

DEPAUL UNIVERSITY

Electrical Safety Program

Environmental Health & Safety

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1.0 PURPOSE

The Electrical Safety Program (ESP) was created to ensure that electrical work at DePaul University is performed only by Facility Operations' electricians/qualified engineers or contracted appliance and repair technicians (together referred to as qualified electrical personnel) who have been provided with all information and tools necessary to protect themselves on the job. This is accomplished through the use of safe work procedures, protective equipment and other controls in accordance with best practices and regulatory requirements. The only other employees permitted to perform electrical work are Theatre personnel doing basic power and lighting setup for productions, according to their own industry standards and following their own safety protocol.

2.0 SCOPE

The ESP applies to qualified electrical personnel. All such employees must comply with the Occupational Safety and Health Administration (OSHA) standards in 29 CFR 1910 Subpart S and the most current edition of the National Fire Protection Association (NFPA) 70E, *Standard for Electrical Safety in the Workplace*. Any energized work on equipment over 480V will be contracted out to a qualified electrical contractor. Normal operation of equipment and work on equipment less than 50V is not considered energized work by this program (see Appendix A: Definitions for the meaning of "normal operation").

3.0 RESPONSIBILITIES

Facility Operations (FO) has ultimate responsibility for implementing safe work procedures and supplying protective equipment required by this program.

Environmental Health & Safety (EHS) is responsible for program development and annual review.

Chief Electricians are responsible for assessing and grouping electricians and qualified engineers into Classes 1-3 annually and for ensuring that safe work procedures are utilized.

Class 1-3 Personnel are responsible for performing electrical work within their class according to safe work procedures required by this program.

Contracted Appliance & Repair Technicians must be trained and have direct control or line of sight to de-energize equipment prior to servicing it, and follow contractor procedures in Section 6.0.

4.0 TRAINING REQUIREMENTS

Awareness level electrical safety training is given to FO electricians, engineers, custodians, painters, and carpenters annually. Class 1-3 personnel receive additional training at least every 3 years. Retraining is required whenever there is evidence that safe work procedures are not being followed or an employee must employ safe work procedures they do not normally use (whether due to new technology/types of equipment, procedural changes or any other reason).

5.0 SAFE WORK PROCEDURES

All equipment should be considered energized until proven otherwise. It is DePaul policy to only conduct energized work via annual or temporary permits, with the goal of limiting such work as much as possible.

5.1 Annual Skills Assessment & Permit Review

Chief electricians at the Lincoln Park and Loop campuses will perform a skills assessment each January (or upon hire for new employees) to review each electrician and qualified engineer's skills and training. They will designate them as Class 1, 2 or 3 personnel (see Appendix B) and facilitate review and sign off of annual permits. Class 3 personnel are also permitted, on a case by case basis, to obtain temporary energized work permits for non-routine tasks.

5.2 Arc Flash Surveys

In 2016, FO committed to a multi-year project to conduct arc flash surveys of all University buildings. The goal is to identify high hazard equipment and reduce the hazards of maintaining it through engineering controls. These surveys will identify equipment that has a greater potential for arc flash and allow us to better protect our qualified electrical personnel. One-line diagrams will eventually be displayed in all main electrical rooms, and all switchboards, panel boards, industrial control panels, meter socket enclosures and motor control centers that are likely to require examination, adjustment, servicing or maintenance while energized will receive arc flash labels.

6.0 CONTRACTOR PROCEDURES

DePaul is required to inform contractors of:

- Known hazards covered by NFPA 70E that may not be recognized by the contractor. If such hazards exist, a documented meeting must take place.
- Information about the employer's installation that the contractor needs to make the assessments required by NFPA 70E.
- Any observed violations of NFPA 70E.

Contractors must advise DePaul of the following:

- Any unique hazards presented by the contractor's proposed work.
- Hazards identified during the course of work that were not communicated by DePaul.
- Measures taken to correct any violations reported by DePaul and to prevent such violation from recurring in the future.

7.0 REPORTING REQUIREMENTS

Any electrical hazards (or suspected hazards) must be immediately reported to a supervisor. If there is evidence that equipment could fail and injure employees, it must be de-energized immediately if it is safe and feasible to do so. Defective or hazardous equipment must be marked out of service until it is repaired or replaced. Injuries must be reported to Public Safety.

APPENDICES

APPENDIX A: DEFINITIONS

Arc Blast: A high-pressure sound wave caused by an arc flash.

Arc Blast Impacts: The heating of air and vaporization of metal during an arc flash creates a pressure wave that can damage hearing and cause memory loss (from concussion) and other injuries. Flying metal debris is also a hazard.

Arc Flash: An extremely high-temperature discharge produced by an electrical fault in air.

Arc Flash Burns: Severe skin burns caused by direct heat exposure and igniting clothing due to an arc flash.

An electric arc flash can occur if a conductive object gets too close to a high-amp current source or by equipment failure (for instance, while opening or closing disconnects). The arc can heat the surrounding air to temperatures as high as 35,000 °F, and vaporize metal in the equipment. The arc flash can cause severe skin burns by direct heat exposure and by igniting clothing.

Boundary, Arc Flash (AFB): When an arc flash hazard exists, an approach limit at a distance from prospective arc source within which a person could receive a second degree burn from an incident energy level of 1.2 calories/cm² if an electrical arc flash were to occur.

Boundary, Limited Approach (LAB): An approach limit at a distance from an exposed energized electrical conductor or circuit part within which a shock hazard exists.

Boundary, Restricted Approach (RAB): An approach limit at a distance from an exposed energized electrical conductor or circuit part within which there is an increased risk of shock, due to electrical arc-over combined with inadvertent movement, for personnel working in close proximity to the energized electrical conductor or circuit part.

Clearing Time: The clearing time is the total time it takes a fuse or circuit breaker to open and clear an overcurrent. The clearing time is the sum of the opening time and the arcing time.

De-Energized Electrical Work: Electrical work that is performed on equipment that has been previously energized and is now free from any electrical connection to a source of potential difference or electrical charges and has been locked out/tagged out.

Electric Shock and Burns: An electric shock occurs when electric current passes through the body. This can happen when touching an energized part. If the electric current passes across the chest or head, death can result. At high voltages, severe internal and external burns can result from current passing through the body.

Electrically Safe Work Condition: A state in which an electrical conductor or circuit part has been disconnected from energized parts, locked/tagged out in accordance with established standards, tested to ensure the absence of voltage and grounded if determined necessary.

Energized Electrical Work: Repair, maintenance, troubleshooting or testing on electrical circuits, components or systems while energized (i.e. live).

Exposed Electrical Parts: Energized parts that can be inadvertently touched or approached nearer than a safe distance by a person or parts not suitably guarded, isolated, or insulated (e.g. terminal contacts or lugs, bare wiring).

Fault Current: A fault current is an abnormal current in an electric circuit due to a fault (usually a short circuit or abnormally low impedance path).

Field Evaluated: A thorough evaluation of non-listed or modified equipment in the field performed by persons or parties acceptable to the Authority Having Jurisdiction (AHJ). The evaluation approval ensures that the equipment meets appropriate codes and standards, or is similarly found suitable for a specified purpose.

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

Ground Fault Circuit Interrupter (GFCI): A device whose function is to cut off the electric circuit to the load when a fault current to ground exceeds a predetermined value that is less than that required to operate the over-current protective device of the supply circuit.

Hazardous (Classified) Location: An area in which an airborne flammable dust, vapor or gas may be present and would represent a hazard if a source of ignition were present (see National Fire Protection Association (NFPA) Class I & II and Division 1 & 2).

Industrial Control Panel: Enclosure that may contain exposed energized conductors or components.

Interlock: An electrical, mechanical, or key-locked device intended to prevent an undesired sequence of operations.

Isolating Switch: A switch intended for isolating an electric circuit from the source of power. It has no interrupting rating, and is intended to operate only after the circuit has been opened by some other means.

Laboratory: A building, space, room, or group of rooms intended to serve activities involving procedures for investigation, diagnostics, product testing, or use of custom or special electrical components, systems, or equipment.

Listed: Equipment, materials or services included in a list published by an organization that is acceptable to AHJ and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states they meet appropriate designated standards or has been tested and found suitable for a specific purpose.

Lockout/Tagout: A standard that covers the servicing and maintenance of machines and equipment in which the unexpected re-energizing or startup of the machines/equipment or release of stored energy could cause injury to employees. It establishes minimum performance requirements for the control of such hazardous energy.

Motor Control Center: A modular assembly specifically designed to plug in motor control units. Motor control centers are supplied by a common bus, usually straight from the switchboard.

Normal Operation: Means to operate equipment in the manner specified by the manufacturer. If the manufacturer states that a push button must be used to operate the equipment, operation by any other means would not be considered normal operation. ([Source](#)) Normal operation is not considered energized work by this program as long as the following conditions are met:

- The equipment is properly installed – in accordance with applicable industry codes, standards, and the manufacturer’s recommendations.
- The equipment is properly maintained – in accordance with the manufacturer’s recommendations and applicable industry codes and standards.
- The equipment doors are closed and secured (if applicable).
- All equipment covers are in place and secured (if applicable).
- There is no evidence of impending failure – evidence such as arcing, over-heating, loose or bound equipment parts, visible damage or deterioration.

Panelboard: A distribution board (or panelboard) is a component of an electrical distribution system which divides an electrical power feed into subsidiary circuits, while providing a protective fuse or circuit breaker for each circuit, in a common enclosure.

Personal Protective Equipment (PPE): Equipment and or apparel worn to protect the individual from hazards.

Qualified Electrical Personnel: A Facility Operations electrician, qualified engineer or contracted appliance and repair technician who has received training in and demonstrated skills and knowledge in the construction and operation of electrical equipment or a specific work method and is trained to recognize and avoid the electrical hazards that might be present with respect to that equipment or work method.

Qualified electrical personnel must be familiar with the proper use of special precautionary techniques, PPE, insulating materials, insulated tools, and be able to select, use and understand the limitations of an appropriate voltage detector.

Remote-Control Circuit: Any electric circuit that controls any other circuit through a relay or an equivalent device.

Risk Assessment: The process of determining the risk associated with a task by considering the frequency, likelihood and severity of injury that may result from it.

Switchboard: One or more panels accommodating control switches, indicators, and other apparatus for operating electric circuits.

Switching Devices: Devices designed to close and/or open one or more electric circuits. Included in this category are circuit breakers, cutouts, disconnecting (or isolating) switches, disconnecting means, interrupter switches, and oil (filled) cutouts.

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

Voltage, Nominal: An approximate value assigned to a circuit or system for the purpose of conveniently designating its voltage class, e.g., 120/240, 480/277, and 600.

Voltage-Rated (V-Rated): Rated and tested for the maximum line-to-line voltage upon which work will be done.

Working On (Energized Electrical Conductors or Circuit Parts): Coming in contact with energized electrical conductors or circuit parts with hands, feet, or other body parts, with tools, probes or with test equipment, regardless of the personal protective equipment a person is wearing. There are two categories of “working on”: *Diagnostic (testing)* is taking readings or measurements of electrical equipment with approved test equipment that does not require making any physical change to the equipment; *repair* is any physical alteration of electrical equipment (such as making or tightening connections, removing or replacing components, etc.)

Personnel Classes

Class 3

- Live work on equipment up to 220V
- Live testing of equipment, throwing switches and breakers up to 480V
- De-energized work on equipment up to 480V
- Select non-routine tasks (after obtaining a temporary permit)

Class 2

- Live work on equipment up to 220V (Supervised)
- Live testing of equipment, throwing switches and breakers up to 480V (No supervision required)
- De-energized work on equipment up to 480V must be inspected by a Class 3 person before re-energizing

Temporary permits for non-routine tasks

Class 1

- Live work on equipment up to 120V
- Live testing of equipment, throwing switches and breakers up to 220V
- De-energized work on equipment up to 480V

Live work supervised

All work supervised

Note: Class 2 can do all Class 1 items. Class 3 can do all Class 1 & 2 items.

APPENDIX C: ELECTRICAL PROTECTIVE EQUIPMENT

Departments must provide employees with all electrical protective equipment required by this program. This includes personal protective equipment (PPE), insulating tools and handling equipment, GFCI protective devices and access limiting equipment (i.e., safety signs and barricades). Electrical protective equipment must be approved, rated, periodically tested and maintained in a safe and reliable condition in accordance with manufacturer's instructions and applicable American Society of Testing and Materials (ASTM) and American National Standards Institute (ANSI) standards.

C.1 PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment (PPE) must be stored in a way that prevents physical damage from moisture, dust, and other deteriorating agents (and if arc-rated, contamination from flammable or combustible materials), and be visually inspected before each use and immediately following any incident that can be reasonably suspected of having caused damage.

Arc-rated protective equipment must have an arc rating suitable for the arc flash exposure involved. Manufacturer's instructions must be followed for care, maintenance, and repair. If arc-rated items become contaminated with grease, oil, flammable liquids or combustible materials, they must be taken out of service immediately.

C.2 INSULATED TOOLS AND HANDLING EQUIPMENT

Insulated tools must be designed and constructed to meet the demands of use and the environment to which they are exposed. Insulating equipment made of materials other than rubber must provide electrical and mechanical protection at least equal to that of rubber equipment. If the insulating capability of equipment is subject to damage during use, the insulating material must be protected by an outer covering of leather or other appropriate material.

Insulating rubber equipment such as gloves, sleeves, blankets, and matting must be stored in an area protected from light, temperature extremes, excessive humidity, ozone, and other substances and conditions that may cause damage. In addition to being tested according to the schedule supplied by the manufacturer, rubber insulated equipment must be:

- Visually inspected before each day's use for damage to the insulation or damage that could limit the tool from performing its intended function, or that could increase the potential for an incident (e.g. damaged tip on screwdriver). Rubber insulating gloves must be given an air test as well as visual inspection.
- Inspected immediately following any incident that could have caused damage.
- Dielectrically tested within 6 months of first use or 1 year of purchase if not used (rubber gloves used without the leather protectors must be removed from service until dielectrically tested).

Rubber insulated equipment found to have defects that might affect its insulating properties must be removed from service until testing indicates that it is acceptable for continued use. Do not

attempt to repair defective rubber insulated equipment. Tools and handling equipment must be replaced if the insulating capability is impaired.

Fuse or fuseholder handling equipment insulated for the circuit voltage must be used to remove or install a fuse if the fuse terminals are energized. Ropes and handlines used within the limited approach boundary of exposed energized equipment parts operating at 50V or more, or where an electrical hazard exists, must be nonconductive and portable ladders used for electrical work must have nonconductive side rails.

C.3 ACCESS LIMITING EQUIPMENT

Access limiting equipment includes safety signs and barricades used to keep unqualified persons out of areas where electrical hazards are present.

Safety signs must be visible, securely attached, and maintained in legible condition.

Barricades must be of sturdy construction and discourage access. Conductive barricades cannot be used if they pose an increased electrical hazard.

APPENDIX D: FLEXIBLE CORDS AND PORTABLE ELECTRICAL EQUIPMENT

All flexible cords (including flexible cord sets, aka extension cords) and portable electrical equipment must be visually inspected before each use for signs of external and internal damage. Any defective equipment must be immediately removed from service until it is repaired and tested to ensure it is safe for use.

Flexible cords and portable electrical equipment must be handled and stored in a manner that will not cause damage.

Flexible cords and portable electrical equipment used in wet or damp locations must be GFCI protected and approved for use in those locations.

D.1 GENERAL REQUIREMENTS

Employees' hands must be dry when plugging and unplugging flexible cords. If the connection could provide a conducting path to employees' hands (e.g., a cord connector is wet), insulating protective equipment must be used to handle the connections.

Attachment plugs and receptacles must not be connected or altered in any way that would interrupt the continuity of the equipment grounding conductor, or for use in a manner that was not intended by the manufacturer. Locking connectors must be properly locked together and cannot be altered to allow the grounding pole to be inserted into current connector slots. Strain relief of cords and cables must be maintained to prevent pull from being transmitted directly to joints or terminals.

Adapters that interrupt the continuity of the equipment grounding connection are prohibited.

- Avoid running cords around sharp corners and projections.
- Do not use defective or damaged cords.
- Never use an extension cord without a ground pin.
- Do not exceed the rating of the cord.
- Do not run cords across an aisle, walkways, or paths of travel in normal work areas.
- Do not run cords through doorways, ceilings, walls, or floors. (They may not be run through windows or doors unless protected from damage, and then only on a temporary basis.)
- Do not run cords above ceilings, under floors or inside walls.
- Flexible cords must remain flexible, do not permanently attach cords to any building structure.
- Do not fasten cords with staples or hang in a way that could damage the outer insulation.
- Turn off devices prior to plugging them in.
- Fully insert plug into outlet and devices into cord, keeping fingers away from metal prongs.
- Do not remove, bend, or modify any metal prongs or pins on the cord.
- Do not use excessive force to make a connection.
- Do not pull on the cord to disconnect, hold the plug to pull from outlet.
- Do not attempt to insert a three prong plug into a two prong cord outlet.

D.2 EXTENSION CORDS

Extension cords (three-prong type) are permitted for temporary use only. Job-made extension cords must use UL listed components and be assembled by a qualified person.

Extension cords do not require inspection for defects and damage prior to use if they remain connected once they are put in place and are not exposed to damage. Extension cords meeting this description only require inspection when they are relocated.

- Do not connect extension cords in series with another extension cord or multi-tap outlet.
- Extension cords must be of equal or greater thickness to the device power cord they are plugged into.
- Multi outlet extension cords without circuit protection are not permitted.
- Household use extension cords are not permitted.
- Unplug immediately after use.

D.3 PORTABLE ELECTRICAL EQUIPMENT

Do not handle equipment by its cord (e.g., raise or lower equipment).

Attachment plugs, receptacles, cover plates, and cord connectors must be maintained such that the following criteria are met:

- There are no breaks, damage, or cracks exposing energized conductors and circuit parts.
- There are no missing cover plates.
- Terminations have no stray strands or loose terminals.
- There are no missing, loose, altered, or damaged blades, pins, or contacts.
- Polarity is correct.

GFCI protection (of the outlet utilized or via a GFCI protective device) is required for cord - and plug-connected equipment used for maintenance or construction supplied by 125-volt, 15-, 20-, or 30-ampere circuits. Where employees operate or use equipment supplied by greater than 125-volt, 15-, 20-, or 30-ampere circuits, an assured equipment grounding conductor program can be implemented in place of GFCI protection.

APPENDIX E: TEMPORARY WIRING

Temporary electrical power and lighting installations 600V or less, including flexible cords, extension cords and cables may only be used during/for renovation, maintenance, repair, experimental or development work and emergencies. Temporary wiring used for decorative lighting, special events and similar purposes cannot exceed 90 days. Temporary wiring must be removed immediately upon completion of the purpose for which it was installed.

E.1 GROUNDING AND CONNECTIONS

GFCI protection must be on all temporary wiring circuits, including extension cords, used for construction or maintenance activities. In addition, equipment and tools connected by cord and plug must be grounded unless they are listed or labeled as “double insulated” tools and appliances.

Receptacles must be of the grounding type unless installed in a complete metallic raceway. Each branch circuit must contain a separate equipment-grounding conductor, and all receptacles must be electrically connected to the grounding conductor.

Feeders must originate in an approved distribution center, such as a panel board rated for the voltages and currents the system is expected to carry. Branch circuits must originate in an approved power outlet or panelboard and suitable disconnecting switches must be installed to permit the disconnection of all ungrounded conductors of each temporary circuit. Neither bare conductors nor earth returns may be used for the wiring of any temporary circuit.

E.2 FLEXIBLE CORDS AND CABLES

Flexible cords and cables used for temporary wiring must be of a listed type and rated for the location and intended use. They may only be used for pendants, wiring of fixtures, connection of portable lamps or appliances, elevators, hoists, connection of stationary equipment where frequently interchanged, prevention of transmission of noise or vibration, data processing cables, or where needed to permit maintenance or repair. They must be protected from accidental damage when they pass through doorways or other pinch points. Avoid sharp corners and projections.

Flexible cords and cables may not be used to run through holes in walls, ceilings or floors, to run through doorways, windows, or similar openings, attached to building surfaces, concealed behind building walls, ceilings, or floors, or as a substitute for the fixed wiring of a structure.

APPENDIX F: WORKING SPACE

Sufficient access and working space must be provided and maintained around all electrical equipment to permit ready and safe operation and maintenance of such equipment.

Due to the fact that University buildings represent many construction types and ages, to include the fact that many structures predate NFPA guidelines, it must be understood that some electrical components, closets and surrounding areas are not physically able to conform with every aspect of the current NFPA guidelines. Starting in calendar year 2018, wherever such conditions exist, DePaul will label such equipment or spaces as "Non-Conforming" to alert its qualified electrical personnel. All qualified electrical personnel are encouraged to be especially cautious and alert when working around non-conforming electrical equipment or in surrounding areas. Qualified electrical personnel are required to report any unlabeled, non-conforming equipment or surrounding areas to the chief electrician, at their respective campus, such that the appropriate label may be installed.

F.1 AROUND ELECTRICAL EQUIPMENT

Working space for equipment operating at 600V, nominal, or less to ground and likely to require examination, adjustment, services or maintenance while energized must comply with the dimensions of OSHA standard 29 CFR 1910.303(g) and OSHA Table S-1 or as required or permitted elsewhere in OSHA 1910 Subpart S (29 CFR 1910.303).

The depth of the working space in the direction of access to live parts may not be less than indicated in OSHA Table S-1. Distances shall be measured from the live parts if they are exposed or from the enclosure front or opening if they are enclosed.

The minimum headroom of working spaces about service equipment, switchboards, panelboards, or motor control centers shall be 1.91 m (6.25 ft.) for installations built before August 13, 2007. For installations built on or after August 13, 2007, 1.98 m (6.5 ft.), except that where the electrical equipment exceeds 1.98 m (6.5 ft.) in height, the minimum headroom may not be less than the height of the equipment. [29 CFR 1910.303(g)(1)(vi)]

The minimum depth of clear working space at electric equipment, 600V or less is provided in OSHA Table S-1 from 29 CFR 1910.303 (g)(1)(vi)(B).

TABLE S-1—MINIMUM DEPTH OF CLEAR WORKING SPACE AT ELECTRIC EQUIPMENT, 600V OR LESS

Nominal voltage to ground	Minimum clear distance for condition ^{2 3}					
	Condition A		Condition B		Condition C	
	m	ft	m	ft	m	ft
0-150	10.9	13.0	10.9	13.0	0.9	3.0
151-600	10.9	13.0	1.0	3.5	1.2	4.0

Notes to Table S-1:

1. Minimum clear distances may be 0.7 m (2.5 ft) for installations built before April 16, 1981.

2. Conditions A, B, and C are as follows:

Condition A—Exposed live parts on one side and no live or grounded parts on the other side of the working space, or exposed live parts on both sides effectively guarded by suitable wood or other insulating material. Insulated wire or insulated busbars operating at not over 300V are not considered live parts.

Condition B—Exposed live parts on one side and grounded parts on the other side.

Condition C—Exposed live parts on both sides of the work space (not guarded as provided in Condition A) with the operator between.

3. Working space is not required in back of assemblies such as dead-front switchboards or motor control centers where there are no renewable or adjustable parts (such as fuses or switches) on the back and where all connections are accessible from locations other than the back. Where rear access is required to work on deenergized parts on the back of enclosed equipment, a minimum working space of 762 mm (30 in.) horizontally shall be provided.

Low Voltage: Smaller working spaces can be permitted where all uninsulated parts operate at not greater than 30V rms, 42V peak, or 60V DC.

Existing Buildings: In existing buildings, where electric equipment is being replaced, Condition B is permitted between dead-front switch boards, panel boards, or motor control centers located across the aisle from each other where maintenance conditions and supervision ensure that written procedures have been adopted to prohibit equipment on both sides of the aisle from being open at the same time. Only qualified electrical personnel who are authorized will service the installation.

Width of Working Space: The width of the working space in front of electrical equipment shall be the width of the equipment or 750 mm (30 in.) whichever is greater. In all cases, the working space shall permit at least a 90-degree opening of equipment doors or hinged panels. [29 CFR 1910.303(g)(1)(i)(B)]

Height of Working Space: The workspace shall be clear and extend from the grade, floor, or platform to the height required by paragraph 29 CFR 1910.303(g)(1)(vi). However, other equipment associated with the electrical installation and located above or below the electric equipment may extend not more than 153 mm (6 in.) beyond the front of the electric equipment. [29 CFR 1910.303(g)(1)(i)(C)]

Clear Spaces: Working space required by 29 CFR 1910.303(g) Table S-1 shall not be used for storage. When normally enclosed energized parts operating at 50V and more are exposed for inspection or service, the working space, if in a passageway or general open space shall be suitably guarded. [29 CFR 1910.303(g)(1)(iii)]

F.2 ACCESS AND ENTRANCE

Minimum Required: At least one entrance not less than 610 mm (24 in.) wide and 1.98 m (6.5 ft.) high shall be provided to give access to the working space around electric equipment. [1910.303(g)(1)(iii) and 1910.303(g)(1)(iv)]

Large Equipment: On switchboard and control panels exceeding 1.83 m (6.0 ft.) in width, there shall be one entrance at each end of such boards unless the location of the switchboards and control panels permits a continuous and unobstructed way of exit travel from the work space. [1910.303(g)(1)(iv)]

Unobstructed Exit: Where the location permits a continuous and unobstructed way of exit travel, a single entrance to the working space shall be permitted. [1910.303(g)(1)(iv)(A)]

Headroom: The minimum headroom of working spaces about service equipment, switchboards, panel boards, or motor control centers shall be 1.98 m (6.5 ft.). Where the electrical equipment exceeds 1.98 m (6.5 ft.) in height, the minimum headroom shall not be less than the height of the equipment. [1910.303(g)(1)(vi)]

Dedicated Equipment Space: All switchboards, panel boards, distribution boards, and motor control centers shall be located in dedicated spaces and protected from damage. Exception: Control equipment that by its very nature or because of other rules of the standard must be adjacent to or within sight of the operating machinery shall be permitted in those locations. [1910.303(g)(1)(vii)]

APPENDIX G: OVERHEAD LINES

When work is performed near overhead lines, the lines must be de-energized and grounded or other protective measures put in place before work begins. If the lines are to be de-energized, arrangements must be made with the person or organization that operates or controls the electric circuits involved to de-energize and ground them. If protective measures (e.g. guarding, isolating, insulating) are provided they must prevent employees from contacting power lines directly with any part of their body or indirectly through conductive materials, tools, or equipment.

G.1 ELEVATED EQUIPMENT

Where any vehicle or mechanical equipment structure will be elevated near energized overhead lines, they must be operated such that the Limited Approach Boundary distance of *NFPA 70E* Table 130.4(C), column 2, is maintained. However, under the following conditions, the clearances can be reduced:

- If the vehicle is in transit with its structure lowered, the Limited Approach Boundary distance to the overhead lines in *NFPA 70E* Table 130.4(C), column 2, can be reduced by 6 ft. If insulated barriers, rated for the voltages involved, are installed and are not part of an attachment to the vehicle, the clearance can be reduced to the design working dimensions of the insulating barrier.
- If an aerial lift insulated for the voltage involved, and the work is performed by a qualified person, the clearance (between the un-insulated portion of the aerial lift and the power line) can be reduced to the Restricted Approach Boundary given in *NFPA 70E* Table 130.4(C), column 4.

G.2 EQUIPMENT CONTACT

Employees standing on the ground must not contact the vehicle or mechanical equipment or any of its attachments, unless one of the following conditions applies:

- The employee is using protective equipment rated for the voltage.
- The equipment is located so that no un-insulated part of the structure (that portion of the structure that provide a conductive path to employees on the ground) can come closer to the line than permitted in *NFPA 70 E* 130.8(F)(1).

G.3 EQUIPMENT GROUNDING

If any vehicle or mechanical equipment capable of having parts of its structure elevated near energized overhead lines is intentionally grounded, employees working on the ground near the point of grounding must not stand at the grounding location whenever there is a possibility of overhead line contact. Additional precautions, such as the use of barricades or insulation, must be taken to protect employees from hazardous ground potentials (step and touch potential), which can develop within a few feet or more outward from the ground point.

APPENDIX H: MAINTENANCE

Maintenance is defined here as: Preserving or restoring the condition of electrical equipment and installations, or parts of either, for the safety of employees who work where exposed to electrical hazards.

This section only covers maintenance requirements associated with employee safety. It is DePaul's responsibility to choose from the various maintenance methods available to satisfy the requirements of this section.

Refer to NFPA 70B, ANSI/NETA MTS, Standard for Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems, and IEEE 3007.2 for guidance on maintenance frequency, methods and tests.

H.1 GENERAL REQUIREMENTS

- Only qualified electrical personnel may perform maintenance on electrical equipment and installations and must be trained in, and familiar with, the specific maintenance procedures and tests required.
- A single-line diagram, where provided for the electrical system, must be maintained in a legible condition and kept current.
- Electrical equipment and electrical protective equipment must be maintained in accordance with manufacturer's instructions or industry consensus standards to reduce the risk associated with failure. The equipment owner or the owner's designated representative is responsible for maintenance and documentation.
- Common industry practice is to apply test or calibration decals to equipment to indicate the test or calibration date and overall condition of equipment that has been tested and maintained in the field. These decals provide immediate indication of last maintenance date and if the tested device or system was found acceptable on the date of test. This assists employees in the assessment of overall electrical equipment maintenance status.
- Overcurrent protective devices must be maintained in accordance with the manufacturers' instructions or industry consensus standards. Maintenance, tests and inspections must be documented.
- All working space and clearances required by electrical codes and standards must be maintained.
- Equipment, raceway, cable tray and enclosure bonding and grounding must be maintained to ensure electrical continuity.
- Enclosures must be maintained to guard against accidental contact with energized conductors and circuit parts and other electrical hazards. Covers and doors must be in place with all associated fasteners and latches secured.
- Locks, interlocks and other safety equipment must be maintained in proper working condition to accomplish the control purpose.
- Access to working space and escape passages must be kept clear and unobstructed.

- Identification of components, where required, and safety-related instructions (operating or maintenance), if posted, must be securely attached and maintained in legible condition.
- Warning signs, where required, must be visible, securely attached and maintained in legible condition.
- Circuit or voltage identification must be securely affixed and maintained in updated and legible condition.
- Electrical cables and single and multiple conductors must be maintained free of damage, shorts and ground that would expose employees to an electrical hazard.
- Flexible cords and cables must be maintained to preserve insulation integrity.
- Cords and cables must not have worn, frayed, or damaged areas that would expose employees to an electrical hazard.
- Strain relief of cords and cables must be maintained to prevent pull from being transmitted directly to joints or terminals.
- Cords and cord caps for portable electrical equipment must be repaired and replaced by qualified personnel and checked for proper polarity, grounding and continuity prior to returning to service.
- For overhead electric lines under the employer's control, grade elevation must be maintained to preserve no less than the minimum designed vertical and horizontal clearances necessary to minimize risk of unintentional contact.

H.2 SUBSTATIONS, SWITCHGEAR ASSEMBLIES, SWITCHBOARDS, PANELBOARDS, MOTOR CONTROL CENTERS AND DISCONNECT SWITCHES

- Enclosures must be kept free of material that would expose employees to an electrical hazard.
- Fences, physical protection, enclosures or other protective means, where required to guard against unauthorized access or accidental contact with exposed energized conductors and circuit parts, must be maintained.
- Current-carrying conductors (buses, switches, disconnects, joints and terminations) and bracing must be maintained to conduct rated current without overheating and withstand available fault current.
- Insulation integrity must be maintained to support the voltage impressed.
- Protective devices must be maintained to adequately withstand or interrupt available fault current. Improper or inadequate maintenance can result in increased opening time of the overcurrent protection device, thus increasing the incident energy.

H.3 PREMISES WIRING

- Covers for wiring system components must be in place with all associated hardware. There must be no unprotected openings.
- Open wiring protection, such as location or barriers, must be maintained to prevent accidental contact.

- Raceways and cable trays must be maintained to provide physical protection and support for conductors.

H.4 CONTROLLER EQUIPMENT

This section applies to controllers, including electrical equipment that governs the starting, stopping, direction of motion, acceleration, speed and protection of rotating equipment and other power utilization equipment in the workplace.

Protection and control circuitry used to guard against accidental contact with energized conductors and circuit parts and to prevent other electrical or mechanical hazards must be maintained.

H.5 FUSES AND CIRCUIT BREAKERS

- Fuses must be maintained free of breaks or cracks in fuse cases, ferrules and insulators. Fuse clips must be maintained to provide adequate contact with fuses. Fuseholders for current-limiting fuses cannot be modified to allow the insertion of fuses that are not current-limiting. Non-current limiting fuses cannot be modified to allow their insertion into current-limiting fuseholders.
- Molded-case circuit breakers must be maintained free of cracks in cases and cracked or broken operating handles.
- Circuit breakers that interrupt faults approaching their interrupting ratings must be inspected and tested in accordance with the manufacturer's instructions.

H.6 ROTATING EQUIPMENT

- Terminal chambers, enclosures and terminal boxes must be maintained to guard against accidental contact with energized conductors and circuit parts and other electrical hazards.
- Guards, barriers and access plates must be maintained to prevent employees from contacting moving or energized parts.

H.7 HAZARDOUS (CLASSIFIED) LOCATIONS

Equipment and installations in these locations must be maintained such that the following criteria are met:

- No energized parts are exposed (exception: Intrinsically safe and non-incendive circuits).
- There are no breaks in conduit systems, fittings or enclosures from damage, corrosion or other causes.
- All bonding jumpers are securely fastened and intact.
- All fittings, boxes and enclosures with bolted covers have all bolts installed and bolted tight.
- All threaded conduit are wrench-tight and enclosure covers are tightened in accordance with the manufacturer's instructions.
- There are no open entries into fittings, boxes or enclosures that would compromise the protection characteristics.
- All close-up plugs, breathers, seals and drains are securely in place.

- Marking of lighting fixtures for maximum lamp wattage and temperature rating is legible and not exceeded.
- Required markings are secure and legible.

Annual Energized Work Permit for Routine Tasks

All electrical work must be supervised by Class 2 or 3 personnel.

1. **Circuits/equipment to be worked on:** **Location:** ☐ LPC ☐ Loop
 Live work up to 120V
 Live testing of equipment, throwing switches and breakers up to 220V
 De-energized work on equipment up to 480V

2. **Energized work must be justified.** Equipment should be de-energized using lockout/tagout procedures when work is performed within the limited approach boundary unless de-energizing introduces additional hazards/increased risk or the task to be performed is infeasible in a de-energized state due to equipment design or operational limitations. See examples of each below.

<i>Additional hazards/increased risk</i> -Interruption of life support equipment -Deactivation of emergency alarm systems -Shutdown of hazardous location ventilation equipment	<i>Infeasible due to equipment design or operational limitations</i> -Diagnostics and testing -Work on circuits that form an integral part of a continuous process that would otherwise need to be completely shut down in order to perform work on one circuit/piece of equipment
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*Conductors/circuit parts under 50V do not need to be de-energized.

By signing below, you attest that you have been trained in lockout/tagout procedures, understand when they are to be used and have access to all equipment (i.e. individual locks) needed to perform them.

Shock Risk Assessment

3. Voltage to which personnel will be exposed: 50V – 120V
4. Limited approach boundary: Exposed movable conductor: 10 ft.
Exposed fixed circuit part: 3 ft. 6 in.
5. Restricted approach boundary: Avoid contact

Arc Flash Risk Assessment

6. If arc flash label is present: Consult for incident energy at working distance and arc flash boundary

If not, consult NFPA 70E Tables 130.7(C)(15)(A)(b) for AC and 130.7(C)(15)(B) for DC

7. Arc-rated shirt and pants must be worn at all times. The following clothing/PPE is available for use depending on the job. All of it is arc-rated for 12 cal/cm².

-Jacket	-Face shield	-Cap bracket	-Rubber gloves	-Safety glasses
-Hard hat	-Chin cup	-Knit Nomex hood	-Leather protector gloves	-Ear plugs
8. Means of restricting unqualified persons access to work areas:
 -Signs -Barricades -Attendants
9. Each task should be preceded by a job briefing. See NFPA 70E Informative Annex I for guidance.

Energized Work Approvals

Employee Name & Title

Supervisor Name & Title

Employee Signature

Supervisor Signature

Date

Date

Annual Energized Work Permit for Routine Tasks

<p>1. <u>Circuits/equipment to be worked on:</u> Live work up to 120V (Supervised) Live testing of equipment, throwing switches and breakers up to 480V De-energized work on equipment up to 480V (Work above 220V must be inspected by a Class 3 person before re-energizing.)</p> <p>2. <u>Energized work must be justified.</u> Equipment should be de-energized using lockout/tagout procedures when work is performed within the limited approach boundary unless de-energizing introduces additional hazards or increased risk or the task to be performed is infeasible in a de-energized state due to equipment design or operational limitations. See examples of each below.</p> <table style="width: 100%;"> <tr> <td style="width: 50%; vertical-align: top;"> <i>Additional hazards/increased risk</i> -Interruption of life support equipment -Deactivation of emergency alarm systems -Shutdown of hazardous location ventilation equipment </td> <td style="width: 50%; vertical-align: top;"> <i>Infeasible due to equipment design or operational limitations</i> -Diagnostics and testing -Work on circuits that form an integral part of a continuous process that would otherwise need to be completely shut down in order to perform work on one circuit/piece of equipment </td> </tr> </table> <p style="text-align: center;">*Conductors/circuit parts under 50V do not need to be de-energized.</p> <p>By signing below, you attest that you have been trained in lockout/tagout procedures, understand when they are to be used and have access to all equipment (i.e. individual locks) needed to perform them.</p>	<i>Additional hazards/increased risk</i> -Interruption of life support equipment -Deactivation of emergency alarm systems -Shutdown of hazardous location ventilation equipment	<i>Infeasible due to equipment design or operational limitations</i> -Diagnostics and testing -Work on circuits that form an integral part of a continuous process that would otherwise need to be completely shut down in order to perform work on one circuit/piece of equipment	<p><u>Location:</u> <input type="checkbox"/> LPC <input type="checkbox"/> Loop</p>																
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Energized Work Approvals

Employee Name & Title

Supervisor Name & Title

Employee Signature

Supervisor Signature

Date

Date

Temporary Energized Work Permit

<p>1. <u>Circuits/equipment to be worked on:</u> List non-routine task/s</p> <hr/> <hr/>	<p><u>Location:</u> <input type="checkbox"/> LPC <input type="checkbox"/> Loop</p>																		
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Energized Work Approvals

Employee Name & Title

Supervisor Name & Title

Employee Signature

Supervisor Signature

Date

Date

APPENDIX J: PROGRAM HISTORY

Date	Revision Number	Brief Description of Changes	Review Completed by
10/15/2018	1	Updated energized work permits to include lockout/tagout information	K. Abma

ACKNOWLEDGEMENTS

This manual was developed using best practice examples from Purdue University, Federal and State regulations, NFPA 70E, *Standard for Electrical Safety in the Workplace* and guidance documents.