduced by one number
4. 65 kA short circuit current available, 0.33 second (20 cycle) fault clearing time
5. 64 kA short circuit current available, up to 1.0 second (60 cycle) fault clearing time
6. For < 25 kA short circuit current available, the Hazard/Risk Category required may be reduced by one number.

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