

1.0 Overview

Environmental Health and Safety (EHS) at Weill Cornell Medicine (WCM) has developed this Electrical Safety Plan to promote a safe work environment for employees who work with electrical systems and equipment.

2.0 Table of Contents

3.0 Objective 2

4.0 Applicability 2

5.0 Responsibilities 2

5.1 ENVIRONMENTAL HEALTH AND SAFETY (EHS)..... 2

5.2 ENGINEERING AND MAINTENANCE (E&M)..... 2

5.3 SUPERVISORS..... 3

5.4 ELECTRICAL USERS..... 3

6.0 Emergency Response 3

6.1 ELECTRICAL INJURIES..... 3

6.2 FIRE EXTINGUISHERS FOR ELECTRICAL FIRES..... 3

7.0 General Requirements 3

7.1 SAFE WORK PRACTICES 3

7.2 EXTENSION CORDS..... 4

7.3 ELECTRICAL REPAIRS OR MODIFICATIONS 4

7.3.1 Building and Laboratory Wiring, Outlet Receptacles, and Breaker Panels 4

7.3.2 Commercial Appliances, Instruments, and Equipment..... 4

8.0 Electrical Safety in the Laboratory 4

8.1 SAFE WORK PRACTICES 4

8.2 PERMANENT ELECTRICAL WIRING 5

8.3 ELECTROPHORESIS EQUIPMENT 5

8.3.1 Safe Work Practices 5

8.3.2 Electrical Leads..... 5

8.3.3 Power Supplies 5

8.3.4 Laboratory Electrical Equipment and Motors..... 6

9.0 Electrical Safety for Engineering 6

9.1 CONTROL OF HAZARDOUS ENERGY 6

9.2 SPACE AROUND ELECTRICAL EQUIPMENT..... 6

9.2.1 Spaces Around Electrical Equipment 6

9.2.2 Access and Entrances to Working Space..... 7

9.2.3 User Request..... 7

9.2.4 Headroom 7

9.2.5 Dedicated Equipment Space 7

9.3 ELECTRICAL EQUIPMENT LABELING 7

9.3.1 General Requirements..... 7

9.4 ARC FLASH HAZARD ANALYSIS..... 8

10.0 Training 9

11.0 Record Retention, Ability, and Revisions..... 9

DATE REVIEWED: May 29, 2020	DATE UPDATED: May 29, 2020	CLASSIFICATION & LOCATION: General Safety, Electrical Safety Z:\Documentation\EHS-Manual\7.8Electric.docx	PAGE: 1 of 9
---------------------------------------	--------------------------------------	--	------------------------



11.1 ARC FLASH HAZARD ANALYSIS 9
 11.2 TRAINING RECORDS 9
 11.3 REVISIONS..... 9
 12.0 References 9

3.0 Objective

The Electrical Safety Program aims to prevent exposure to hazardous electrical conditions and ensure compliance with the regulatory requirements applicable to electrical systems. The hazards associated with electricity are electrical shock and fire.

All work on electrical equipment must be performed in a de-energized state unless de-energizing introduces an increased hazard or is not feasible (such as voltage testing to troubleshoot).

This program is designed to provide guidance protect the WCM community from electrical hazards and ensure that any energized electrical work is performed safely by qualified electrical workers who have the proper training and who utilize safe work procedures, personal protective equipment, and other safety controls.

4.0 Applicability

This program applies to anyone who may be exposed to electrical hazards at WCM, including all employees, students, contractors, and volunteers working in the laboratory, clinical, and administrative/service work environments.

5.0 Responsibilities

5.1 ENVIRONMENTAL HEALTH AND SAFETY (EHS)

EHS duties include:

- Assist the WCM community in the implementation of this program.
- Provide or coordinate general training for groups on the content of this program, as requested.
- Impart or assist in training for electrical work qualifications.
- Retain all training records.
- Review and update this written program periodically.
- Assess work being performed and determine compliance with this program.
- Evaluate the overall effectiveness of the electrical safety program regularly.

5.2 ENGINEERING AND MAINTENANCE (E&M)

E&M responsibilities include:

- Assist employees in the implementation of electrical safety practices addressed in this program.
- Ensure employees comply with all provisions of the electrical safety program.
- Verify that employees receive training appropriate to their assigned electrical tasks.
- Develop and maintain a listing of all qualified employees under their supervision.
- Confirm that employees receive and use appropriate protective equipment.
- Coordinate the completion of arc flash analyses required by this program as needed and during equipment replacement or upgrading.
- Minimize electrical hazards through the application of engineering and design controls.
- Promote consistency in electrical installations throughout the various facilities.
- Report any safety concerns regarding electrical installations to EHS.

DATE REVIEWED: May 29, 2020	DATE UPDATED: May 29, 2020	CLASSIFICATION & LOCATION: General Safety, Occupational Safety Z:\Documentation\EHS-Manual\7.8Electric.docx	PAGE: 2 of 9
--------------------------------	-------------------------------	---	-----------------



5.3 SUPERVISORS

Supervisors must:

- Assist employees in the implementation of electrical safety practices addressed in this program.
- Ensure that employees comply with all provisions of the electrical safety program.
- Confirm that employees receive training appropriate to their assigned electrical tasks.
- Verify that employees receive and use appropriate protective equipment.

5.4 ELECTRICAL USERS

Electrical users are required to:

- Follow the work practices described in this document, including the use of appropriate protective equipment and tools.
- Attend all required training relative to this program.
- Report any concerns related to electrical safety to their supervisor immediately.

6.0 Emergency Response

6.1 ELECTRICAL INJURIES

If someone has received an electrical shock, do not touch the person, equipment, or cord. Call EMS immediately: 212-472-2222 on campus (2-2222 from a campus phone) or 911.

If it is safe to do so, disconnect the power source immediately, and do not touch any power source or energized equipment if unsure whether it is safe to do so.

6.2 FIRE EXTINGUISHERS FOR ELECTRICAL FIRES

If an electrical fire occurs, leave the area immediately and follow your [Building Specific Fire Safety and Emergency Action Procedure](#).

If it is safe to do so, shut down the power source while exiting the area.

Only employees trained in the use of a fire extinguisher may use one to extinguish an electrical fire. A type C fire extinguisher must be used on electrical fires. Any fire extinguisher that does not have type C classification may NOT be used to extinguish an electrical fire. The ABC or BC fire extinguishers installed in many locations on campus are also suitable for electrical fires.

7.0 General Requirements

7.1 SAFE WORK PRACTICES

- Inspect wiring of equipment before each use. Replace damaged or frayed electrical cords immediately and do not use equipment that has damaged or frayed electrical cords.
- Use safe work practices every time electrical equipment is used.
- Know the location and how to operate shut-off switches and/or circuit breaker panels. Use these devices to shut off equipment in the event of a fire, electric shock, or electrocution.
- Limit the use of extension cords. Use only for temporary operations. In all other cases, request installation of a new electrical outlet.

DATE REVIEWED: May 29, 2020	DATE UPDATED: May 29, 2020	CLASSIFICATION & LOCATION: General Safety, Occupational Safety Z:\Documentation\EHS-Manual\7.8Electric.docx	PAGE: 3 of 9
---------------------------------------	--------------------------------------	--	------------------------



7.2 EXTENSION CORDS

Extension cords are only permitted for temporary operations.

The following requirements apply to the use of extension cords:

- Extension cords must be visually inspected before use for external defects such as loose parts, deformed or missing pins, damage to outer jacket or insulation, or possible internal damage such as a pinched or crushed outer jacket.
- Extension cords must be of the three-wire type and designed for hard or extra hard usage (for example, types S, ST, and SO). The rating or approval must be visible.
- Extension cords must be protected from damage and cannot be run through windows or doors unless protected from damage, and only on a temporary basis. Extension cords may not be draped above ceilings or inside or through walls, ceilings or floors, and may not be fastened with staples or otherwise hung in such a fashion as to damage the outer jacket or insulation.
- Extension cords must be covered by a cord protector or tape when they extend into a walkway or other path of travel to avoid creating a trip hazard.

Any defective cords or damaged cords must be removed from service and immediately discarded, or tagged and repaired by a qualified person.

7.3 ELECTRICAL REPAIRS OR MODIFICATIONS

Electrical repairs and modifications may only be performed by a qualified person.

Unauthorized modifications are not permitted.

7.3.1 Building and Laboratory Wiring, Outlet Receptacles, and Breaker Panels

Any modifications to existing electrical service in a laboratory or building must be approved by and coordinated with E&M. E&M or a licensed electrician must perform maintenance or modifications to existing electrical service such as breaker panels, outlet receptacles, wall switches, or wiring.

Laboratory personnel may only reset ground fault circuit interrupters (GFCIs). E&M must be contacted to shut off or reset tripped breakers.

7.3.2 Commercial Appliances, Instruments, and Equipment

Maintenance or modifications to commercial appliances, instruments, and equipment may only be performed by the manufacturer or an authorized service representative. Any interfaces with the college electrical system must be coordinated with E&M.

8.0 Electrical Safety in the Laboratory

In addition to the General Electrical Safety requirements, the following are requirements specific to electrical safety in the laboratory. This section applies to all staff conducting work in a laboratory at WCM.

8.1 SAFE WORK PRACTICES

- Keep corrosive chemicals and organic solvents away from electrical cords, as these can easily erode the insulation on wires.
- Keep flammable materials away from electrical equipment.
- Extension cords and outlet strips are not permitted in chemical hoods or areas where flammable vapors may be present.

DATE REVIEWED: May 29, 2020	DATE UPDATED: May 29, 2020	CLASSIFICATION & LOCATION: General Safety, Occupational Safety Z:\Documentation\EHS-Manual\7.8Electric.docx	PAGE: 4 of 9
---------------------------------------	--------------------------------------	--	------------------------



- When it is necessary to handle equipment that is plugged in, be sure hands are dry and, when possible, wear nonconductive gloves and shoes with insulated soles.
- Minimize the use of electrical equipment in cold rooms or other areas where condensation is likely. If equipment must be used in such areas, mount the equipment on a wall or vertical panel.
- If water or a chemical is spilled onto equipment, shut off power at the main switch or circuit breaker and unplug the equipment.
- Ensure that any equipment used near water sources is plugged into outlets with ground-fault circuit interrupter (GFCI) capability.

8.2 PERMANENT ELECTRICAL WIRING

Permanent electrical outlets must be installed for all stationary electrical equipment (e.g., refrigerators, freezers). Stationary electrical equipment may not be plugged into extension cords, power strips, or other non-permanent outlets.

8.3 ELECTROPHORESIS EQUIPMENT

Electrophoresis equipment can pose a significant electrical hazard. This equipment is capable of providing a lethal shock if used improperly.

8.3.1 Safe Work Practices

- All pieces of equipment must be inspected before each use.
- All leads and power cords must be inspected for any deficiencies in insulation and other damages.
- All equipment must be operated as detailed in the manufacturer's instructions.
- **All employees must be trained on the proper use of electrophoresis equipment before use.**
- Exposed parts and gel chamber must be guarded against accidental contact. Gel chamber must have a lid or interlocked cover to prevent accidental contact with energized electrodes or buffer solution.
- Equipment must always be attended while energized.
- Equipment must be kept clear of all conductors and grounding points (water sources, metal plates, jewelry, aluminum foil, etc.)
- Turn off all equipment before opening the gel chamber.

8.3.2 Electrical Leads

- Turn off the power supply before connecting or disconnecting leads.
- Always connect leads with dry hands.
- Leads must be connected one at a time, using one hand only.

8.3.3 Power Supplies

- Equipment must be labeled with a "Danger" warning
- Equipment must have 3-prong plugs with a proper ground prong.
- Power supplies may only be connected to power strips if they have safety features that detect changes in load, no-load, overload, short circuits, and ground leaks.

DATE REVIEWED: May 29, 2020	DATE UPDATED: May 29, 2020	CLASSIFICATION & LOCATION: General Safety, Occupational Safety Z:\Documentation\EHS-Manual\7.8Electric.docx	PAGE: 5 of 9
---------------------------------------	--------------------------------------	--	------------------------



8.3.4 Laboratory Electrical Equipment and Motors

In areas where volatile flammable materials are used, motor-driven electrical equipment should be equipped with non-sparking induction motors or air motors. Avoid series-wound motors, (e.g., vacuum pumps, rotary evaporators and stirrers, blenders, mixers, vacuum motors, and power drills).

If non-intrinsically safe equipment is used, flammable vapors must be adequately controlled prior to using any of this equipment in a laboratory, and control must be verified by standard EHS ventilation-inspection procedures.

9.0 Electrical Safety for Engineering

9.1 CONTROL OF HAZARDOUS ENERGY

The Hazardous Energy Control (Lockout/Tagout) Program aims to protect employees from exposure to all forms of hazardous energy while performing maintenance or work on WCM equipment, systems, and/or utilities. Equipment is isolated from energy sources and injuries to workers are prevented by using specific procedures that involve applying locks and tags. Refer to the [EHS Manual 7.4 – Hazardous Energy Control \(Lockout/Tagout\)](#) for more information.

9.2 SPACE AROUND ELECTRICAL EQUIPMENT

9.2.1 Spaces Around Electrical Equipment

- **Access.** Sufficient access and working space shall be provided and maintained around all electric equipment to permit ready and safe operating and maintenance of such equipment. Enclosures that house electric apparatus and are controlled by lock and key must be accessible to qualified persons only.
- **Working Space.** Working space for equipment operating at 600 volts, nominal, or less to ground, and likely to require examination, adjustment, service or maintenance while energized; shall comply with the dimensions of 1910.303(g) Table S-1 or, as required or permitted elsewhere in the OSHA Subpart S Standard.
- **Depth of Working Space.** The depth of the working space in the direction of access to live parts may not be less than indicated in NFPA 70E. Distances shall be measured from the live parts if they are exposed; or from the enclosure front or opening if they are enclosed.
- **Dead-front Assemblies.** Working space is not required in the back or sides of assemblies (such as dead-front switchboards or motor control centers) where all connections and all renewable or adjustable parts (such as fuses or switches) are accessible from locations other than the back or sides. Where rear access is required to work on non-electrical or de-energized parts on the back of enclosed equipment, a minimum horizontal working space of 762mm (30 in) shall be provided.
- **Low Voltage.** Smaller working spaces are permitted where all insulated parts operate at not greater than 30 volts RMS, 42 volts peak, or 60 volts dc.
- **Existing Buildings.** In existing buildings where electric equipment is being replaced, Condition B working clearance shall be permitted between dead-front switchboards, panelboards, or motor control centers located across the aisle from each other. Conditions of maintenance and supervision and written procedures must be adopted to prohibit equipment on both sides of the aisle from being open at the same time. Qualified and authorized electrical workers must service the installation.
- **Width of Working Space.** The width of the working space in front of the electrical equipment shall be the width of the equipment or 762 mm (30 in), whichever is greater. In all cases, the work space shall permit at least a 90-degree opening of equipment doors or hinged panels.
- **Height of Working Space.** The work space shall be clear and extend from the grade, floor, or platform to the height required by paragraph (g)(1)(vi) of the Subpart S 1910.303 standard. However, other equipment associated with the

DATE REVIEWED: May 29, 2020	DATE UPDATED: May 29, 2020	CLASSIFICATION & LOCATION: General Safety, Occupational Safety Z:\Documentation\EHS-Manual\7.8Electric.docx	PAGE: 6 of 9
---------------------------------------	--------------------------------------	--	------------------------



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.

- **Clear Spaces.** Working space required by the Subpart S 1910.303(g) Table S-1 standard shall not be used for storage. When usually enclosed live parts operating at 50 volts or more are exposed for inspection or service, the working space must be adequately guarded if in a passageway or general open area.

9.2.2 Access and Entrances to Working Space

- **Minimum Required.** At least one entrance of sufficient area must access the working space about electric equipment.
- **Large Equipment.** On switchboards, overcurrent devices, and control panels on equipment rated 1200 amperes or more and over 1.83 m (6.0 ft.) in width, there shall be one entrance at each end of the working space. If the location of the equipment permits a continuous and unobstructed way of exit travel, or unless the workspace is doubled, only one means of exit is required.
- **Unobstructed Exit.** Where the location permits a continuous and unobstructed way of exit travel, a single exit to the working space is allowed.

9.2.3 User Request

- **General.** Employees shall not enter spaces containing electrical hazards unless there is sufficient illumination that enables the employees to perform the work safely. Lighting must be able to be manually controlled.
- **Obstructed View of Work Area.** Where lack of illumination or an obstruction precludes observation of the work to be performed, employees shall not perform any task within the Limited Approach Boundary of energized electrical conductors, or circuit parts operating at 50 volts, or more or where an electrical hazard exists.

9.2.4 Headroom

The minimum headroom of working spaces above service equipment, switchboards, panelboards, 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.

9.2.5 Dedicated Equipment Space

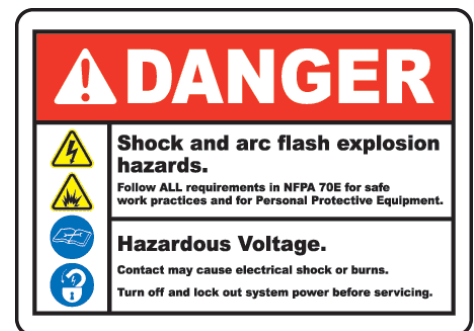
All switchboards, panelboards, distribution boards, and motor control centers shall be located in dedicated spaces and protected from damage. As an exception, control equipment that, by its very nature or because of other rules of the standard, must be adjacent to or within sight of the operating machinery shall be permitted in those locations.

9.3 ELECTRICAL EQUIPMENT LABELING

Article 110.16 of the NEC 2020 code requires switchboards, panel boards, industrial control panels, motor control centers, and service equipment rated 1200 amps or more to be field or factory marked to warn workers of potential electric arc flash hazards.

9.3.1 General Requirements

- The term “Industrial Control Panel” must be visible on every enclosure that may contain exposed energized conductors or components.
- Markings are designed to reduce the occurrence of severe injury or death due to arcing faults to workers working on or near energized electrical equipment.
- Markings (labels) shall be located so they are visible to personnel before the examination, adjustment, servicing, or maintenance of the equipment.



DATE REVIEWED: May 29, 2020	DATE UPDATED: May 29, 2020	CLASSIFICATION & LOCATION: General Safety, Occupational Safety Z:\Documentation\EHS-Manual\7.8Electric.docx	PAGE: 7 of 9
---------------------------------------	--------------------------------------	--	------------------------



- The DANGER label should be used to notify a qualified worker who intends to open the equipment for analysis or work of the following:
 - Electric arc flash hazard exists
 - Turn off all power before opening
 - Follow all requirements of NFPA 70E for safe work practices and wear appropriate personal protective equipment (PPE) for the specific hazard.
- When arc flash and shock data are available for industrial control panels, WARNING labels must include information on flash hazard boundary, the hazard category, required PPE, minimum arc rating, limited approach distances, restricted approach distances, and prohibited approach distances.
- Labels for service equipment must include the nominal system voltage, available fault current at the service overcurrent protective devices, clearing time of overcurrent protective devices, and the date the label was applied.
- Unqualified person(s) may not be near open energized equipment.

⚠ WARNING

Arc Flash & Shock Hazard Appropriate PPE Required

<p>ARC FLASH HAZARD PROTECTION</p> <p>Hazard Risk Category: 2</p> <p>Incident Energy (cal/cm²): 7.27 at 18in.</p> <p>Arc Flash Boundary: 54in.</p> <p>208 VAC Shock Hazard When Cover is Removed</p> <p>Shock Protection Boundaries:</p> <p>Limited Approach Boundary: 42 in.</p> <p>Restricted Approach Boundary: 12 in.</p> <p>Prohibited Approach Boundary: 1 in.</p> <p>Equipment ID: 001-BUS</p>	<p>PPE Min. Arc Rating For AR PPE (cal/cm²): 8</p> <ul style="list-style-type: none"> ■ AR Jacket & Pants; Shirt & Pants; Coveralls ■ AR Face Shield or Arc Flash Suit Hood ■ Hard Hat ■ Sock Hood (Balaclava) ■ Safety Glasses or Safety Goggles ■ Hearing Protection (ear canal inserts) ■ Leather Gloves ■ Leather Work Shoes
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Date of Analysis: 1/25/2012

9.4 ARC FLASH HAZARD ANALYSIS

An arc flash hazard analysis is required for all work presenting an arc flash hazard.

A hazard analysis includes the following steps:

1. Collect data on the facility's power distribution system:
 - Arrangement of components on a one-line drawing with nameplate specifications of every device.
 - Lengths and cross-section area of all cables.
 2. Contact the electrical utility (i.e., ConEd) or WCM E&M for information including the minimum and maximum fault currents that can be expected at the entrance to the facility.
 3. Conduct a short circuit analysis followed by a coordination study.
 4. Feed the resultant data into the NFPA 70E-2020 or IEEE Standard 1584-2002 equations.
 - These equations produce the necessary **flash protection boundary distances** and **incident energy** to determine the minimum PPE requirement.
 - The **flash protection boundary** is the distance at which PPE is needed to prevent incurable burns (2nd degree or worse) if an arc flash occurs. (It is still possible to suffer 1st or 2nd-degree burns).
- For systems of 600 volts and less, the flash protection boundary is 4 feet, based on an available bolted fault current of 50 kA (kiloamps) and a clearing time of 6 cycles (0.1 seconds) for the circuit breaker to act, or any combination of fault currents and clearing times not exceeding 300 kA cycles (5000 ampere-seconds).
 - For other fault currents and clearing times, see NFPA 70E.
 - If an arc flash analysis has not been performed, refer NFPA 70E for proper PPE.
 - The analysis should be updated when changes occur in the electrical distribution system that can affect the results of the study, and should be reviewed for accuracy at a minimum every five years.

<p>DATE REVIEWED: May 29, 2020</p>	<p>DATE UPDATED: May 29, 2020</p>	<p>CLASSIFICATION & LOCATION: General Safety, Occupational Safety Z:\Documentation\EHS-Manual\7.8Electric.docx</p>	<p>PAGE: 8 of 9</p>
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10.0 Training

Each department must maintain documentation of training and experience of Qualified Electrical Workers.

Documentation is necessary to demonstrate that individuals have met the training and experience requirements for the types of work being performed. Retraining in safety-related work practices and applicable changes to any relevant standards must be completed at a minimum every three years, and more frequently if additional training is considered necessary.

11.0 Record Retention, Ability, and Revisions

11.1 ARC FLASH HAZARD ANALYSIS

Supervisors are responsible for maintaining all hazard analyses for 1 year.

11.2 TRAINING RECORDS

Individual departments must maintain training of qualified workers. EHS will retain all other training records.

11.3 REVISIONS

EHS will review the Electrical Safety Program annually. The program will be revised should any deficiencies be identified during the annual review. Updates to the OSHA or NFPA 70E standards will prompt a review of this manual.

12.0 References

- Occupational Safety and Health Administration (29 CFR 1910 Subpart S, “Electrical”; 29 CFR 1910.147, “The Control of Hazardous Energy)
- National Fire Protection Association (70-E “Standard for Electrical Safety in the Workplace” 2020 Edition)
- Institute of Electrical and Electronics Engineers (Standard 1584-2002, “Guide for Performing Arc Flash Hazard Calculations”)

DATE REVIEWED: May 29, 2020	DATE UPDATED: May 29, 2020	CLASSIFICATION & LOCATION: General Safety, Occupational Safety Z:\Documentation\EHS-Manual\7.8Electric.docx	PAGE: 9 of 9
---------------------------------------	--------------------------------------	--	------------------------