Office of Safety, Health & Environment

Electrical Safety Standard for Laboratories and Workshops

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1.0 Introduction

Commonly used laboratory equipment, like hot plates, stirrers, vacuum pumps, electrophoresis apparatus, lasers, heating mantles, ultrasonicators, power supplies, and microwave ovens, can pose electrical hazard to students and staff working in laboratories. Large capacitors found in many laser flash lamps and other systems are capable of storing huge amounts of electrical energy and pose risk to health and safety even if the power source has been disconnected. So it is important that users are able to recognize and evaluate electrical hazards arising and implement safety measures to minimize the safety and health risks.

2.0 Scope

This document sets the safety standard for the safe use of all **electrical equipment under normal operating conditions** in all NUS laboratories and workshops.
Safety and health requirements for activities involving **electrical installations** are not covered by this standard. Activities involving shall comply to Singapore Standard CP 5 : 1998 Code of Practice for Electrical Installations ("SS CP5"). Temporary electrical installation in construction site or building worksites shall comply to Singapore Standard CP 88 : 2001 Code of Practice for temporary electrical installations in construction and building worksites ("SS CP88").

3.0 Definitions

3.1 **Electrical Installation:** The electrical installation is the electricity supply to a building, and includes the main switchboard, distribution board and all fixed wiring to isolation switches or general purpose outlets.

3.2 **Electrical Equipment:** Electrical equipment is an electricity consuming device or carrying device that is connected to, or capable of being connected to the electrical installation**.**

3.3 **Licensed electrical workers:** An electrical worker who is licensed under the Electricity Act to perform electrical work.

4.0 Policy statements

4.1 All NUS staff & students shall comply with the requirements of this standard for use of all electrical equipment in NUS laboratories and workshops.

4.2 Head of Department is responsible for the implementation of the requirements of this standard within their respective department. Principal Investigators are responsible for implementation of the requirements of this standard for activities within their research group.

4.3 NUS staff and students shall engage only Licensed Electrical Workers (LEW) to carry out any electrical installation, maintenance and repair work.

4.4 Risk assessments shall be performed prior to conduct of any laboratory based activities, to identify the relevant electrical hazards and implementing appropriate corrective measures.

5.0 Hazards and consequences

5.1 **Shock**

5.1.1 Shock results from accidental contact of human body with exposed parts of electric circuits. The resultant damage depends on the intensity of the electric current, the type of current, and the duration and the frequency of current flow. Alternating current (AC), direct current (DC), and mixed current cause different kinds and degrees of damage. Water is a great conductor of electricity and so working with electrical circuits under wet conditions can increase the risk of electrical shock. The effect of the shock may range from a slight tingle to severe burns or even cardiac arrest.

5.1.2 The chart below shows the degree of bodily injury that can occur from exposure to different magnitudes of current. Most electrical circuits can provide, under normal conditions, up to 20,000 milliamperes of current flow.

Current	**Reaction**
1 milliampere	Perception level. Slight tingling sensation.
5 milliamperes	Slight shock felt; not painful but disturbing.
6-16 milliamperes	Painful shock, begin to lose muscular control. Commonly referred to as the freezing current or "let-go" range.
17-99 milliamperes	Extreme pain, respiratory arrest, severe muscular contraction. Individual cannot let go. Death is possible.
100-2000 milliamperes	Ventricular fibrillation. Muscular contraction and nerve damage begins to occur. Death is likely.
>2000 milliamperes	Cardiac arrest, internal organ damage, and severe burns. Death is probable.

5.2 **Burns**

Accidents involving exposure to electrical current can result in damage to internal tissues because the body's inability to dissipate the heat generated by current flowing through the body tissues. The exposure can also result in thermal burns similar to that experienced from contact with the hot surfaces of overheated electric conductors.

5.3 **Fire**

The sparks from electrical equipment can serve as an ignition source for flammable or explosive vapors or combustible materials that are present in the lab. Use of defective electrical equipment and improper use of electrical equipment are major causes of fires in laboratories

5.4 **Arc Flash**

When an electric current passes through the air from one conductor to another, the temperature of the surrounding air can increase up to 20,000°C. Exposure to such extreme temperatures can result in higher intensity burns to the human body.

5.5 **Arc Blast**

The extreme temperatures created during an arc flash will result in an explosive expansion of both metal and the surrounding air. This creates a blast wave in which the material and molten metal are projected at speeds exceeding 1000 km per hour. Arc blasts often cause severe injuries and death.

6.0 Recognizing sources of hazards

6.1 **Exposed electrical wiring**

6.1.1 When wires or other electrical parts are exposed from their normal protective sheaths, the likelihood of accidental contact with electrical circuit increases. Electrical terminals in motors, appliances, and electronic equipment may become exposed due to improper handling or maintenance. Electric hand tools and equipment that are old, damaged, or misused may result in damage to the electrical insulation. This exposes the electrical wiring and may energize the metal parts of the equipment. Exposed electrical wiring in wet environments such as cold rooms and near water baths are potential sources of electrical hazards.

6.2 **Improper grounding**

6.2.1 Metal parts of motors, appliances, or electronics that are plugged into improperly grounded electrical circuits may become energized. The metal housings of equipment are usually grounded through the electrical plug or special grounding wires. Broken ground wire or plugs and use of improper electrical sockets and power cables may result in improper grounding and thus can result in an electrical hazard.

6.3 **Overloading circuits/ Inadequate wiring**

6.3.1 Electrical circuits and extension cords are designed to carry a maximum load of current. When the current drawn by the equipment plugged to the circuit or extension cord exceeds this maximum load, the wires may overheat and can cause fires. High temperatures may also melt the insulation and result in arcing.

6.4 **Environment considerations**

6.4.1 Electric tools, extension cords, switches and overcurrent protection devices like fuses and circuit breakers, may heat up and occasionally arc or spark. This may result in fire or an explosion if present in areas that contain flammable gases or vapors (eg. fumehoods), finely pulverized flammable dusts, or fibers or metal filings (eg. workshops). Electrical systems have to be modified to be able to be used in such hazardous environments.

6.4.2 Water is a good conductor of electricity and hence students and staff must take extra precaution while working around electrical equipment in wet conditions. Handling equipment with wet hands, working on them in puddle of water, wet clothing, high humidity, and perspiration can increase the chances of being electrocuted.

6.4.3 Electric cables and extension cords when used in high traffic area, may result in trips and falls.

6.4.4 The insulation on extension cords and power cables for electrical equipment may become damaged or worn on prolonged use in environments where corrosive chemicals are being used.

6.5 **Power Loss:**

Loss of electrical power can result in hazardous situations. Flammable or toxic vapors may be released as a chemical warms when a refrigerator or freezer fails. Fume hoods may cease to operate, allowing vapors to be released into the laboratory. If magnetic or mechanical stirrers fail to operate, safe mixing of reagents may be compromised.

7.0 Evaluating hazards & risks

All users shall perform a thorough evaluation of risks and hazards associated with the use of electrical equipment and identify and implement controls to minimize risks. Where applicable, the risk assessment should take into consideration the following:

- Purchase of electrical equipment and accessories
- Scope and method of use of electrical equipment and accessories
- The environment in which the electrical equipment and accessories are used (presence of flammable materials, water, hanging wires or wires on floor in high pedestrian area etc.,)
- The presence of exposed terminals and wires in the circuit
- The overloading of circuits and extension cords and means of detecting them (inspections, burning odors, repeated blown fuses and circuit breakers may indicate that the breaker is defective etc.,)
- The changing work conditions and users
- The combination of different type of electrical hazards (ex., a damaged equipment used in wet conditions; improper grounding and exposed wires etc.,)

The most appropriate and practical safety measures shall be selected and implemented to minimize the risk from electrical hazards. The various safety measures that can be followed to minimize the risk involved are provided in the section 8. As a general rule, the selection of safety measures are prioritized as below

- Elimination
- Substitution
- Engineering Controls
- Administrative Controls
- Personal Protective Equipment

8.0 Safety measures for controlling hazards

8.1 Electrical Equipment

8.1.1 The electrical equipment shall be operated and maintained in accordance to the manufacturer's operating and maintenance instructions and recommendations. Sufficient access and working space shall be provided and maintained around all electrical equipment to permit safe operation and maintenance of such equipment. The power cables shall be periodically inspected to ensure that they are not damaged. Any damaged power cables shall be replaced prior to using the equipment.

8.1.2 Electrical equipment should not be used in wet conditions, unless the appliance is specifically designed for use around water. (Eg.,circulation pumps, water-bath heaters, rotary evaporators, etc.). If any electrical equipment is required to be used near sources of water, the users shall evaluate the safety and health risks and implement appropriate safety measures.

8.1.3 Electrical equipment and wiring in locations where there is presence of flammable vapors, liquids, gas, combustible dusts, or fibers shall comply with relevant code of practice or standards.

8.1.4 For installation of electrical equipment drawing current greater than the standard socket amperage (eg. 13A or 15A) in the laboratory or workshop, a competent person such as a LEW should be engaged to perform an electrical load analysis and/or calculation to ensure that the overall electrical circuit load designed for the laboratory or workshop will not be exceeded. The Office of Facilities Management shall be contacted if access to the electrical distribution board is required to determine the electrical load. The list of LEW can be found in the Energy Market Authority website. Click here to access the website.

8.2 Electrical Plugs and Sockets

8.2.1 Plugs suitable for the socket outlets in NUS:
Figure 1 shows the type of plugs suitable for the socket outlets in NUS.

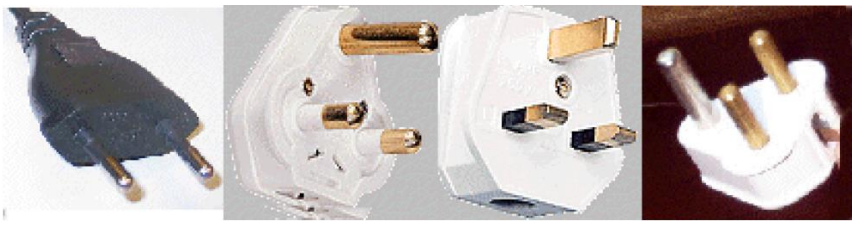

Figure 1: Type of plugs suitable for the socket outlets in NUS (From left: 2.5A round pin, 5A round pin, 13A rectangular pin, 15A round pin). Courtesy of SPRING Singapore

Figure 2 shows the type of plugs not suitable for the socket outlets in NUS. When these plugs are plugged directly into the socket outlets in NUS, may result in overheating and can result in fires.

Figure 2: Type of plugs not suitable for the socket outlets in NUS (From left : Flat-blade plug, Schuko plug with side grounding contact, Schuko plug with side grounding contact, 10/16-Amp round pin, Flat-blade but with round grounding pin, Flat-blade but with round grounding pin). Courtesy of SPRING Singapore

8.2.2 For equipment with plugs that are not suitable for the socket outlets in NUS, user shall seek vendor's recommendations on the use of appropriate converters, connectors, or adapters for use in the socket outlets in NUS.

8.2.3 Plugging or unplugging energized equipment with wet hands should be avoided. The cords should not be forcefully unplugged as this may cause a short circuit or breakage. The electrical supply shall be switched off before the plug is gently removed from the socket.

8.2.4 Plugs shown in figure 1 shall bear the "Safety Mark" logo. A typical "Safety Mark" logo is shown in Figure 3 below.

SAFETY MARK
1 2 3 4 5 6 - 0 0

Figure 3: "Safety Mark" logo

8.2.5 Three-prong plugs shall be inserted into a three-prong socket outlet. Three-prong plugs shall not be altered or rewired to fit into a two-prong outlet.

8.2.6 The prongs of an electrical plug shall not be removed. Plugs with missing, loose or bent prongs shall be replaced.

8.2.7 The building facility manager shall be contacted for the removal of any plug prongs that has been broken off and stuck inside a socket outlet.

8.2.8 Plugs and sockets that are hot during normal use or have scorch marks shall be removed from service immediately.

8.2.9 The maximum current loading for each power socket outlet shall not exceed the socket amperage (eg. 13A or 15A).

8.3 **Adapters**

8.3.1 Multi-plug Adapters

- Multi-plug adapters (Figure 4) shall be labelled with the "Safety Mark" logo shown in figure 3.

- All plugs inserted in a multi-plug adapter should be labelled with the respective current rating (in Amperes) of the equipment. The current rating of the equipment is usually listed on the equipment. Alternatively it can be obtained by dividing the power rating of the equipment in Watts by 220 Volts.

Figure 4: Example of a multi-plug adapter

8.3.2 Universal Travel Adapters

- Only equipment that are rated to operate at 220 V shall be plugged into the Universal Travel Adapters. Equipment that is plugged into the electrical socket for electrical power supply via a universal travel adapter (Figure 5) shall not exceed the adapter's amperage limit that is specified by the manufacturer.

Figure 5: Examples of universal travel adapters

- Equipment that is plugged into the electrical socket for electrical power supply via the universal travel adapter shall not be left unattended. The electrical power supply shall be switched off or disconnected if the equipment is to be left unattended.

- Universal travel adapter should conform to appropriate international safety standards such as BS1363, IEC60884, or the European Directive 93/68/EEC. Products complying with the European Directive 93/68/EEC bear the "CE mark". However, there are misleading "CE mark" in the market that does not fulfill the European Directive. Figure 6 below shows the difference between a real "CE mark" and a misleading or fake "CE mark".

Real CE mark	
Misleading or fake CE mark	

Figure 6: Comparison between real CE mark and misuse or fake CE mark

8.4 **Extension Cords (also known as flexible cords, power strips, or portable socket outlets)**

8.4.1 Extension cords (Figure 7) supplement fixed wiring by providing the flexibility required for maintenance, portability, isolation from vibration, and emergency and temporary power needs.

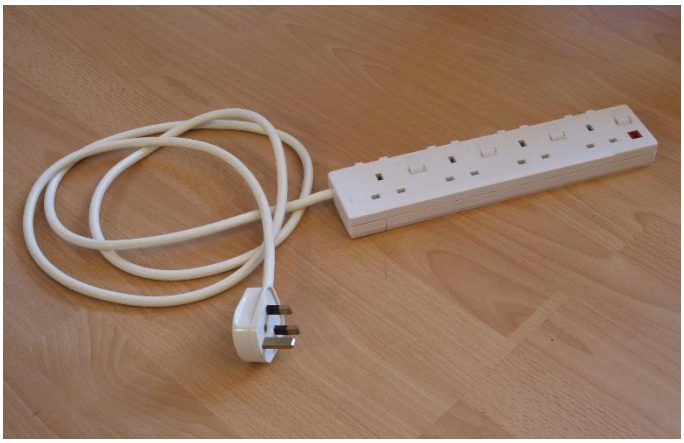

Figure 7: An example of an extension cord

2 Purchase:
All extension cords used in NUS shall bear the "Safety Mark" certification (Figure 3). Extension cords purchased overseas may not satisfy local regulatory requirements and hence shall not be used in NUS unless they have been certified to the "Safety Mark" standards.

8.4.3 Conditions of "Safety Mark" certification:
The extension cords bearing "Safety Mark" shall be used only under the following conditions to ensure validity and safety:

- An ambient temperature having a peak value not exceeding 40°C, the average value over 24 hours not exceeding 35°C. When used in conditions where they are exposed to the Sun, specific precautions shall be taken to ensure the above mentioned temperatures are not exceeded.
- An atmosphere not subject to abnormal pollution by smoke, chemical fumes, rain, spray, prolonged periods of high humidity or other abnormal conditions.

8.4.4 All extension cords shall be clean and properly maintained with no exposed live parts or conductors, exposed underground metal parts, splices, substantial abrasion, or other damage that might compromise its safe usage. Some indoor cords with more than one outlet have

covers for the unused openings. They prevent debris and moisture from entering the unused outlets and shall not be tampered with.

8.4.5 Extension cords designed specifically for indoor use may not be durable enough to be used outdoors. The manufacturer will be able to provide details on whether their extension cord can be used outdoors.

8.4.6 Extension cords shall not be used in an area that may contain explosive metal dusts, flammable gases and vapors (e.g. solvent storage room, paint cabinet). These environments require specially rated, intrinsically safe extension cords to prevent explosions

8.4.7 Extension cords shall not:

- run through holes in walls, ceilings, conduits, floors or any location where easy inspection is not possible
- run through doors, ceilings, windows, hinged door openings or any location where it can damaged by being 'pinched'
- run across roads, or across areas of high foot traffic where it may result in trip and fall. Securely tape on the floor if they have to be used in high traffic area
- run under carpets or covered by combustible materials
- attached to building surfaces, tied to over-head pipes
- attached to any structure with nails or staples as they may damage the cord

8.4.8 Users shall be aware of the extension cord's total current rating (how much current the cord can carry) as specified by the manufacturer. The total amount of current drawn by all the equipment plugged into the extension cord shall not exceed the total current rating of the extension cord.

8.4.9 All plugs inserted in the extension cord should be labelled with the respective current rating of the equipment. The current rating of the equipment is usually listed on the equipment. Alternatively it can be obtained by dividing the power rating of the equipment in Watts by 220 Volts to obtain the current drawn by the equipment in units of Amperes.

8.4.10 Extension cords used in NUS shall not exceed 6m in length and shall be 1.25mm^2 or 1.5mm^2 in conductor cross-sectional area.

8.4.11 Proper usage:

- Extension cords shall not be daisy-chained (connecting multiple extension cords together). This may result in overheating of the wires and can result in fires.
- Extension cords should not be used for heat-producing appliances such as coffee pots, toasters, hot plate, water bath and space heaters. The load from these devices coupled with the added cord length increases the chance of overheating.
- Extension cords with the third prong (grounding prong) removed from the plug shall not be used.
- Extension cords that are cut, damaged, or with exposed inner conductors shall not be used.
- Multi-plug adapters should not be plugged onto extension cords.

- Electrical tapes or any other tapes should not be used to repair extension cords as it may not have comparable integrity as the original insulation.
- Extension cords shall not be coiled. Coiling or winding excess cord length or tying a knot may cause overheating to the cord.
- Extension cord should be unplugged and secured when not it is not in use.
- Extension cords may be used for temporary applications only. “Temporary” generally means it is associated with a one-time job or with a transient condition. Install permanent wiring for long-term or repetitive needs. An extension cord may be used while awaiting permanent wiring.

8.4.12 Extension cords with universal socket outlet shown in Figure 8 below are not approved for use in NUS. Those extension cords have a high tendency to overheat and result in fire hazard. The temperatures of the Live and Neutral contacts are found to exceed safety limits when loaded to the rated current of the sockets in Singapore.

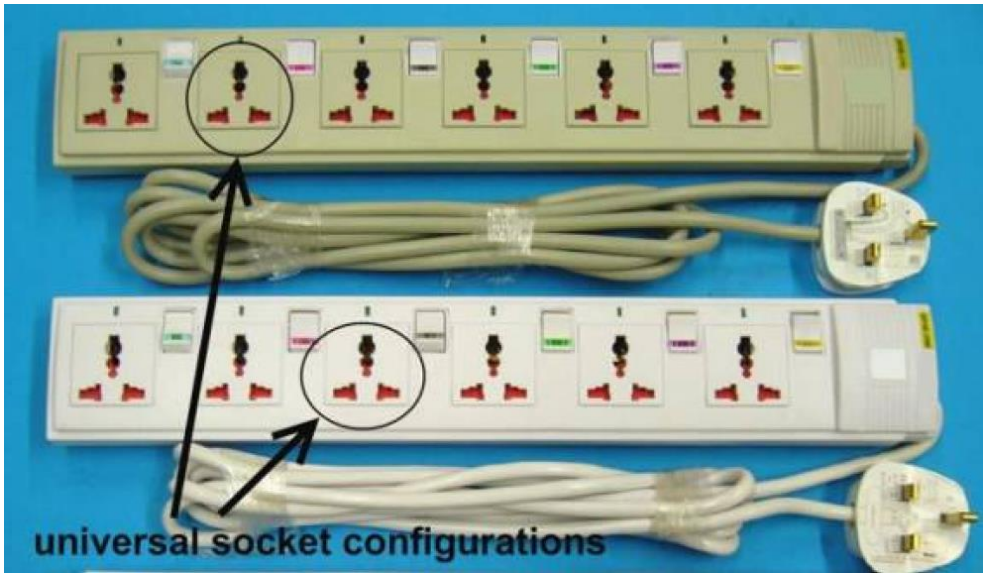

Figure 8: Extension cords with universal socket outlets
Courtesy of SPRING Singapore

8.5 **Power Track System**

The power track is a system that allows electrical power to be tapped off anywhere along the track through the use of specially designed tap-off units such as plug and adapter. An example of a power track system is shown in Figure 9. All power track systems in NUS shall comply with the following requirement:

Figure 9: An example of a power track system

8.5.1 The Office of Estate Management shall ensure that all power track systems in NUS laboratories and workshops are to be labelled with the maximum current rating and the maximum allowable number of tap-off units the power track system is designed for.

8.5.2 Users of the power track system should label all the plugs inserted via the tap-off unit to power track with the respective current rating of the equipment. The current rating of the equipment is usually listed on the equipment. Alternatively it can be obtained by dividing the power rating of the equipment in Watts by 220 Volts to obtain the current drawn by the equipment in units of Amperes.

8.5.3 User shall ensure that the maximum current rating and the maximum allowable number of tap-off units of the power track system is not exceeded.

8.6 **Exposed wires**

8.6.1 Equipment with exposed wiring from frayed or worn out wires from prolonged or unintended usage shall be immediately removed from service. Exposed wirings shall not be contacted or covered up with tapes.

8.6.2 Equipment with exposed wiring or electrically energized parts during normal operation shall be isolated and guarded by panels, screens, barriers, covers, or partitions

8.6.3 The following precautions shall be taken to prevent injuries from contact with live parts:

- All exposed live parts for high voltage equipment such as electrophoresis units, laser, etc, shall be identified.
- Guards, panels, or barriers that can only be removed by means of tools should be provided to prevent access to the live parts during operation.
- Appropriate labels shall be provided on the guards, panels, or barriers to warn personnel on the presence of live parts beyond the guarding.
- For cases where it is not possible to barricade the live parts, the live parts shall be made out of reach. Precaution shall be taken to prevent objects such as metal rods or pipes from contact to these live parts.

- Unused conduit openings in boxes should be closed or sealed to prevent foreign objects (pencils, metal chips, conductive debris, etc.) from entering and damaging the circuit inside.

8.7 Electrical Distribution/Panel Boards

8.7.1 Users shall be aware of the location of the electrical distribution/panel boards.

8.7.2 Circuit switches shall not be taped to prevent a breaker from tripping.

8.7.3 Breaker circuits shall be accurately labelled within panel boxes.

8.7.4 The door of the panel box shall be secured.

8.7.5 Panel boxes shall not be blocked. There should be at least 1 metre clear space in front of a panel box.

8.7.6 Report tripped breakers and refer any electrical questions to Office of Facilities Maintenance

8.8 Circuit Breakers and Fuses

When a circuit breaker trips or a fuse blows, the cause must be found. After an overload is found and corrected, a blown fuse must be replaced with a new one of appropriate amperage. A circuit breaker should not be used regularly to turn power on or off in a circuit, unless the breaker is designed for this purpose and is marked as a switching device.

8.9 Insulations

8.9.1 The cords of the electrical equipment shall be inspected on a routine basis to identify any damage. Extra precaution shall be taken to monitor the electrical cords, while using electrical equipment in environment like fumehoods or other areas where corrosive chemicals and solvents are being used. Damaged cords should be replaced immediately.

8.9.2 All electrical cords should have sufficient insulation to prevent direct contact with wires. Staples or other sharp objects that may damage the insulation shall not be used to support electrical cords. Bends in a cable must have an inside radius of at least 5 times the diameter of the cable so that insulation at a bend is not damaged.

8.10 Inspection, maintenance and repair

8.10.1 Routine inspection of the electrical equipment, components, wiring or sockets should be conducted to identify any damaged or malfunctioning electrical equipment and frayed wires. Refer to Figure 10 for examples of things to look out for during routine inspections.

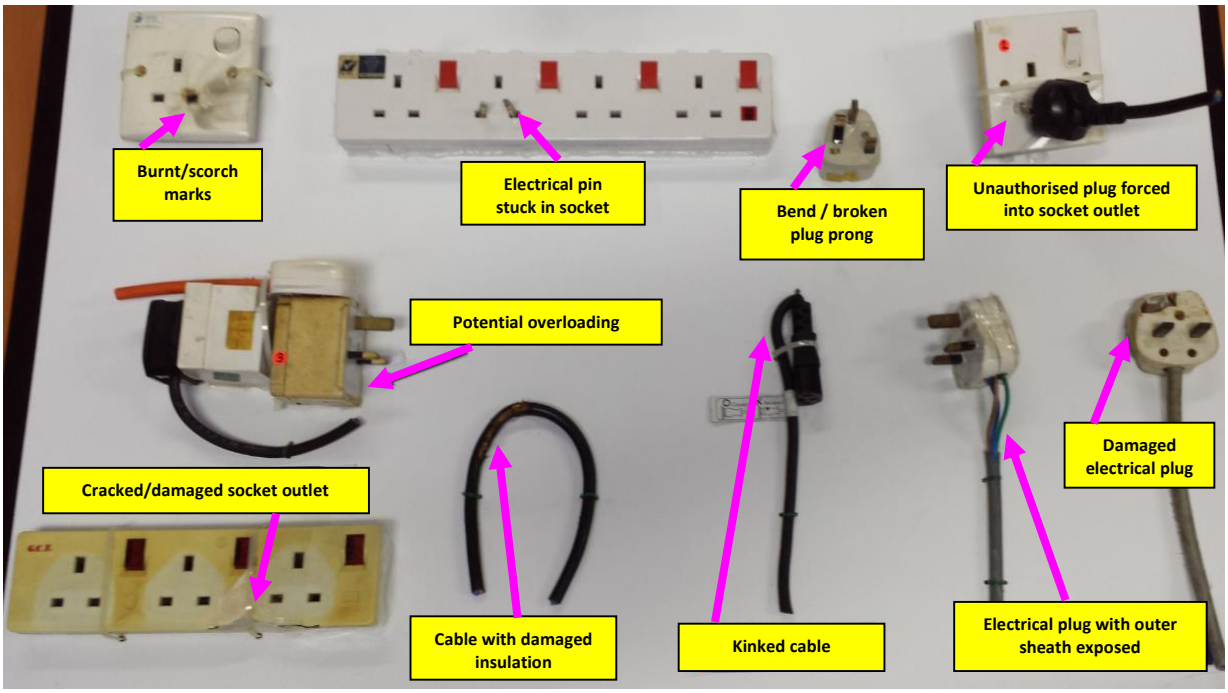

Figure 10: Examples of things to look out for during routine inspections

8.10.2 The power source to the electrical equipment should be disconnected prior to servicing or repairing the electrical equipment. If that is not possible, any maintenance work involving handling energized or live electrical circuits shall comply with the NUS Standard for Establishing Lock-Out Tag-Out Procedures and any other relevant regulations.

8.10.3 Maintenance and repairs of high voltage or high current equipment shall be performed only by licensed electrical workers.

8.10.4 Work involving electrical installations (new wiring, rewiring, extensions, etc) and any work involving energized equipment shall be performed only by licensed electrical workers. The Office of Facilities Management may be contacted for advice on licensed electrical workers.

8.10.5 Tag out and remove from service all damaged receptacles and portable electrical equipment.

8.10.6 Repair all damaged receptacles and portable electrical equipment before placing them back into service.

8.10.7 Report all electrical problems, including tripped breakers, broken switches, and flickering lights, to Office of Facilities Maintenance.

8.10.8 Appliance that sparks, smokes, or becomes excessively hot during operation shall not be used unless the appliance is specifically designed to exhibit these characteristics.

8.10.9 Formerly known as Earth Leakage Circuit Breaker or ELCB, the residual current circuit breaker (RCCB) is a safety device available in all households and buildings. The RCCB helps prevent electric shock by cutting off electricity supply immediately upon detecting any current leakage

in an electrical circuit. Ensure that a RCCB has been installed in the premise and has been checked once a month by pressing the test button to ensure that it is in good working condition.

8.10.10 Electrical accessories such as plugs, sockets, and portable socket outlets shall be replaced when it is damaged/broken, or when the manufacturer's recommended shelf life has been exceeded.

8.11 Valve-Regulated Lead Acid (VRLA) batteries

A VRLA battery is a type of lead-acid rechargeable battery. While the VRLA battery is widely promoted as 'maintenance free', it still requires cleaning and regular functional testing to ensure optimal performance and safety during its usage. Thermal runaway of VRLA remains a serious safety concern when such batteries are continually connected to the power supply and the load as in UPS systems. The following safety practices must be followed while using VRLA batteries.

8.11.1 Ensure risk assessments for activities involving VRLA batteries have evaluated the risks arising from charging and maintenance of the batteries.

8.11.2 When performing risk assessments, review the manufacturer's user manual on the conditions for the safe use, maintenance and storage such as :

1. The optimal temperature of the location where these batteries are used and stored.
2. The capacity of the batteries and the conditions to prevent overloading them.
3. The battery enclosure design to allow efficient heat dissipation.
4. The life span of the batteries (Batteries must be replaced prior to expiry).

8.11.3 Conduct visual inspections of both newly received and existing batteries to note the physical conditions and identify :

i. Any signs of physical damage such as punctured or dented batteries

ii. Any signs of lead sulphate deposits. Prolonged charge deprivation causes batteries to have lead sulphate deposits (Figure 11). This will affect the batteries' capacity and charging time leading to increased risk of damage to the batteries. Take note of this and engage contractors for anti-sulphation services.

Figure 11: Lead sulphate deposits on battery connector

iii. Any signs of bloating in the batteries. All bloated batteries should be replaced. An illustration can be found in Figure 12.

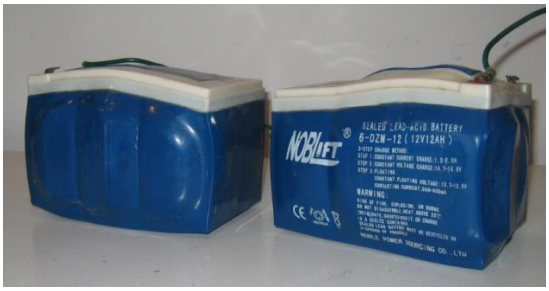

Figure 12: Bloated lead acid batteries

9.0 Emergency Preparedness

9.1 **General:**

All personnel shall be aware of the location of (1) electricity shut-offs ("kill switches"), (2) first-aid supplies, and (3) a telephone.

9.2 **Spills and Flooding:**

If water or a chemical is spilled onto equipment, shut off power at the main switch and unplug the equipment. In the event of flooding, all power sources should be switched off before cleaning/ drying the affected areas. After the affected areas have been dried, a licensed electrician should be engaged to certify that all affected electrical cords, sockets & equipment are safe for use. If water or chemical is spilled onto equipment, shut off power at the main switch and unplug the equipment before dealing with the spill

9.3 **Electric Shock and burn:**

9.3.1 When someone suffers serious electrical shock, he or she may be knocked unconscious. If the victim is still in contact with the electrical current, immediately turn off the electrical power source. If the power source cannot be disconnected, separate the victim from the power source with a nonconductive object, such as a wooden pole. The victim shall not be contacted with bare hands when he or she is still in contact with a power source. Contact the Office of Campus Security at 6874 1616 immediately. The victim shall not be left unattended unless there is absolutely no other option. Stay with the victim until SCDF arrives.

9.3.2 Once the electrical current is no longer flowing through the victim, call out to the victim to see if he or she is conscious (awake). If the victim is conscious, tell the victim not to move. It is possible for a shock victim to be seriously injured but not realize it. Quickly examine the victim for signs of major bleeding. Place a cloth over the wound and apply pressure and gently elevate the injured area (if possible) to stop the bleeding. Keep the victim warm and talk to him or her until help arrives.

9.3.3 If the victim is unconscious, check for signs of breathing. Avoid moving the victim as much as possible. If the victim is not breathing, a personnel trained in CPR should begin artificial breathing and check if the victim has a pulse. To be effective, CPR must be performed within 4 minutes of the shock. Refer to this link for more information on CPR training https://inetapps.nus.edu.sg/osh/portal/shmgt/ssts.html

9.4 **Electrical Fire:**

If an electrical fire occurs, try to disconnect the electrical power source (pull the plug or trip the circuit breaker), if possible. Use a Class C or multipurpose (ABC) fire extinguisher (Figure 13) to extinguish the fire if it is small and will not pose immediate danger to personnel. NEVER use water to extinguish an electrical fire. Activate the fire alarm and remove any unconscious victims from the vicinity of the fire. Notify Campus Security immediately at 6874 1616. Refer to this link for more information on training on using fire extinguishers and fire safety training https://inetapps.nus.edu.sg/osh/portal/shmgt/ssts.html

Figure 13: Example of a fire extinguisher that can handle electrical fire (Class C fire)

10.0 Incident and Accident Reporting

All incidents or accidents and injuries are to be reported to OSHE within 24 hours via online reporting using the "Accident/Incident Reporting System" (AIRS) that can be accessed using the following link:

11.0 References

- Electricity Act
- Singapore Standard CP 5: 1998 Code of Practice for Electrical installations
- Singapore Standard CP 88: Part 2 : 2001 Code of Practice for Temporary electrical Installations for construction and building sites
- Singapore Standard SS 145: part 2: 2010 Specification for 13A plugs and socket-outlets (13A switched and unswitched socket-outlets)
- National Fire Protection Association Code NFPA 70: National Electrical Code
- "How Electrical Current Affects the Human Body", Occupational Safety & Health Administration https://www.osha.gov/SLTC/etools/construction/electrical_incidents/eleccurrent.html
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