
Electrical Safety Procedures

Version 2.0

Data Center Management

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	Date: 7/25/2010

procedures will assist electrical workers in eliminating situations, practices and actions that can result in accidents to personnel and property. The risks of injury to personnel involved in the operation and maintenance of facilities is considerable when unsafe acts involving energy from electrical power systems are performed.

This document applies to the following XX Data Centers.

Prop. ID	Building Name	Address	City	St.

2.0 Operational Interpretations

The requirements contained in this document are based on:

- NFPA 70E: Standards for Electrical Safety in the Workplace, 2004 Edition.
- 29CFR 1910.137, 147, and 303-399

3.0 Responsibilities

The Data Center Management team has responsibility for maintaining this policy. Any questions arising from implementing this policy should be referred to Infrastructure& Operations Data Center Management.

The Facilities Contractors are the vendors that XX Data Center have retained to provide daily operational and maintenance functions for the building infrastructure. The Facilities Contractors are responsible for the safety of its own employees and may exercise oversight of other contractors if their acts are deemed unsafe or deleterious to facility operation.

3.1 Management Responsibilities

- Ensure that employees under their cognizance are provided a workplace that is free from recognized hazards.
- Ensure that employees under their cognizance performing electrical work are trained and qualified (see Section 5).
- Ensure that approved, maintained, and tested personal protective equipment (PPE) and clothing is provided to the employees under their cognizance, available, and used properly.
- Establish, implement, and maintain procedures and practices that will ensure safe conduct of electrical work.
- Keep and maintain records as required.
- Monitor compliance with this directive and take timely corrective actions when deficiencies are identified.

3.2 Employee Responsibilities

- Responsible for understanding and following the procedures and policies contained in this document.
- Immediately reporting to management any unsafe electrical condition or practice
- Failure to comply with these directives may result in disciplinary action

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4.0 Definitions

Ampacity; the current in amperes a conductor can carry continuously under the conditions of use without exceeding its temperature.

Attachment plug; a device that, by insertion into a receptacle, establishes a connection between conductors of the flexible cord and the conductors connected permanently to the receptacles.

Bonding; the permanent joining of metallic parts to form an electrically conductive path that will assure electrical continuity and the capacity to conduct safely any current likely to be imposed.

Branch circuit; circuit conductors between the final over-current device protecting the circuit and the outlet(s).

Cabinet; an enclosure designed either for surface or flush mounting, and provided with a frame, mat or trim in which a swinging door or doors are or may be hung.

Circuit breaker; 600 volts nominal or less; a device designed to open and close a circuit by non-automatic means and to open the circuit automatically on a predetermined over-current without injury to itself when properly applied within its rating.

Over 600 volts, nominal; a switching device capable of making, carrying and breaking currents under normal circuit conditions, and also making, carrying for a specified time and breaking currents under specified abnormal circuit conditions such as a short circuit.

Class 1 locations; locations in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures.

Class 2 locations; locations that are hazardous because of the presence of combustible dust.

Class 3 locations; locations are those that are hazardous because of the presence of the easily ignitable fibers or filings, but in which such fibers or filings are not likely to be in suspension in the air in quantities sufficient to produce ignitable mixtures.

Conductor; Bare; a conductor having no covering or electrical insulation whatsoever.

Covered; a conductor encased within material of composition or thickness that is not recognized as electrical insulation.

Insulated; a conductor encased within a material of composition and thickness that is recognized as electrical insulation.

Cutout; (over 600 volts, nominal); an assembly of a fuse support with a fuse holder, fuse carrier or a disconnecting blade(s). The fuse holder or fuse carrier may include a conducting element (fuse link) or may act as the disconnecting blade by the inclusion of a non-fusible member.

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Dead front; without live parts exposed to a person on the operating side of the equipment.

Disconnecting means; a device, or group of devices or other means by which the conductors of a circuit can be disconnected from their source of supply.

Enclosed; Surrounded by a case, housing, fence or walls that will prevent persons from accidentally contacting energized parts.

Equipment; a general term including material, fittings, devices, appliances, fixtures, apparatus and the like, used as a part of, or in connection with, an electrical installation.

Explosion proof; apparatus enclosed in a case that is capable of:

- Withstanding an explosion of a specified gas or vapor that may occur within
- Preventing the ignition of a specified gas or vapor surrounding the enclosure by sparks, flashes or explosion of the gas or vapor within
- Operating at such an external temperature that it will not ignite a surrounding flammable atmosphere

Feeder; circuit conductors between the service equipment or the generator switchboard of an isolated land and the final branch circuit over current device.

Fitting; an accessory such as a locknut, bushing or other part of a wiring system that is intended primarily to perform a mechanical rather than an electrical function.

Fuse; (over 600 volts, nominal); an overcurrent, grounded or shorted conductor protective device with a circuit opening fusible part that is heated and severed by the passage of overcurrent through it.

Ground; a conducting connection, intentional or accidental, between an electrical circuit or equipment and the earth or to some conducting body that serves in place of the earth.

Grounded; connected to earth or to some conducting body that serves in place of the earth.

Grounded, effectively; (over 600 volts nominal); permanently connected to earth through a ground connection of sufficiently low impedance and having sufficient ampacity that ground fault current which may occur cannot build up to voltages dangerous to personnel.

Grounded conductor; a system or circuit conductor that is intentionally grounded. **Ground Fault Circuit Interrupter (GFCI);** a device for the protection of personnel that functions to de-energize a circuit or portion thereof within an established period of time when a current to ground exceeds some predetermined value that is less than that required to operate the overcurrent protective device of the supply circuit.

Guarded; covered, shielded, fenced or otherwise protected by means of a suitable cover.

Interrupter switch (over 600 volts, nominal); a switch capable of making, carrying and interrupting specified currents.

Isolated; not readily accessible to persons unless special means for access are used.

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Labeled; equipment or materials to which has been attached a label, symbol or other identifying mark of a qualified testing laboratory that indicates compliance with appropriate standards or performance in a specified manner.

Location:

- **Damp;** partially protected locations under canopies, marquees, roofed open porches and like locations and interior locations subject to moderate degrees of moisture, such as some basements.
- **Dry;** a location not normally subject to dampness or wetness. A location classified as dry may be temporarily subject to dampness or wetness, as in the case of a building under construction.
- **Wet;** installations underground or in concrete slabs or masonry in direct contact with earth and location subject to saturation with water or other liquids, such as locations exposed to weather and unprotected.

Motor Control Center (MCC); an assembly of one or more enclosed sections having a common power bus and principally containing motor control units.

Outlet; a point on the wiring system at which current is taken to supply utilization equipment.

Overload; operation of equipment in excess of normal, full-load rating, or of a conductor in excess of rated ampacity which, when it persists for a sufficient length of time, will cause damage or dangerous overheating.

Panel board; a single panel or group of panel units designed for assembly in the form of a single pane, including buses, automatic over-current devices and with or without switches for the control of light, heat or power circuits; designed to be placed in a cabinet or cutout box placed in or against a wall or partition and accessible only from the front.

Qualified Person; one who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated his/her ability to solve or resolve problems relating to the subject matter, the work or the project.

Receptacle; a contact device installed at the outlet for the connection of a single attachment plug. A single receptacle is a single contact device with no other contact device on the same yoke. A multiple receptacle is a single device containing two or more receptacles.

Service; the conductors and equipment for delivering energy from the electricity supply system to the wiring system of the premises served.

Switches; General use; a switch intended for the use in general distribution/branch circuits. It is rated in amperes, and is capable of interrupting its rated current at its rated volts.

General snap switch; a general-use switch so constructed that it can be installed in flush device boxes or on outlet box covers.

Isolating switch; a switch intended for isolating an electric circuit from the source of power. It has no interrupting rating, and is intended to be operated only after the circuit has been opened

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by some other means.

Motor circuit switch; a switch, rated in horsepower, capable of interrupting the maximum operating overload current of a motor of the same horsepower rating as the switch at the rated voltage.

Voltage (of a circuit); the greatest root mean-square (effective) difference of potential between any two conductors of the circuit concerned.

Watertight; so constructed that moisture will not enter the enclosure.

Weatherproof; so constructed or protected that exposure to the weather will not interfere with successful operation. Rainproof, rain tight, or watertight equipment can fulfill the requirements for weather proof where varying weather conditions other than wetness, such as snow, ice, dust or temperature extremes, are not a factor.

5.0 General Procedures

Posted warnings: Employees shall read and comply with all posted warning signs and instructions.

All electrical circuits shall be treated as energized until they have been Locked Out, Tagged Out (LOTO) and verified de-energized with safety grounds applied as applicable.

All electrical conductors and equipment shall be listed or labeled by a Nationally Recognized Testing Laboratory (NRTL).

All installation, operations, maintenance, and repair of any equipment should be in accordance with manufacturer's literature and the instructions included in the listing or labeling. The instructions contained in this document are designed to supplement the manufacturer's literature, industry standards, experience, and knowledge. The instructions contained are not designed to be used by inexperienced personnel or address all possible situations, conditions, or hazards.

Conductors and equipment shall be protected from over-current in accordance with their ability to safely conduct current.

Following the operation of a circuit protective device, the circuit may not be manually re-energized until the equipment and circuit have been verified to be in a safe condition.

Cables and wires shall be spliced or joined with splicing devices suitable for intended use. No wiring system of any kind shall be installed in ducts used to transport dust, loose stock or flammable vapors.

All splices, joints and free ends of a wire or cable shall be insulated.

Sufficient workspace shall be provided and maintained around electrical equipment to permit safe operation and maintenance of equipment.

Energized equipment shall be guarded.

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Ground wires must be identified and distinguishable from all other wires in accordance with the National Electrical Code.

Electrical control panels with open wires shall be guarded to make them accessible only to Qualified Persons.

In addition to guarding, warning and high voltage signs shall be posted when unqualified personnel could come into contact with live parts.

The area surrounding work areas is free of conductive equipment, parts or debris.

Circuits shall be identified as to their use.

Each service, feeder, and branch circuit, at its disconnecting means or over-current device, shall be legibly and durably marked to indicate its purpose, unless located and arranged so the purpose is evident.

Each disconnect switch or over-current device required for a service, feeder, or branch circuit must be clearly labeled to indicate the circuit's function, and the label or marking should be located at the point where the circuit originates.

All electrical equipment and cords shall be inspected prior to each use. The inspection shall include but is not limited to the following:

- Physical integrity of enclosures and cabling insulation.
- Insulation of portable test equipment and tool cords and casings.
- Test instruments and equipment and their accessories shall be rated for the circuits and equipment to which they will be connected and shall be suitable for the environment in which they will be used.
- Test equipment calibration is within periodicity (normally annually) where required.
- Any material not meeting the above criteria shall be immediately reported to the employee's supervisor and removed from service until repairs are made.

Energized parts of electrical equipment operating at 50 volts or more shall be guarded against accidental contact by approved cabinets or other forms of approved enclosures, or by any of the following means:

- By location in a room, vault, or similar enclosure that is accessible only to Qualified Persons.
- By suitable permanent, substantial partitions or screens so arranged that only Qualified Persons would have access to the space within reach of the energized parts. Any openings in such partitions or screens shall be so sized and located that persons are not likely to come into accidental contact with the energized parts or to bring conducting objects into contact with them.
- By location on a suitable balcony, gallery, or platform.
- By elevation of eight feet or more above the floor or other working surface. Note that, although equipment elevated at least eight feet is considered to be guarded, this may not be adequate if material being handled is likely to make contact with energized parts.

Entrances to rooms and other guarded locations containing exposed live parts shall be marked with conspicuous warning signs forbidding unqualified persons to enter.

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In addition to the above requirements XX Data Center shall conduct, or cause to be conducted, and document an annual physical integrity inspection of all permanently installed electrical enclosures. Criteria and checklists used for this inspection shall be derived from NFPA 70E Article 400.

Additionally, all maintenance employees shall conduct a physical integrity and grounding system visual inspection anytime a piece of equipment is opened for servicing.

5.1 Job planning, briefing and documentation.

All energized electrical work at the facility shall be planned and first-time procedures shall be documented and retained by the manager responsible for the work for future reference. Hazard analysis for job planning shall be conducted using the guidance contained in NFPA 70E and the Data Center's Change Management process.

The job plan shall contain the following minimum elements:

- Purpose of task
- Qualifications and number of employees to be involved
- Hazardous nature and extent of task
- Limits of approach
- Safe work practices to be utilized
- Personal protective equipment involved
- Insulating materials and electrically rated tools involved
- Special precautionary techniques
- Electrical diagrams, equipment details, sketches/pictures of unique features, and any reference data to be used.

5.2 Job Briefings

- The person responsible for the work shall brief all jobs with the affected employees and supervisors.
- An affected employee is one whose job requires him/her to operate or use a machine or equipment, or whose job requires him/her to work in an area, on which servicing or maintenance is being performed.
- The brief shall encompass the elements contained in section 5.
- In addition to the above requirements, supervisors shall ensure that all job plans and briefs attempt to anticipate unexpected events and identify and minimize all possible hazards.
- Where a task will be repeated throughout the day, only one briefing is required to be performed prior to the commencement of work.
- Job plans and briefs shall be used as a tool to eliminate or control hazards associated with the work.

5.3 Energized Work

- **The Chief Engineer, Facility Manager or their designated representatives shall approve all Energized Work Permits.**
- Normally all live parts (> 50 volts) which an employee may come into contact with shall be put into an electrically safe condition utilizing the Lock-Out / Tag-Out (LOTO) procedure.
- Personnel shall not work on energized circuits unless they are qualified to do so,

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or, for training purposes, unless they work under the direct supervision of a qualified person (See section 6).

- Personnel shall not make cable connections to energized components connections unless connectors are specifically listed for that purpose and approved by the Chief Engineer.
- All electrical conductors shall be considered live until placed in an electrically safe condition and verified via the LOTO procedure.
- No bare-hand work is ever to be conducted on exposed energized electrical conductors or circuit parts above 50 volts to ground.
- Performing checks to verify that equipment is de-energized shall be considered Energized Work for the purpose of this instruction.
- Only when it can be demonstrated that de-energizing the equipment will introduce additional or increased hazards, or is infeasible due to equipment design or operational limitations, will energized work be authorized by the Chief Engineer, the Facility Manager or their designated representatives, (e.g. quantitative or qualitative electrical diagnostic measurements or routine adjustments).
- Authorization for energized work shall be obtained utilizing the Energized Electrical Work Permit
- Routine testing, voltage measurements, and troubleshooting by qualified employees may be conducted without the use of an energized work permit as long as the safe work procedures and required PPE (designated in Table 2 of enclosure (2) of this document are utilized. Removing bolted covers from energized equipment or the insertion or removal of circuit breakers or motor control units from energized cubicles shall never be considered routine work.

Examples of work not requiring an energized work permit:

- Opening a hinged cover on an enclosure to perform a visual inspection
- Performing voltage measurements to verify a zero energy state
- Connecting an I/O device to a PLC or Variable Frequency Drive.
- Other frequently performed tasks which local site management has approved.

Personnel precautions for performing energized work:

- No personnel shall perform energized work when alertness may be impaired due to illness, fatigue or other reasons.
- Personnel shall not reach blindly into energized areas.
- Personnel shall not perform energized work where the view is obstructed or adequate illumination does not exist.
- Personnel shall verify that they are not wearing conductive articles, clothing or jewelry prior to working on energized electrical equipment.
- Personnel shall only wear clothing made from natural fibers when performing energized work.
- Personnel shall not bring any non-electrically rated tools or equipment into the work area (this includes ladders and stools).
- If work is to be accomplished in the vicinity of potentials in excess of 50 volts or the work is deemed particularly hazardous, a safety observer shall be assigned. The safety observer shall monitor the area for unsafe conditions, provide warnings when these conditions exist and shall be briefed on equipment cutouts and electrical emergency procedures. The safety observer will be qualified in

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- CPR and have no other duties.
- Precautions when electrical Arcing and Flashes may occur
- Employees must wear protective equipment for the eyes or face wherever there is a potential danger of electric arcs or flashes or from flying materials resulting from an arc blast. This shall include polycarbonate safety glasses with side shields, a full-face shield, and additional flame-retardant protective clothing to cover the arms and torso. NFPA 70E, Standard for Electrical Safety Requirements for Employee Workplaces, shall be practiced.
- The following scenarios are examples of situations with the potential for arcs:
 - Switching of 208-volt phase-to-phase or higher circuits.
 - Installation or removal of low voltage circuit breakers in 208-volt phase-to-phase or higher energized circuits
 - Installation or removal of low-voltage motor starters with an energized bus in 208-volt phase-to-phase or higher circuits
 - Any energized electrical work task that could initiate a short circuit condition.
- PPE for the prevention of arc-flash injuries shall be selected based on the incident energy involved and shall be in accordance with Table 3
- For equipment where incident energies have not yet been determined, the PPE shall be in accordance with Table (4.)
- A work area shall be established and marked around the energized work at either the limited approach or the flash hazard boundary whichever distance is greater.
- No unqualified persons shall cross these boundaries.
- Qualified persons shall only cross these boundaries when their duties require them and only when wearing the proper PPE (See Enclosure (2) for PPE details).
- Shock Prevention Boundaries shall be determined based on the values contained in Table (1) Enclosure (1).
- Qualified persons. When a qualified person is working in the vicinity of exposed energized parts, they may not approach or take any conductive object without an approved insulating handle closer to exposed energized parts than shown in Table (2) unless:
 - The person is insulated from the energized part (gloves, with sleeves if necessary, rated for the voltage involved are considered to be insulation of the person from the energized part on which work is performed), or
 - The energized part is insulated both from all other conductive objects at a different potential and from the person, or
 - The person is insulated from all conductive objects at a potential different from that of the energized part.
 - The person has justified the reason for the work and has a plan based on risk analysis.

Table (1)

Limited Approach Boundaries

Nominal System Voltage	Exposed Movable Conductor	Exposed Fixed Conductor
50-750 V	3.05 m (10 ft)	1.07 m (3 ft 6 in)
751 V-15 kV	3.05 m (10 ft)	1.53 m (5 ft)
15.1 kV-36 kV	3.05 m (10 ft)	1.83 m (6 ft)
36.1 kV-46 kV	3.05 m (10 ft)	2.44 m (8 ft)
46.1 kV- 72.5 kV	3.05 m (10 ft)	2.44 m (8 ft)

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72.6 kV-121 kV 3.25 m (10 ft) 2.44 m (8 ft)

The Limited Approach Boundary is the distance at which unqualified persons and uninsulated equipment must be kept away from exposed live parts. An unqualified person may only cross this boundary if their job task absolutely requires it and then only under the continuous supervision of a qualified employee.

Table (2)

Restricted Approach Boundaries

Nominal System Voltage

50-300 V	Avoid Contact
301-750 V 304.8 mm	(1 ft 0 in)
751 V-15 kV 660.4 mm	(2 ft 2 in)
15.1 kV-36 kV 787.4 mm	(2 ft 7 in)
36.1 kV-46 kV 838.2 mm	(2 ft 9 in)
46.1 kV- 72.5 kV 965.2 mm	(3 ft 2 in)
72.6 kV-121 kV 991 mm	(3 ft 3 in)

The Restricted Approach Boundary is the distance at which unqualified persons may never cross. Qualified employees must be wearing the proper voltage rated PPE, employ only insulated tools, have an approved procedure and hazardous work permit or be performing an approved routine task per section 4.

6.0 Training & Qualifications

All Employees

All employees shall be trained in the electrical hazards associated with their specific work environments

Qualified Employees

In order for a facilities service vendor employee to be considered qualified, he / she shall have been an employee at the site for at least 6 weeks, received training and have demonstrated to the Chief Engineer the requisite knowledge and skill to work safely around energized conductors. As a minimum the training will include the topics listed below.

- Identification of live parts.
- Determination of nominal voltages.
- Determination and significance of approach distances.
- Hazard identification, mitigation and PPE required.
- Proper inspection and use of portable test equipment including calibration and grounding.
- Safely de-energizing of parts and subsequent electrical lockout and tagging procedures as required by the LOTO policy.
- Proper precautionary work techniques.
- Proper use of personal protective equipment to include non-conductive gloves, aprons, head protection, safety glasses and face shields.
- Proper selection and use of rated test instruments and equipment including the capability to visually inspect all parts of the test equipment for defects.
- Use of insulating and shielding materials for employee protection to include auxiliary shields, guards, mats, or other specific equipment.

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- Proper use of insulated tools or other non-conductive devices such as fuse pullers, fish tapes, hot sticks, ropes or hand lines.
- The importance of illumination and to work only in properly illuminated areas.
- Proper work techniques for work in enclosed or confined workspaces.
- Removal or special handling of any conductive materials and equipment.
- Proper and safe use of portable ladders around electrical equipment.
- Removal of any conductive apparel or jewelry.
- Proper alerting techniques such as safety signs and tags, barricades, attendants, and work practices
- Any other safety related work practice not listed above but is necessary for them to safely do their job.
- The Chief Engineer shall maintain a list of qualified employees in their areas and shall conduct and document semi-annual reviews of the training and safety performance of these personnel. Refresher training on the above topics shall be conducted annually.

7.0 Contractors

Outside contractors that will be performing work on site shall follow at a minimum, the XX Data Center Critical Systems Electrical Safety Policy and be pre-qualified to perform electrical work.

Site engineering and the outside Contracting firm must inform each other of their respective Electrical Safety procedures. The responsibility of training outside contractor's employees lies with their employer. However, XX Data Center or its designated representative may conduct training for the outside contractor.

All Contractors shall be trained in XX Data Center's Critical Environment and Electrical Safety procedures consistent with section 6 of this standard and have been pre-qualified prior to conducting any work associated with electrical equipment.

XX Data Center or its designated representative shall review the Contractor's Electrical Safety program and performance record in detail to assure safe coordination and implementation that protects all workers.

8.0 Miscellaneous Requirements

Work in Hazardous Locations

Energized electrical work in a Class I or Class II, Division 2 rated-location requires special hazard precautions. Work shall only be performed after a thorough analysis has been made to verify the work can be performed safely, and approval has been obtained from the responsible manager.

A thorough test of the area must be performed with a properly calibrated (to the type of vapor that might be present) combustible gas indicator and continuously during any energized electrical work. If any indication of a vapor in the air is sensed on the combustible gas indicator, work will not proceed or will stop until the source of the vapor is controlled or entirely eliminated. In all cases work shall be performed in a de-energized and locked out condition to prevent an electric spark potential in such an area.

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Energized electrical work in a hazardous location shall be pre-approved by the XX Data Center Chief Engineer in all cases to insure that hazard controls are adequate.

Work in Wet or Damp Locations

Standing water, which could pose a risk to electrical equipment, shall be removed, pumped, or squeegeed with all electrical power in the affected area disconnected and locked out. Any electrical equipment used to remove water shall be rated for wet or dry work and must be connected to a GFCI-equipped power source; any extension cords used will have molded end caps and be free of any defects in the insulation. All other energized electrical work shall be postponed until the standing liquid can be cleaned up to a damp condition.

Work in damp locations shall be accomplished with the highest level of regard for safety. Equipment shall be powered through GFCI-equipped circuits. Energized electrical work shall be minimized except for testing or metering to verify de-energized conditions until the area can be properly dried.

Cords

Flexible cords (extension cords) shall not be substituted for fixed wiring.

Flexible cords shall be protected from accidental damage.

Cords shall be routed so that they do not present a trip hazard in aisles and workspaces.

Temporary wiring shall be run overhead where possible and never through walls, doors, partitions, or holes in the floor or ceiling. This includes any extension cords or power strips used in cubicle, office, or employee eating areas. Cords shall be kept at least 6 inches above floor surfaces wherever there is a potential for liquid leaks and spills.

Insulation integrity must be assured or protected to prevent current leakages. A visual inspection for insulation damage is required before use.

Overriding Safety Interlocks

When a qualified person is required to override safety interlocks to perform metering, testing or troubleshooting equipment with the power on (i.e., energized electrical work), the following safe work practices shall be followed:

Overriding safety interlocks shall only be performed by Qualified Persons or Qualified Electrical Workers who are experienced with the equipment being serviced and understand the consequences of overriding the interlocks.

All safety interlocks shall be restored after the work has been completed. Where possible, positive confirmation should be made to verify that each interlock functions as intended. This may be accomplished by a de-energized continuity check where possible or by activating the interlock with the equipment energized.

Switching

Devices used to open circuits under load conditions must be designed to interrupt the current involved.

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A high percentage of accidents occur during switching operations. The following steps will minimize risk to personnel and equipment while performing switching:

- Secure authorization before performing any switching, preferably in writing as part of a MOP.
- Review one-line diagram to identify all equipment affected by operation.
- Perform a system walkthrough to verify diagrams and identify location specific hazards.
- When deemed necessary, affix switching tags adjacent to devices to be operated.
- Notify all personnel affected by the switching operation.
- Once the worker is prepared to operate the switch, it should be operated as if it may fail.
- Personal protective equipment shall be worn as determined by a flash hazard analysis or as required by NFPA 70E (See enclosure (2)).
- Identify the immediate blast zone. If the switch fails, where will the blast go? If you cannot operate the device remotely, stand off to the side that offers the most protection from an anticipated blast.
- Have a backup person who can render assistance if necessary, but make sure they stay out of the immediate blast zone.
- Keep all others out of the switching area.
- Make sure panel covers and doors are secure.
- Before re-energization, verify that all locks, blocks and tags have been removed and a qualified person has tested the circuit safe for re-energization.
- Tool Control
 - When work is performed inside of a switchboard all tools and equipment entering the enclosure shall be listed.
 - When the work is complete and prior to closing out the enclosure, an inventory of the tools used will be conducted and the equipment shall not be closed out until the switchboard is inspected and all tools are accounted for.
- Personal Protective Grounds – During the performance of LOTO if it is necessary to apply personal protective grounds, they shall on be applied and removed by qualified electrical workers in accordance with the below procedures. **ONLY AFTER THE EQUIPMENT IS APPROPRIATELY DE-ENERGIZED, LOCKED, TAGGED, AND VERIFIED, GROUNDING CABLES MAY BE APPLIED.**

Ratings

Grounding cable sets must be rated for the maximum available fault current of the system on which they are applied.

Where the available fault current exceeds the rating for one set of ground cables, multiple sets must be applied.

ASTM has developed grading criteria for grounding set component ratings. This ASTM standard (F855) is based on either 15 cycle or 30 cycle ratings (for 60 cycles).

Maximum Available Fault Current (kA)

ASTM Grade	15 Cycle Clearing Time	30 Cycle Clearing Time	Copper Cable Size (AWG)
1	14.5	10	#2
2	21	15	1/0
3	27	20	2/0

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4	36	25	3/0
5	43	30	4/0
6	54	39	250MCM
7	74	54	350MCM

Note - When applying grounds, wear the personal protective equipment as listed in this policy.

Procedure: The following shall be performed in the order given:

- Perform checks to verify that no voltage is present.
- The ground cable or the ground set is to be securely connected to an effective ground point.
- Bring the other end of the ground cable or one free end of the grounding cable set into contact with the closest phase of the de-energized apparatus using an insulating handle, "shotgun", or other suitable device.
- Repeat for the remaining phases of the apparatus.
- Securely clamp the ground to the apparatus. Starting with the closest phase.
- In close clearance low voltage cubicles, it may be necessary to apply the grounds without an insulating handle.
- The application or removal of any ground shall be completed so it will not be required to cross an ungrounded system phase.

Tagging:

- After the application of grounds is complete, the location of the grounding set should be tagged with a "Caution Grounds Applied" sign. This sign should be connected to the ground set yoke using high visibility yellow tape/rope.
- This sign should be placed outside the enclosure and in a highly visible place, preferably near the switching means.
- Each individual shall personally satisfy himself or herself that all necessary steps have been executed in the proper manner before they begin work.

Temporary Removal:

- Grounds should be left on circuits, except when it is necessary to remove them for testing, while work is in progress.
- When any work requiring the removal of grounds is complete, the grounds shall be reapplied until final removal in preparation for re-energization.

Emergency Response

- Employees who are part of the emergency response team shall be trained in techniques for recognizing electrical hazards, coordinating with qualified Facilities or Equipment personnel to ensure that power is turned off (and various methods for accomplishing this) before attempting rescue, techniques for extracting persons from live circuits, and first aid response. The persons shall be practiced and proficient in their response to ensure their own safety as well as the victims being rescued.

Energized Work Permit

Use Hot Work Permit designated by local contractor or DCM Hot Work Permit 021-01

Shock Protection Boundaries

Table (1) Enclosure 1

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Limited Approach Boundaries

Nominal System Voltage	Exposed Movable Conductor	Exposed Fixed Conductor
50-750 V	3.05 m (10 ft)	1.07 m (3 ft 6 in)
751 V-15 kV	3.05 m (10 ft)	1.53 m (5 ft)
15.1 kV-36 kV	3.05 m (10 ft)	1.83 m (6 ft)
36.1 kV-46 kV	3.05 m (10 ft)	2.44 m (8 ft)
46.1 kV- 72.5 kV	3.05 m (10 ft)	2.44 m (8 ft)
72.6 kV-121 kV	3.25 m (10 ft)	2.44 m (8 ft)

The Limited Approach Boundary is the distance at which unqualified persons and uninsulated equipment must be kept away from exposed live parts. An unqualified person may only cross this boundary if their job task absolutely requires it and then only under the continuous supervision of a qualified employee.

Table (2) Enclosure 1

Restricted Approach Boundaries

Nominal System Voltage	Avoid Contact
50-300 V	Avoid Contact
301-750 V	304.8 mm (1 ft 0 in)
751 V-15 kV	660.4 mm (2 ft 2 in)
15.1 kV-36 kV	787.4 mm (2 ft 7 in)
36.1 kV-46 kV	838.2 mm (2 ft 9 in)
46.1 kV- 72.5 kV	965.2 mm (3 ft 2 in)
72.6 kV-121 kV	991 mm (3 ft 3 in)

The Restricted Approach Boundary is the distance at which unqualified persons may never cross. Qualified employees must be wearing the proper voltage rated PPE, employ only insulated tools, have an approved procedure and hazardous work permit or be performing an approved routine task.

Flash Protection Boundary

The Flash Protection Boundary is the distance from an energized conductor where a person's body will not be exposed to an incident energy of 1.2 cal/cm² (the onset of second degree burns) or greater.

The Flash Protection Boundary is determined by conducting an incident energy study. For voltages at below 600 V, where the incident energy has not been determined, a distance of 4 ft shall be used.

Required Personal Protection Equipment (PPE) For Electrical Work

Standards

- ASTM D 120-02 approved insulating gloves rated for the highest voltage to be encountered.
- ANSI Z87.1 approved safety glasses.
- ASTM F 696-02 approved leather glove protectors.
- ANSI Z87.1 approved safety glasses.
- ANSI Z89.1 approved electrically rated hardhat, types E and G

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- ANSI Z87.1, ASTM F 2178-02 approved arc rated face shield.
- ASTM F 1959-99 approved Fire Retardant pants and long sleeved shirt or Fire Retardant coverall with a minimum Arc Thermal Performance Value (ATPV) equal to or greater than the highest incident energy, which may be encountered.

Insulating Equipment

- Insulating equipment made of materials other than rubber shall be rated to provide electrical and mechanical protection at least equal to that of rubber equipment.
- PPE will be maintained in a safe, reliable condition and shall be inspected before each use and electrically tested in accordance with Table 1 below. The equipment shall be replaced if the insulating capability of the protective equipment is decreased due to damage during use.
- Before each use, the insulating equipment will be visually inspected and again immediately following any incident where the equipment may have been damaged. Visual inspections will consist of examining for holes, tears, punctures or cuts; ozone checking; embedded foreign objects; textural defects such as swelling, softening, hardening or stickiness; any other defect that results degradation of the insulating quality.
- Insulating gloves will be inflated with air and then sealing off the cuff area or rolling up the sealed cuff. The glove shall stay inflated with no leakage.
- Leather protective gloves will be worn over insulating gloves for:
 - Class 00 insulation - at greater than 250 volts
 - Class 0 insulation - only when damage to rubber could occur
 - Class 1, 2, 3, 4 insulation - at all times
- Daily Glove Checks will be recorded on a form similar to Table 5.
- Defective equipment will be removed from service and destroyed.

Table 1 Enclosure 2

Rubber Insulating Equipment Testing Intervals

Type of Equipment Electrical Testing Frequency

- Rubber Insulating Gloves Before first issue and every 6 months thereafter.
- Rubber Insulating Blankets and Floor Mats Before first issue and every 12 months thereafter
- Rubber Insulating Sleeves Before first issue and every 12 months thereafter

(Note: If any insulating equipment has been electrically tested but not placed in service, it may not be placed into service unless it has been electrically tested within the previous 12 months. Employees are responsible for ensuring the above requirements are met prior to use.)

PPE for Routine Work not requiring a Hazardous Work Permit

When routine work is being conducted under section 5 of this document, the following minimum PPE shall be employed:

Table 2. Enclosure 2

PPE for Routine Tasks Operating Voltage Shock Prevention PPE Arc-Flash PPE

> 50 V – < 208 V

Class 00 Rubber Insulating Gloves All natural fiber clothing with long sleeves, Safety glasses or

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goggles.

 > 208 V – < 600 V
 Class 0 Rubber
 Insulating Gloves

All natural fiber clothing, Safety glasses or goggles, leather gauntlets over electrically rated insulating gloves. ATPV rated face shield with a minimum arc rating of 8, Fire Retardant (FR) Shirt and Pants or FR Coverall with a minimum arc rating of 8, Class E rated hardhat, leather work shoes.

(Note: The PPE requirements for Arc-Flash protection listed above are only to be used until an Arc-Flash study has been completed on the equipment being serviced. Once the study has been completed, PPE should be selected based on the results.)

Arc Flash PPE for Work Requiring a Hazardous Work Permit

Table 3. Enclosure 2

Arc Flash PPE for non-routine Tasks Incident Energy Arc-Flash PPE < 8 cal/cm²

All natural fiber clothing, Safety glasses or goggles, leather gauntlets over electrically rated insulating gloves. ATPV rated face shield with a minimum arc rating of 8, Fire Retardant (FR) Shirt and Pants or FR Coverall with a minimum arc rating of 8, Class E rated hardhat and leather work shoes.

 > 8 cal/cm² < 40 cal/cm²

All natural fiber clothing, Safety glasses or goggles, leather gauntlets over electrically rated insulating gloves. Multi-layered switching hood and suit (min arc rating of 40) worn over Fire Retardant (FR) Shirt and Pants or FR Coverall with a minimum arc rating of 8, Class E rated hardhat and leather work shoes.