



Health & Safety Standard Operating Procedure

SOP-02

Electrical Safety

Produced by

Health & Safety – Facilities & GS Department

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SOP-02: Electrical Safety

1 Overview

1.1 Purpose

The purpose of this Health, Safety and Environment (**HS**) Standard Operating Procedure (**SOP**) is to provide a detailed procedure pertaining to electrical safety associated with activities undertaken at Qatar University (**QU**).

1.2 Hazards and Risks

1.2.1 Electrical Hazards

An electrical hazard is a dangerous condition such that contact or equipment failure can result in electric shock, arc flash burn, thermal burn, or blast.

Electrical hazards also include being exposed to live electricity through contact with live wires or working near high voltage overhead conductors, transformers or electrical switchgear.

1.2.2 Risks and Potential Outcomes

Major impacts of electrical hazards include electric shock, arc flash/blast, and fires. These impacts can result in explosions, burns, electrocution, and death.

The severity and effects of an electrical shock depend on a number of factors, such as the pathway through the body, the amount of current and the length of the exposure time. Other factors that may affect the severity of the shock are the voltage of the current, presence of moisture in the environment, the phase of the heart cycle when the shock occurs, and the general health of the person prior to the shock.

Arc flash/blast occurs when electric current flows through air gaps between conductors. Typical results from an arc flash/blast include:

- Burns (Non fire resistant clothing can burn onto skin)
- Fire (could spread rapidly through a building)
- Flying objects (often molten metal)
- Blast pressure (upwards of 9,750 kilogram-force / sq. meter)
- Sound Blast (noise can reach 140 dB – loud as a gun)
- Heat (upwards of 19,500 degrees C)

Sparks from electrical devices can serve as an ignition source for flammable or explosive vapours or combustible material.

1.3 Key Terminology

Table 1. Key Terms

Term	Definition
Insulator	An insulator is a substance with such a high resistance that it can be used to prevent the flow of electrical current.
Grounding	Grounding refers to the process of connecting an object directly to ground, the earth, or to a conductive body that extends the ground connection.
Arc flash	A flashover of electric current leaves its intended path and travels through the air from one conductor to another, or to ground. The results are often violent and when a human is in close proximity to the arc flash, serious injury and even death can occur.
Qualified worker or person	One who has demonstrated skills and knowledge related to the construction and operation of electrical equipment and installations and has received safety training to identify and avoid the hazards involved.
Ground fault circuit interrupter (GFCI)	A device intended 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 the values established

2 Scope

The requirements outlined in this SOP are applicable to all QU workers, students, contractors, and visitors who are working for QU, and/or conducting work on QU premises. The following subsections outline some of routine and non-routine activities in which the conditions covered by this technical guidance may be encountered.

2.1 Routine

Electricity is integral to all areas of QU. It presents the greatest hazard and risk during the following routine activities:

- General office work involving electrically powered equipment
- Routine building maintenance
- Use of laboratory equipment
- Use of kitchen equipment

2.2 Non-routine

QU workers or contractors may be involved in or near non-routine activities that present electrical hazards. These could include:

- Testing or maintenance of building-wide or campus-wide electrical systems
- Opening of electrical panels, switchgear, or transformers
- Construction activities near overhead electrical wires
- Underground construction activities near buried electrical wires

3 Roles and Responsibilities

Each employee should be on the alert for hazardous conditions and promptly report any to the Health & Safety Section (**HS**).

The department is responsible for the correction of any operational deficiencies that are discovered. Facility deficiencies must be reported to the HS.

The QU Departments are the primary organization responsible to implement and maintain sound electrical safety practices and that assure safety compliance in their respective areas.

3.1 VPs, Deans, Directors, Managers, Head Sections

VPs, Deans, Directors, Managers, Head Sections/Units and Project Managers have the primary responsibility of directing and managing electrical safety and therefore have responsibility for assuring sound safety practices and compliance within the Department and Colleges. They are ultimately responsible for enforcing consequences arising from moderately serious and very serious incidents.

3.2 Employees, Contractors and Students

Employees, contractors and students are responsible for compliance with safety regulations and this SOP, as applicable.

3.3 Health & Safety Section (HSS)

The HSS is responsible for Electrical Safety Orientation on an annual basis or as need arises to all workers, faculties, and students.

4 Risk Prevention

4.1 General Prevention Requirements

The following prevention practices should be followed to minimize the potential risk associated with electrical hazards:

- Ensure a competent person is engaged / called to perform tasks on exposed live electrical components.
- Use double-insulated tools.
- Ground all exposed metal parts of a device.
- Use all equipment devices according to the manufacturer's instructions.
- Do not modify cords or use them incorrectly.
- Inspect wiring of equipment devices before each use.
- Replace damaged or frayed electrical cords immediately.
- 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 the equipment in the event of a fire or electrocution.
- Limit the use of extension cords. Use only for temporary operations and only for short periods of time. In all other cases, request installation of a new electrical outlet.

- Multi-plug adapters must have circuit breakers or fuses.
- Place exposed electrical conductors behind shields.
- Minimize the potential for water or chemical spills on or near electrical equipment.
- Equipment and electronic systems must conform to the National Electric Code, National Fire Protection Association Code (NFPA) 70E and KAHRAMAA requirements. Compliance must be adjudicated by licensed electricians or duly trained personnel.
- Insulated tools or handling equipment shall be used by staff working near exposed energized conductors or circuit parts if the tools or handling equipment might make contact with such conductors or parts. If the insulating capability of insulated tools or handling equipment is subject to damage, the insulating material shall be protected.
- Protective shields, protective barriers, or insulating materials must be used to protect workers from shock, burns, or other electrically related injuries while staff are working near exposed energized parts which might be accidentally contacted or where dangerous electric heating or arcing might occur. Under no circumstances may a non-qualified person be within the limited approach boundary of exposed energized equipment.
- When normally enclosed live parts are exposed for maintenance or repair, they are to be guarded to protect unqualified persons from contact with the live parts.
- Fuse Handling Equipment insulated for the circuit voltage shall be used to remove or install fuses when the fuse terminals are energized.
- Ropes and Hand-lines used near exposed energized parts shall be nonconductive.

4.2 Maintenance, Inspection and Testing

QU shall ensure that an appropriate inspection, maintenance and testing arrangements are in place for all electrical systems. Where a contractor is responsible for the electrical systems, QU shall ensure prior to engaging the contractor, that they have an appropriate inspection, maintenance and testing program in place.

QU shall periodically review the effectiveness of their maintenance, inspection and testing provisions to determine on-going asset performance/condition, and maintenance effectiveness.

4.3 Specific Prevention Methods

4.3.1 Insulation

All electrical cords should have sufficient insulation to prevent direct contact with wires and should be checked prior to each use. Before each use, portable cord- and plug-connected equipment shall be visually inspected for external defects (such as loose parts or deformed and missing pins) and for evidence of possible internal damage (such as a pinched or crushed outer jacket).

If there is a defect or evidence of damage that might expose a worker to injury, the defective or damaged item shall be removed from service. No worker shall use it until a person(s) qualified to perform the repairs and tests necessary to render the equipment safe has done so.

4.3.2 Guarding

Live parts of electric equipment operating at 50 volts or more must be guarded against accidental contact. Plexiglas shields may be used to protect against exposed live parts.

4.3.3 Grounding

When properly done, current from a short or from lightning follows this path, thus preventing the buildup of voltages that would otherwise result in electrical shock, injury and even death.

System or service ground consists of a wire called “the neutral conductor” grounded at the transformer and again at the service entrance of the building. This is primarily designed to protect machines, tools and insulation against damage.

Equipment ground is intended to offer enhanced protection to the workers themselves. If a malfunction causes the metal frame of a tool to become energized, the equipment ground provides another path for the current to flow through the tool to the ground. Grounded equipment has a power cord equipped with a three-pronged plug.

4.3.4 Circuit Protection Devices

Circuit protection devices are designed to automatically limit or shut off the flow of electricity in the event of a ground-fault, overload or short circuit in the wiring system. Fuses, circuit breakers, and ground-fault circuit interrupters are three well-known examples of such devices.

Fuses and circuit breakers prevent over-heating of wires and components that might otherwise create fire hazards. They disconnect the circuit when it becomes overloaded. This overload protection is very useful for equipment that is left on for extended periods of time.

The ground-fault circuit interrupter, or GFCI, is designed to shutoff electric power if a ground fault is detected, protecting the user from a potential electrical shock. The GFCI is particularly useful near sinks and wet locations. Since GFCIs can cause equipment to shutdown unexpectedly, they may not be appropriate for certain apparatus. Portable GFCI adapters (available in most safety supply catalogs) may be used with a non-GFCI outlet.

4.3.5 Motors

Motor-driven electrical equipment should be equipped with non-sparking induction motors or air motors. These motors must meet National Electric Safety Code, NFPA 70E, Class 1, Division 2, Group C-D explosion resistance specifications and/or QCS 2010 Electrical Standards.

Avoid series-wound motors, such as those generally found in some vacuum pumps, rotary evaporators and stirrers. Series-wound motors are also usually found in household appliances such as blenders, mixers, vacuum cleaners and power drills. These appliances should not be used unless flammable vapors are adequately controlled.

5 Safe Work Practices

5.1 General Work Practices

The following practices may reduce risk of injury or fire when working with electrical equipment and must be followed by all workers unless specifically qualified:

- Avoid contact with energized electrical circuits. All electrical circuit conductors and circuit parts shall be considered energized until the source(s) of energy is (are) removed.
- Follow the buddy system when performing electrical works.
- Disconnect the power source before servicing or repairing electrical equipment/devices.
- 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 expected. If equipment must be used in such areas, mount the equipment on a wall or on a vertical panel.
- If water or a chemical is spilled over equipment, shut off the power at the main switch or circuit breaker and unplug the equipment.
- If an individual has come in contact with a live electrical conductor, do not touch the equipment, cord or the individual. Disconnect the power source from the circuit breaker or pull out the plug using a leather belt.
- Avoid contact with known hazards such as “high voltage”, “high temperature”, “possible shock”, “wear protective equipment”, etc.
- Repairs of high voltage or high current equipment should be performed only by trained electricians.
- Before staff and contractors may be exposed to or work on or near live parts or circuits they must be de-energized unless the employer can demonstrate that de-energizing introduces additional or increased hazards or is unfeasible due to equipment design or operational limitations.
- If the exposed live parts are not de-energized (i.e., for reasons of increased or additional hazards or unfeasibility), only qualified workers may perform work within the area. Additional safety related work practices shall be used to protect staff and contractors who may be exposed to the electrical hazards involved. Such work practices shall protect staff and contractors against contact with energized circuit parts directly with any part of their body or through some other conductive object. The work practices that are used shall be suitable for the conditions under which the work is to be performed and for the voltage level of the exposed electric conductors or circuit parts.

5.2 Specific Work Practices

A qualified worker is one who has demonstrated skills and knowledge related to the construction and operation of electrical equipment and installations and has received safety training to identify and avoid the hazards involved. Only qualified workers may work on electric circuit parts or equipment that has not been de-energized. Equipment or electric circuit parts should be de-energized following lock-out / tag-out procedures, if

possible, prior to performing work. Refer to HSEMS Technical Guidance TG-02 Lockout / Tagout for additional information.

If equipment cannot be de-energized and due to the unique hazards to which qualified workers may be exposed, the following safety precautions must be followed:

- Staff and contractors shall not enter spaces containing exposed energized parts, unless illumination is provided that enables the staff to perform the work safely.
- Staff and contractors are not to perform tasks on or near exposed energized parts where there is a lack of illumination or an obstruction which precludes observation of work to be performed.
- For confined or enclosed work spaces, prior to entry staff and contractors must be trained in the confined space entry requirements. For staff and contractors working in confined or enclosed spaces such as manholes or vaults that contain exposed energized parts, they shall be provided with protective shields, protective barriers, or insulating materials as necessary to avoid inadvertent contact with these parts. Doors, hinged panels and the like shall be secured to prevent their swinging into staff and causing the staff and contractor to contact exposed energized parts.
- Conductive materials or equipment that is in contact with any part of a staff member or contractor's body shall be handled in a manner that will prevent the staff from contacting exposed energized conductors or circuit parts.
- If a worker must handle long dimensional conductive objects (such as ducts and pipes) in areas with exposed live parts, the employer shall institute work practices (such as the use of insulation, guarding, and material handling techniques) which will minimize the hazard.
- All portable ladders shall be non-conductive if to be used by staff and contractors exposed to energized parts.
- Staff and contractors are not allowed to wear conductive articles of jewellery and clothing such as watch bands, bracelets, rings, key chains, necklaces, metalized aprons, cloth with conductive thread, or metal headgear if they might contact exposed energized parts. However, such articles may be worn if rendered non-conductive by covering or wrapping with an insulating material.
- Housekeeping duties shall not be performed close enough for possible contact with live parts, unless adequate safeguards such as insulating equipment or barriers are provided.
- Electrically conductive cleaning materials including conductive solids such as steel wool, metalized cloth, and silicon carbide, as well as conductive liquid solutions shall not be used near energized parts unless procedures are followed which prevent electrical contact.
- Only qualified workers are allowed to defeat an electrical safety interlock following the above specified procedures for working on or near exposed energized parts, and then only temporarily while they are working on the equipment. Also, the interlock system will be returned to its operable condition when this work is completed and verified to be operational.

5.3 Use of Equipment

The following precautions apply when using electrically powered equipment.

5.3.1 General precautions

- All portable electric equipment and flexible cords used in highly conductive work locations, such as those with water or other conductive liquids, or in places where staff are likely to contact water or conductive liquids must be approved for those locations.
- Workers' hands shall not be wet when plugging and unplugging flexible cords and cord-and-plug connected equipment, if energized equipment is involved. If the connection could provide a conducting path to staff hands, (if, for example, a cord connector is wet from being immersed in water) the energized plug and receptacle connections must be handled only with insulating protective equipment. Locking-type connectors shall be properly locked into connector
- Where flammable or ignitable materials are present only occasionally, electric equipment capable of igniting them shall not be used unless measures are taken to prevent hazardous conditions from developing. Materials include, but are not limited to; flammable gases, vapours, or liquids; combustible dust; and ignitable fibers or fillings.

5.3.2 Portable equipment

- Portable electrical equipment applies to the use of cord and plug connected equipment and flexible cord sets (extension cords).
- Portable equipment shall be handled in a manner which will not cause damage. Flexible electric cords connected to equipment may not be used for raising or lowering the equipment.
- Flexible cords are not to be fastened with staples or otherwise hung in such a fashion as to damage the outer jacket or insulation.
- Portable cord and plug connected equipment and flexible cord sets (extension cords) shall be visually inspected before use on any shift for external defects such as loose parts, deformed and missing pins, or damage to outer jacket or insulation and for possible internal damage such as pinched or crushed outer jacket.
- When defects or evidence of damage which might expose staff to injury are detected, the defective or damaged item shall be removed from service and no person shall use it until it is repaired and tested to ensure it is safe for use.

5.3.3 Grounded equipment

- Flexible cords used with grounded equipment shall contain an equipment grounding conductor.
- Attachment plugs and receptacles may not be connected or altered in any manner which would prevent proper continuity of the equipment grounding conductor at the point where plugs are attached to receptacles. Additionally, these devices may not be altered to allow the grounding pole to be inserted into current connector slots. Clipping the grounding prong from an electrical plug is prohibited.
- Adapters which interrupt the continuity of the equipment grounding connection may not be used.

5.3.4 Electric Power and Lightings Circuits

- Load rated switches, circuit breakers, or other devices specifically designed as disconnecting means shall be used for the opening, reversing, or closing of circuits under load conditions.
- Cable connectors not of the load-break type, fuses, terminal lugs, and cable splice connections may not be used for opening, reversing, or closing circuits under load conditions except in an emergency.
- After a circuit is de-energized by a circuit protective device (e.g., blown fuse, tripped GFCI), the circuit may not be manually re-energized until it has been determined that the equipment and circuit can be safely energized. The repetitive manual re-closing of circuit breakers or re-energizing circuits through replaced fuses is prohibited. When it can be determined from the design of the circuit and over current devices involved that the automatic operation of a device was caused by an overload rather than a fault condition, no examination of the circuit or connected equipment is needed before the circuit is re-energized.
- Over-current protection of circuits and conductors may not be modified, even on a temporary basis.

5.3.5 Test Equipment and Instruments

- Only qualified persons may perform testing work on electric circuits or equipment.
- Test instruments and equipment including all associated test leads, cables, power cords, probes and connectors shall be visually inspected for external defects and damage before the equipment is used. If there is a defect or evidence of damage that might expose a worker to injury, the defective or damaged item shall be removed from service, tagged out of service and no staff may use it until repairs and tests necessary to render the equipment safe have been made.
- Test instruments, equipment, and their accessories shall be rated for the circuits and equipment to which they will be connected and designed for the environment in which they will be used.

5.4 Personal Protective Equipment (PPE)

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

The following general requirements apply to PPE used to guard against electrical hazards:

- Protective equipment shall be maintained in a safe, reliable condition, and periodically inspected or tested.
- If the insulating capability of protective equipment may be subject to damage during use, the insulating material shall be protected by covering with leather or other appropriate materials.
- Nonconductive head protection shall be worn whenever there is danger of head injury from electric shock or burn due to contact with exposed energized parts.

- Protective equipment for the eyes or face shall be worn whenever there is danger of injury to the eyes or face from electric arcs, flashes or flying objects resulting from electrical explosion.

5.5 Warning devices

The following alerting techniques are used to warn and protect staff from electrical shock hazards, burns, or failure of electric equipment parts.

- Safety signs, safety symbols, or accident prevention tags are to be used where necessary to warn staff about electrical hazards which may endanger them.
- Barricades are used in conjunction with safety signs where necessary to prevent or limit staff access to work areas exposing staff to un-insulated energized conductors or circuit parts. Conductive barricades may not be used where they might cause an electrical contact hazard.
- If signs and barricades do not provide sufficient warning from electrical hazards, an attendant is to be stationed to warn and protect staff.

6 Training

Workers exposed to an electrical hazard when the risk associated with that hazard is not reduced to a safe level by the applicable electrical installation requirements shall be trained.

QU shall ensure that no person is engaged in any work activity on or in the vicinity of electrical systems unless such person has the competency gained from training, technical knowledge and experience of the precautions to be taken against the risk of death or personal injury, and is under such degree of supervision as may be appropriate having regard to the nature of the work.

Refer to ***QU HSEMS Section 11.0: Training and Competency Procedure*** for additional information regarding training processes.

6.1 General Worker Training

The type and extent of training shall be determined by the risk to the worker and shall include:

- Sufficient information to provide the worker with an understanding of the specific hazards and risks associated with electrical energy.
- Safety-related work practices and procedural requirements, as necessary and as identified in the risk assessment / this procedure, to provide protection from the electrical hazards associated with their respective job or task assignments.
- Information to identify and understand the relationship between electrical hazards and possible injury.
- Reporting procedure in the event of incidents involving electrical systems.

The required training shall be classroom, on-the-job, or a combination of the two.

6.2 Specific Worker Training

In addition to the training requirements identified above in Section 6.1, a qualified worker, at a minimum, shall be:

- trained and knowledgeable in the construction and operation of equipment or a specific work method;
- trained to identify and avoid the electrical hazards that might be present with respect to that equipment or work method; and
- familiar with the proper use of the special precautionary techniques, applicable electrical policies and procedures, PPE, insulating and shielding materials, and insulated tools and test equipment.

A person can be considered qualified with respect to certain equipment and methods but still are unqualified for others.

6.3 Training Documentation

QU shall maintain a record of required training and attained competency with respect to electrical safety for all persons working on or in the vicinity of electrical systems.

7 Document Control

This SOP is a controlled document. The controlled version of this SOP is located on the QU Documentation Management System.

Any printed copies of this controlled document are reference copies only. It is the responsibility of all of those with printed copies to ensure their copy is kept up to date.

Refer to **QU HSEMS – Document Control and Record Retention**.

8 References

NFPA 70E, Standard for Electrical Safety in the Workplace, National Fire Protection Association, 2015 Edition.

US Occupational Safety and Health Administration Regulations, 29 CFR 1910.