

Point Lisas  
Energy  
Association  
(PLEA)

# PLEA ELECTRICAL SAFE WORK GUIDELINE

# Disclaimer

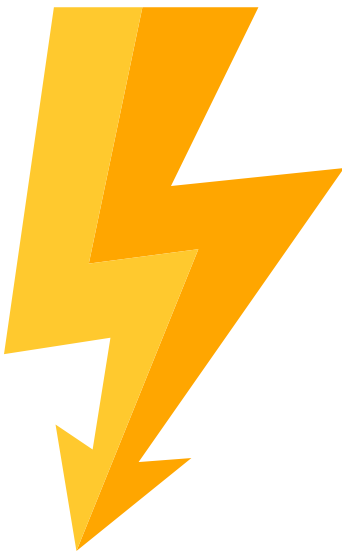


This document is prepared by the Electrical Safety Sub-Committee (“ESSC”) of the Point Lisas Energy Association (“PLEA”). The objective of PLEA includes, inter alia, the encouraging of its members to improve their performance in health, safety and environmental quality. In this regard, PLEA members established the ESSC with the common objective of establishing guidelines to ensure the safety and protection of workers and facilities when executing electrical works.

Electrical Safe Work Guideline presents and recommends the basic requirements and best practices that should be implemented by PLEA member companies to ensure electrical work is undertaken in a safe manner by all relevant workers.

This document is based on a review of existing published and unpublished material available to the ESSC at the time of preparation, and was guided by specialist input and advice throughout its preparation.

While care has been taken in the preparation of this document to ensure its contents are accurate, complete and up-to-date as at the date indicated below, the ESSC and PLEA members do not guarantee and are not responsible for the quality, currency, accuracy of the information, recommendations, conclusions or statements contained in this document or any source documentation referred to herein; and shall not be responsible for any errors, omissions, injury, loss or damage arising from or relating to the use or misuse of any information, statements or conclusions contained in or implied in this document or in any source documentation.



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# 1.0 Definitions



**Arc Flash** – The light and heat generated as part of an arcing fault that occurs between an energised conductor through the air to ground or another phase.

**Arc Thermal Performance Value (ATPV)** - the incident energy on a material that results in a 50% probability that sufficient heat transfer through the specimen is predicted to cause the onset of second-degree burn injury based on the Stoll Curve. The unit for ATPV is typically in cal/cm<sup>2</sup>.

**Certified Training Institution** – An institution that has been pre-approved by the PLEA ESSC to administer and certify personnel in Electrical Safety Awareness principles and practices. A Certified Trainer shall perform the training.

**Certified Trainer** – A person that has been approved by the PLEA Electrical Safety Subcommittee to impart knowledge and principles in Electrical Safety Awareness. The requirements for Certified Trainers are specified in Section 5.0.

**Competent Personnel** – A qualified person who has demonstrated the practice and implementation defined for Qualified Personnel and has been approved by a Facility Owner/Operator or Contract company to work on or around electrical equipment. (NFPA 70E – 2018: A person who meets all the requirements of qualified person, as defined in Article 100 in Chapter 1 of this standard and who, in addition, is responsible for all work activities or safety procedures related to custom or special equipment and has detailed knowledge regarding the exposure to electrical hazards, the appropriate control methods to reduce the risk associated with those hazards, and the implementation of those methods.)

**Contract Company** – An entity that operates within a facility owned or operated by another entity.

**Energy Breakopen Threshold (EBT)** – The incident energy on a material that results in a 50% probability of breakopen. Breakopen is defined as any open area at least 1.6 cm<sup>2</sup> (0.5 in.<sup>2</sup>)

**Electrical Safe Work Champion/Authority** – A person or group formed by a Facility Owner/Operator assigned the responsibility for the implementation, execution and review of Electrical Safe Work Policies and Procedures specific to an area and this document.

**Facility Owner** – A person or entity who owns a facility operating in the Point Lisas Industrial Estate for the purposes of the provision of goods and/or services.

**Facility Operator** – An entity and its employees whose core function is the operation and maintenance of a facility operating in the Point Lisas Industrial Estate.

**High Voltage** – Voltages that are in excess of 35000 volts. (IEC 60038)

**Incident Energy** – The measure of thermal energy at the working distance from the fault. The typical unit of measure for incident energy is cal/cm<sup>2</sup>.

**Lock Tag Try (LTT)** – The procedure for ensuring a zero energy condition for equipment to be handed over which entails the steps Lock, Tag and Try.

**Low Voltage** – Voltages that are 1000 volts or less. (IEC 60038)

**Management** – The person or group so designated within an organisation (Facility Owner/ Operator or Contract Company) to administer the daily operations of the organisation.

**Medium Voltage** - Voltages that are greater than 1000 volts up to 35000 volts. (IEC 60038)

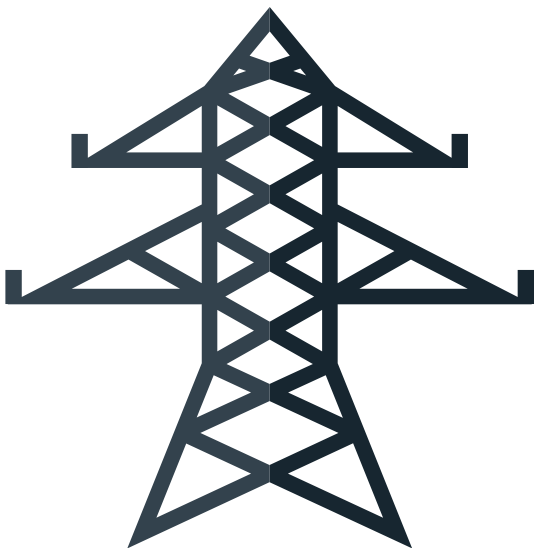
**Electrical/Power System Engineer** – A person possessing the requisite qualifications within an institution for the design, installation, and maintenance of electrical equipment.

**Qualified Personnel** – A person who has received technical training in the field of electrical installation and maintenance, possesses a certificate to display this qualification and has been trained in the identification and mitigation of electrical hazards. (NFPA 70E – 2018: 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 the hazards and reduce the associated risk.)

**Task Qualified Personnel** – A person who is not a qualified person but performs routine tasks that would cause the individual would directly introduce electrical hazards. Examples of such persons include but are not limited to: HVAC Technicians, Elevator Technicians, Fire and Gas Technicians, Electrical Helpers, Portable Electrical Equipment Operators.

**Unqualified Personnel** – A person who is NOT qualified.

**Working Distance** – The distance between the energised conductor and where the worker stands. This distance is typically 18 inches.



# 2.0 Scope of Documentation



## 2.1 Purpose

The purpose of this document is to outline the basic requirements and serves as a guideline/ best-practice for Electrical Safe Work for companies operating in the Point Lisas Industrial Estate. Compliance with these guidelines is voluntary, however, PLEA member companies may adopt this guideline as a condition for contractors working on their respective sites.

## 2.2 Basis of this Guideline

This document was prepared by a Committee, comprised of nominated members, on behalf of the PLEA.

The content of this document is based on the National Fire Protection Association 70E 2018 (Standard for Electrical Safety in the Workplace) and other well-established guidelines of the participating companies. It has been developed as a guide to eliminate workplace injuries and fatalities as a result of electrical hazards by ensuring the proper training of all crafts working on or around electrical equipment, establishing Electrical Safe Work conditions where applicable and fostering the ability to identify and protect against electrical hazards. This document has been designed to work in conjunction with the NFPA 70 (National Electrical Code) and the TTS 171:1 & 2 (Trinidad and Tobago Bureau of Standards Electrical Installation Codes) and is not intended to replace these codes.

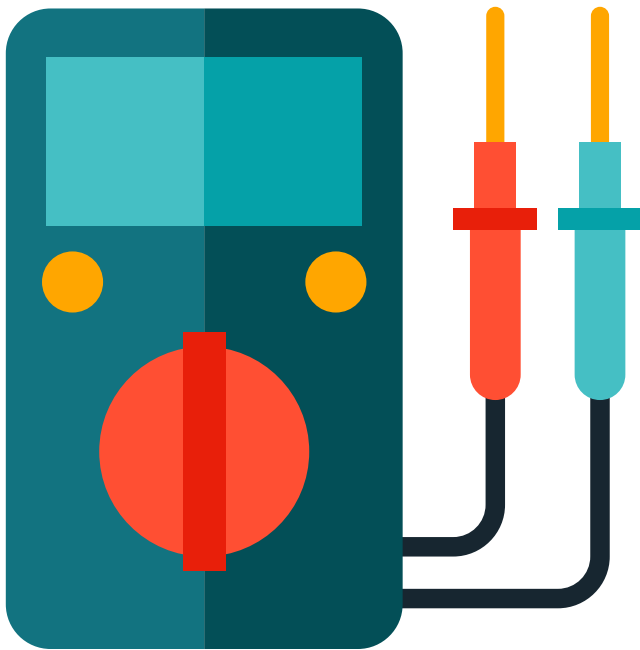
## 2.3 Electrical Safe Work Guideline Principles

Electrical Safe Work Programs are based on the following principles:

- Protecting all employees from the hazards of electricity
- De-energising and isolating all electrical equipment that operates at 50 volts or more
- Installing, inspecting and maintaining electrical equipment to ensure safe equipment
- Identifying electrical hazards and taking action to eliminate or minimise those risks
- Assessing people's abilities and providing training and field work supervision to ensure safe work practices
- Audit these principles to ensure the necessary procedures are implemented
- Qualified electrical work.

## 2.4 Scope

This document applies to all companies associated with PLEA, inclusive of contract companies and their associates. These guidelines shall be adhered to in an effort to protect persons and the environment within which PLEA member companies operate. It is expected that all persons and companies shall respect these guidelines. The ultimate objective is not to monitor and police personnel, but to ensure that there is voluntary compliance with these improved electrical safe work practices in place.





# 3.0 Responsibilities and Authorities



**Facility Owner** – shall provide the necessary infrastructure and capital funding within reason to allow for the implementation of Electrical Safe Work practices, which shall include but are not limited to the upgrade of defective equipment, installation of equipment for the reduction of electrical hazards, signage and barricades and the deployment of standards and policies.

**Facility Operator** – shall ensure that all work practices and policies are designed to ensure that the Electrical Safe Work guidelines and controls identified within this document are adhered to. The Operator shall ensure that personnel working on electrical systems are properly equipped with tools and PPE to safely perform their duties as well as have the adequate training to identify and eliminate electrical hazards. The facility operator and its representatives shall duly inform contract personnel operating on the site of the Electrical Hazards and mitigations that exist on the site.

**Contract Company** – shall ensure its personnel are provided with the necessary tools and PPE required to routinely perform all electrical work as identified by the hazards associated with the tasks to be performed unless otherwise specified. It is mandatory that PPE be provided for working on voltages of 600V or less and with an arc flash hazard of 8.0cal/cm<sup>2</sup> or less unless otherwise dictated by contractual obligation as a minimum standard. The contract company and its personnel shall participate and adhere to any safety rules, guidelines and restrictions enforced by the facility owner or operator. The contract company's management is responsible for the querying of electrical hazards and the dissemination of this information to all employees assigned to operate on the specific facility.

**Facility and Contractor Management** – shall ensure that full cooperation, guidance and implementation of Electrical Safe Work standards are executed and shall support any necessary Electrical Safe Work programme that includes but is not limited to the implementation of policies and procedures, the provision of training, tools and PPE as well as Capital Funding required to facilitate Electrical Safe Work.

**Electrical Safe Work Champion/Authority** – shall ensure that all policies and procedures are adhered to and updated and shall be responsible for the review and final approval of any Electrical Safe Work plans to be implemented.

**Electrical/Power System Engineer** – shall ensure that all equipment design, installation and maintenance is performed in a manner to facilitate Electrical Safe Work, proper isolation, does not introduce additional hazards to personnel and reduces or eliminates the hazards present. The engineer is responsible for the routine review and update of single line diagrams and power system studies within an operating area that contains electricity.

**Isolation Authority** – A competent person who has been identified by the facility operator to be responsible for the de-energisation and LTT of electrical equipment to be handed over for maintenance and/or repair works.

**Qualified Personnel** – A qualified person who shall ensure conformance with a facility's written policies and procedures and practice electrical safe work policies.

**Competent Personnel** – A competent person who shall ensure conformance with a facilities written policies and procedures and practice electrical safe work policies. The competent person shall be assessed by company personnel at regular intervals to ensure that training and competency are maintained. Extended periods of absence (greater than 6 months) shall require the re-evaluation of a competent person. Non-competent persons shall always be accompanied by competent persons when entering or working near energised equipment.

**Live Work Managerial Approver** – shall be the person responsible for the final authorisation and approval to proceed with the execution of live work that meets the requirements within this document and follows a specific safe work plan for the task to be performed.

**PLEA ESSC** – shall be responsible for the periodic review and modifications to the PLEA Electrical Safe Work Guideline to ensure that the content is in accordance with international and industry recognised standards. May perform audits on facilities and systems to ensure that policies and practices are in accordance with the document. Shall be the final authority to make determinations on discrepancies associated with the document and practical applications.

# 4.0 Electrical Hazards

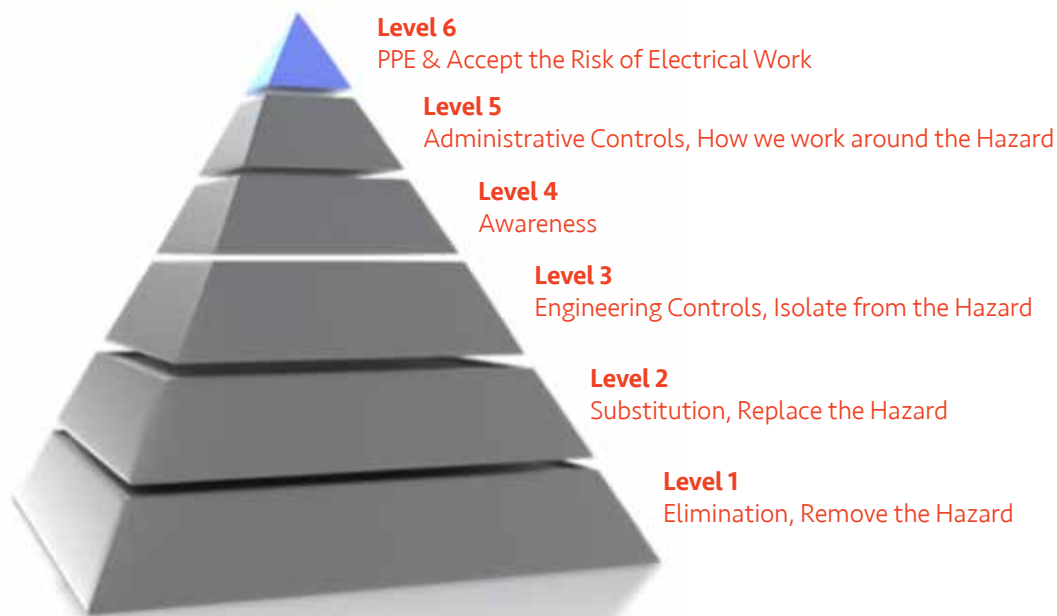
## Introduction



There are three major hazards associated with working on or with energised electrical equipment. These are:

1. **Electrical shock:** a reflex response possibly involving trauma that occurs when electrical current passes over or through a worker's body. It usually involves burns, an abnormal heart rhythm and unconsciousness.
2. **Arc flash:** A dangerous condition associated with the possible release of energy caused by an electric arc. An arc flash hazard may exist when energised electrical conductors or circuit parts are exposed or when they are within equipment in a guarded or enclosed condition, provided a person is interacting with the equipment in such a manner that could cause an electric arc.
3. **Arc blast:** A release of mechanical, acoustical, thermal and optical energy from an electric arc.

The intent of this document is to provide guidelines regarding the reduction of the hazards associated with electrical energy by employing a combination of the six (6) elements of control: Elimination, Substitution, Engineering, Awareness, Administrative Controls and PPE.



**Figure 1:** Hierarchy of Controls (Source: ANSI/AIHA Z10, American National Standard for Occupational Health and Safety Management Systems)

This document does not provide formal training on the theory of electricity or these hazards, however, the following section contains details regarding each of these hazards to provide a brief insight into the effects of these hazards and the importance of following of these guidelines.

## 4.1 Electrical Shock

Electrical shock is the most common hazard associated with working on or around energised electrical equipment. This phenomenon occurs when a person’s body becomes the electrical path for current to flow. This can occur by touching an energised electrical conductor, either intentionally or during work or by improperly installed electrical equipment.

Current	Effects
Below 1 Milliampere	Generally not perceptible
1 Milliampere	Faint tingle
5 Milliampere	Slight shock felt. Not painful but disturbing. Average individual can let go. Strong involuntary reactions can lead to other injuries
6 to 25 Milliampere (women)	Painful shocks. Loss of muscle control
9 to 30 Milliampere (men)	The freezing current or “let go” range. If extensor muscles are excited by shock, the person may be thrown away from the power source. Individuals cannot let go. Strong involuntary reactions can lead to other injuries
50 to 150 Milliampere	Extreme pain, respiratory arrest, severe muscle reactions. Death is possible
1.0 to 4.3 Amperes	Rhythmic pumping action of the heart ceases. Muscular contraction and nerve damage occur; death is likely
10 Amperes	Cardiac arrest, severe burns, death is probable

**Table 1:** Effects of different current thresholds on the human body (Source: OSHA 3075)

## 4.2 Arc Flash

An arc is caused by the ionisation of air molecules between two conductors. An electrical arc is also associated with heat (arc welding). When not contained or extinguished, an electrical arc can result in an arc flash. An arc flash can produce temperatures up to 19,400°C (approximately four times the temperature of the sun). An arc flash can occur by the abnormal operation of electrical equipment and a worker in its proximity can suffer severe burns and injuries. Metals and other objects can be melted instantly.

### 4.3 Arc Blast

An arc blast occurs as a result of the intense heat associated with an arc flash, expanding the air within the area of the arc. This explosion pitches molten metal from the blast, heat and sound/pressure waves outwards. Personnel working in the proximity of an arc blast can suffer additional injury to those associated with the arc flash.

It is important to note that an arc can occur during the malfunctioning of equipment being routinely operated. This dictates the necessity for proper precautions to be taken when operating electrical equipment.

### 4.4 Hazard Mitigation

Electrical hazards can occur during normal operation of equipment, as a result of performing live work, equipment failure or because of an unintended electrical path between energised conductors and ground.

It is important that each task be properly evaluated for the hazard(s) that may occur and that applicable methods of hazard mitigation reflecting the six (6) elements of control be employed to protect electrical workers.

In some instances, external hazards may be present with consequences that would exceed the electrical hazards. The preparation of a proper job plan is critical in order to identify these and to alleviate the associated risks.

A risk assessment should always be completed prior to performing works on electrical equipment.



**Figure 2:** Electrical Hazard Mitigation

The final element in any job and the last line of defense is PPE. Arc flash and electric shock PPE should be properly maintained and selected based on the magnitude of the hazards associated with the tasks to be performed. PPE should be tested and certified as outlined within this document.

A second degree burn affects the outer layer of the skin (epidermis) and part of the second layer of skin (dermis). The onset of a second degree burn occurs at 1.2 cal/cm<sup>2</sup>. Second degree burns are easily treatable and as such PPE selection is designed to protect up to the occurrence of a second degree burn.

# 5.0 Training



This section of the document outlines the recommended training to be completed by all companies to ensure the safety of persons who work with and around electricity.

The training outlined below for the respective titles shall be either Computer Based Training (CBT) or Class classroom training developed and facilitated by a certified institution as approved by the PLEA Electrical Safety Sub Committee or NFPA 70E.

The completion of Electrical Safety Awareness Training by a Certified Trainer shall be a prerequisite for the completion of the PLEA Electrical Safety Guideline CBT.

## **a. Qualified Personnel**

- i. Facility Specific Electrical Safety Training – Annually
- ii. Electrical Safety Training
- iii. Competency Evaluation – As required
- iv. Rescue Plan Training – As required
- v. First Aid, CPR and AED specific to Shock Victims and Electrical Burns – Every three (3) years or based on programme expiration
- vi. PLEA Electrical Safety Guideline CBT – two-year refresher.

## **b. Task qualified Personnel**

- i. Facility Specific Electrical Safety Training – Annually
- ii. Electrical Safety Training – Every three (3) Years
- iii. PLEA Electrical Safety Guideline CBT – two-year refresher.

## **c. Unqualified Personnel**

- i. Facility Specific Electrical Safety Awareness Training – Annually

## **d. Emergency Response Personnel**

- i. Electrical Contact Release, First Aid, CPR and AED specific to Shock Victims and Electrical Burns – Every three (3) years or based on programme expiration, whichever comes first.

Company management or training officials shall ensure that training records and/or documentation are updated annually. Where refresher courses are required, these shall be provided for the employee within a three (3) month period of the expiration date. In cases where required training has lapsed by more than one (1) month, the employee should be debarred from the execution of electrical works.

All training records shall be accessible or available to Facility Operators or PLEA ESSC upon a formal written request.

## 5.1 Certified Trainer

The PLEA ESSC shall be responsible for the review and approval of persons or institutes that are designated as Certified Trainers to administer Electrical Safety Awareness Training. A Certified Electrical Trainer shall possess the following and be required to submit to the Committee for review and approval as required:

1. Qualifications and certifications
2. Work experience
3. Certificates of technical training
4. Certificate of NFPA 70E or equivalent training completion
5. Trainer certification
6. Training experience
7. Safety certifications and experience
8. Evidence of electrical safety experience and demonstration

The training course to be administered as a general Electrical Safety Awareness Training shall incorporate the following guidelines:

1. Define electrical safety hazards and how to protect against shock, electrocution and arc flash
2. Identify safety policies and procedures employers are legally required to provide for their workers
3. Describe the safety procedures needed to work safely while exposed to live circuits
4. Determine arc flash PPE categories for many common workplace tasks and conditions
5. Recognise the intent and limitations of PPE
6. Describe requirements for energising and de-energising power circuits
7. Identify the elements of an Electrical Hazard Assessment
8. Use the NFPA 70E Arc Flash PPE Tables to determine Arc Flash PPE category for various tasks
9. Identify safety-related maintenance requirements for a wide range of electrical equipment, including those specific to batteries and battery rooms, electrical distribution equipment, and safety grounding equipment
10. Identify the hazards to personnel working with equipment and employee responsibilities

# 6.0 Electrical Safe Work Rules



This section outlines the rules that all companies and personnel shall be guided to conform with this document.

- a. All electrical repairs and maintenance shall be performed in a de-energised state unless:
  - i. Additional Hazards or Increased Risk - Energised work shall be permitted where the employer can demonstrate that de-energising introduces additional hazards or increased risk.
  - ii. Infeasibility - Energised work shall be permitted where the employer can demonstrate that the task to be performed is infeasible in a de-energised state due to equipment design or operational limitations, e.g. control circuit troubleshooting, infrared scans, phasing out, voltage/current measurement
- b. No live electrical work shall be permitted at voltages 50V or above other than
  - i. Infrared scans
  - ii. Troubleshooting: <600VAC with appropriate PPE, tools, and Safe Work Plan. Consideration should be given to the use of an external power supply with a quick-trip breaker or GFCI to provide additional protection to the employee when troubleshooting of control circuit is required.
  - iii. Measurement of voltages <600V (inclusive of battery bank testing)
- c. All lighting repairs shall be performed de-energised, excluding the replacement of tubes and/or bulbs
- d. It is prohibited to place hands or body parts into an energised enclosure to perform works or tests if there is no line of sight with the energised conductors or illumination levels are below satisfactory levels.
- e. Motor terminal boxes and switchgear/MCC bus covers shall NEVER be opened energised. In cases where inspections or testing is required (>600V) the circuit must be isolated, panel or cover opened, a hard barrier installed around the arc flash boundary. Entry into the barricaded area must only be allowed with the approved PPE based on an arc flash hazard, rated shock protection based on a shock hazard assessment and an approved safe work plan and permit, which include a rescue plan.



- f. All electrical energised Work  $\geq 50V$  inclusive of isolation in preparation for work must be completed with a minimum of two (2) persons and an AED and rescue hook must be on standby.
- g. All electrical energised work  $>600V$  requires a rescue plan to be developed and an emergency response team on standby (This does NOT include isolations).
- h. The normal operation of electrical equipment, which includes isolation, racking in/out of equipment and operation of equipment, may have inherent electrical hazards associated with it and as such, an electrical hazard assessment shall be performed prior to completing these tasks and the necessary precautions implemented.

## 7.0 Guidelines for Energised/De-energised Repair Work



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### 7.1 Energised Repair/Maintenance Work

**Prior to the completion of energised work, the following must be satisfied:**

- a. An Electrical Authorisation to Work Permit must be completed and approved. (Reference NFPA 70E – 2018: Informative Annex J – See Appendix A). This permit may vary at different locations and may be incorporated into another permit.
- b. A hazard assessment shall be completed by qualified workers following the guidelines of NFPA 70E Informative Annex F with the intent to reduce the risk to low by the application of various mitigation procedures. It is recommended that if, after hazard reduction, the risk level is deemed to be high, energised work shall NOT be performed.
- c. A safe work plan must be prepared for the execution of the works and approved by the Electrical Safe Work Authority and Company Management.
- d. An arc flash hazard assessment must be completed and the appropriate PPE be made available.

- e. An electrical shock hazard assessment must be completed and the appropriate PPE be made available.
- f. A rescue plan must be completed.
- g. Personnel performing these works shall ensure that an AED with a trained operator and rescue hook are available at all times.
- h. A documented toolbox meeting must be held and completed outlining the roles and responsibilities of personnel on the crew.
- i. Boundaries must be identified and outlined. Unqualified persons shall not enter the limited approach boundary during these works.
- j. Vitals of the employee undertaking the work shall be performed to ensure physical health does not impede the task to be undertaken.
- k. Change in the scope of works shall result in the entire job being halted and reassessed.

## 7.2 De-energised Repair/Maintenance Work

### 1. Prior to the commencement of de-energised work (which includes switching, isolation and racking-out), the following must be satisfied:

- a. A safe work plan must be prepared for the execution of the works and approved by the Electrical Safe Work Authority.
- b. An isolation and re-energisation plan/procedure must be developed. It is advisable to accompany the procedure with updated one-line diagrams to indicate all sources of energy and isolation points (See Appendix B).
- c. Personnel performing these works shall ensure that an AED with a trained operator and rescue hook are available at all times.
- d. An arc flash hazard assessment must be completed and the appropriate PPE be made available for the purposes of switching/isolation or the hazards associated with nearby energised exposed conductors, whichever is higher.
- e. An electrical shock hazard assessment must be completed and the appropriate PPE be made available for the purposes of switching/isolation.
- f. Boundaries must be identified and outlined. During the de-energisation process, unqualified persons shall not enter the limited approach boundary while the equipment is still energised.
- g. A documented toolbox meeting must be held and completed outlining the roles and responsibilities of personnel on the crew.

### 2. Prior to making contact and removing PPE and performing works:

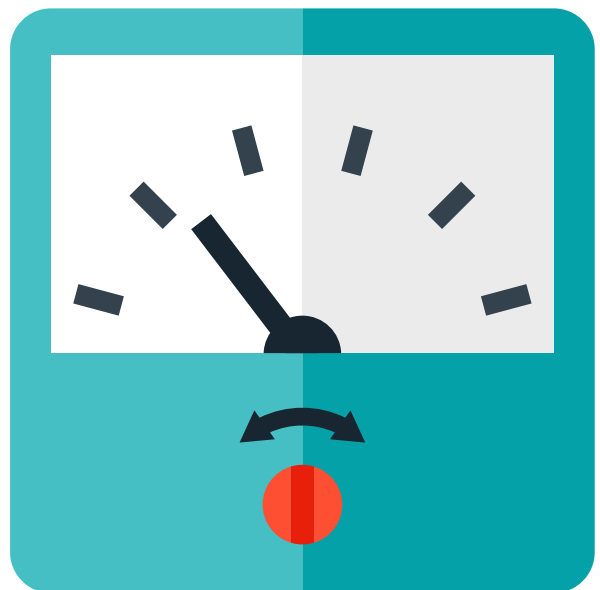
- a. ALL electrical equipment shall be Locked, Tagged and Tried/Checked.
- b. Installation of grounding on all equipment with power sources available. It

is advisable to accompany the procedure with a grounding diagram to show installed grounds and verify removed (See Appendix C).

- c. Verification of the de-energised state by testing against a known source, testing against the equipment to be worked on and retesting against a known source without adjustment of the meter or the test devices. Where applicable, the position of blades or contacts should be verified.
- d. All electrical and mechanical stored energy must be released.
- e. In the event electrical testing has to be performed, the de-energised condition, LTT and permitting associated with the equipment shall be reviewed.

**3. Prior to re-energisation of an electrical system:**

- a. All grounds shall be removed and documented.
- b. PPE appropriate to the electrical hazard assessment must be donned.
- c. An isolation and re-energisation plan/procedure must be reviewed.
- d. Personnel performing these works shall ensure that an AED with a trained operator and rescue hook are available at all times.
- e. All operating voltages and currents should be recorded and documented before equipment handover to ensure that it is in proper working condition.



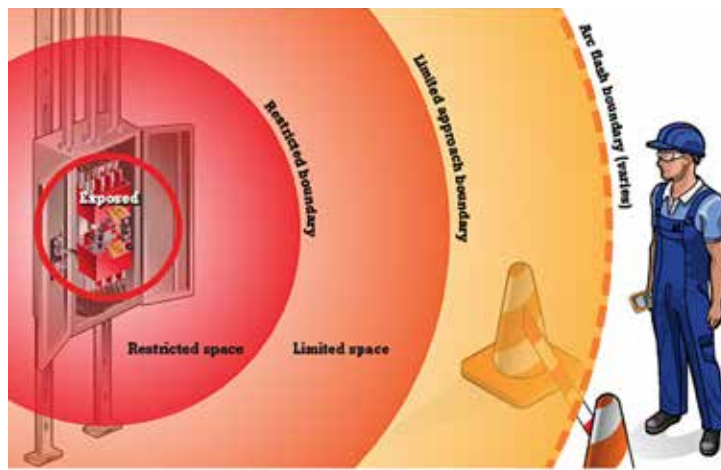
# 8.0 Identification of Electrical Hazards



This section provides the guidelines for the determination of electrical hazards. These analyses shall take place for all energised work as well as for the de-energisation of equipment for the creation of an electrically safe working condition. Energised work includes the utilisation of a meter for testing as well as troubleshooting.

## 8.1 Shock Hazard Assessment

1. All facilities shall routinely perform a shock hazard assessment to identify the applicable shock hazards that exist, so that appropriate PPE shall be available for employees.
2. All persons working on or near energised electrical equipment or portable equipment shall ensure that conductive clothing or jewelry is not worn. This includes wearing metal-frame safety glasses.
3. Prior to the completion of energised work, inclusive of de-energisation to facilitate a safe work condition, a shock hazard assessment shall be completed and the proper PPE selected and donned as identified in the NFPA 70E.
4. NFPA 70E Tables 130.4 (D) (a) and (b) shall be referenced for the typical approach boundaries for energised electrical equipment.



**Figure 3:** Location and Definition of Areas Around Energised Conductors (Source: NFPA 70E Figure C.1.2.3)

(1) Nominal System Voltage Range, Phase to Phase	(2) Limited Approach Boundary – Exposed Movable Conductor		(3) Limited Approach Boundary – Exposed Fixed Circuit Part		(4) Restricted Approach Boundary – Includes Inadvertent Movement Adder	
Less than 50	Not Specified		Not Specified		Not Specified	
50 to 150	10 ft 0 in	3.0 m	3 ft 6 in	1.0 m	Avoid Contact	
151 to 750	10 ft 0 in	3.0 m	3 ft 6 in	1.0 m	1 ft 0 in	0.3 m
751 to 15 kV	10 ft 0 in	3.0 m	5 ft 0 in	1.5 m	2 ft 2 in	0.7 m
15.1 kV to 36 kV	10 ft 0 in	3.0 m	6 ft 0 in	1.8 m	2 ft 7 in	0.8 m
36.1 kV to 46 kV	10 ft 0 in	3.0 m	8 ft 0 in	2.5 m	2 ft 9 in	0.8 m
46.1 kV to 72.5 kV	10 ft 0 in	3.0 m	8 ft 0 in	2.5 m	3 ft 3 in	1.0 m
72.6 kV to 121 kV	10 ft 8 in	3.3 m	8 ft 0 in	2.5 m	3 ft 4 in	1.0 m
138 kV to 145 kV	11 ft 0 in	3.4 m	10 ft 0 in	3.0 m	3 ft 10 in	1.2 m
161 kV to 169 kV	11 ft 8 in	3.6 m	11 ft 8 in	3.6 m	4 ft 3 in	1.3 m
230 kV to 242 kV	13 ft 0 in	4.0 m	13 ft 0 in	4.0 m	5 ft 8 in	1.7 m
345 kV to 362 kV	15 ft 4 in	4.7 m	15 ft 4 in	4.7 m	9 ft 2 in	2.8 m
500 kV to 550 kV	19 ft 0 in	5.8 m	19 ft 0 in	5.8 m	11 ft 10 in	3.6 m
765 kV to 800 kV	23 ft 9 in	7.2 m	23 ft 9 in	7.2 m	15 ft 11 in	4.9 m

**Table 2:** Excerpt of Table 130.4 (D) Shock Protection Approach Boundaries to Exposed Energised Electrical Conductors or Circuit Parts for Alternating-Current Systems

## 8.2 Arc Flash Hazard Assessment

1. All facilities shall routinely review their arc flash hazard assessment to identify the applicable arc flash hazards that exist, so that appropriate PPE shall be available for employees. The recommendation for this is at minimum every five (5) years or when there are major changes to the electrical system.
2. Prior to the completion of energised work, inclusive of de-energisation to facilitate a safe work condition, the arc flash hazards associated with the task shall be assessed. It is the recommendation that a review must be completed and mitigation methods implemented where arc flash hazards are greater than 40cal/cm<sup>2</sup>. Proper arc flash PPE shall be selected and donned when completing works until an electrically safe work condition has been developed.
3. In cases where arc flash studies have not been completed, NFPA 70E Tables 130.5 (C), 130.7 (C) (15) (a) and (b) shall be referenced for the associated arc flash hazard levels and required PPE.

# 9.0 Guidelines for Working Near Energised Equipment



This section provides guidelines for working near energised electrical equipment. This is defined as working in areas which include but are not limited to:

1. Substations/MCCs
2. Incoming power stations
3. Transformer yards
4. Cable trays
5. Cable spiking and discharging

Unqualified persons shall ALWAYS be accompanied by a competent person when entering these areas and/or the limited approach boundary and prior to entry into these areas shall attend a formal toolbox meeting, and the appropriate hazards shall be described and the necessary mitigations implemented. Typical activities completed by unqualified persons include grass cutting, janitorial services, scaffolding construction, civil works and other mechanical tasks.

Prior to working near such equipment or in such areas the following shall be performed:

1. A shock hazard assessment to determine the possibility of electrical shock
  - a. This assessment must ensure that conductive bodily attachments do not extend away to be within the limited approach boundary
  - b. Contact with equipment does not present a shock hazard
  - c. Step potential voltages exist
  - d. Working or walking surface has the potential to be energised based on equipment conditions or environmental factors
  - e. Proper PPE must be selected

2. An arc flash hazard assessment
  - a. This assessment must ensure the activity being performed does not introduce the risk of an arc flash
  - b. Location within the arc flash boundary and external activities that may cause a potential arc flash hazard
3. Handling any equipment, inclusive of cables, shall require a full assessment and properly rated gloves and tools (hot sticks) should be utilised
4. Boundaries and energised electrical equipment shall be clearly identified

# 10.0 Working Near Overhead Lines (Exposed)



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Prior to working near overhead lines the following shall be performed:

1. A shock hazard assessment to determine the possibility of electrical shock
  - a. This assessment must ensure that conductive bodily attachments do not extend away to be within the Restricted Approach Boundary
  - b. Contact with equipment is not possible
  - c. Step potential voltages exist for fallen lines
  - d. Working or walking surface has the potential to be energised based on equipment conditions or environmental factors
  - e. Proper PPE must be selected
  - f. Non-conducting scaffolding equipment should be utilised and where metal equipment is utilised the material shall be adequately grounded
2. An arc flash hazard assessment
  - a. This assessment must ensure the activity being performed does not introduce the risk of an arc flash
  - b. Location within the arc flash boundary and external activities that may cause a potential arc flash hazard

# 11.0 Excavation



Prior to beginning any excavation, the following steps should be adhered to:

1. A comprehensive review of cable layout drawings shall be performed inclusive of a site visit to determine the existence of any underground cables. Cable locators or ground penetrating radars should be considered for use where there may be uncertainty.
2. A detailed safe work and recovery plan shall be developed prior to commencing any excavation to address concerns of electrical shock as a result of accidental exposure of energised cables.
3. A toolbox shall be held with all persons to inform them of the hazards associated with electrical shock which shall include step potential.
4. Where cables have been installed underground and meet the installation requirements identified in NFPA 70 -2017 and are properly identified or protected, motorised equipment may be used until the protection media is identified. This protection method shall be properly documented in the equipment installation manuals. Where reasonably practical, the cables shall be de-energised during the excavation works.
5. Where cables are not properly installed or identified, it is recommended that:
  - a. Cables are de-energised
  - b. Motorised equipment should not be utilised
  - c. Hand tools, non-conductive tools as far as practical are utilised
  - d. A shock and arc flash hazard assessment is performed
  - e. A rescue plan should be developed
6. It is recommended that for all excavation type works a dedicated 'spotter' is designated to look for cables being unearthed.
7. In the event that unidentified cables are unearthed, the excavation shall be stopped. It is recommended that:
  - a. All cables shall be treated as live
  - b. An arc flash and shock hazard assessment shall be completed to determine the PPE required to handle the cables as necessary
  - c. Cables should be isolated as far as practical and inspected for damage and repaired as necessary



- d. Additional excavation shall be performed with a safe work plan, properly identified PPE and non-conductive articles
8. It is recommended that subsequent to the completion of all excavations, proper installation and barriers be installed for underground equipment.

## 12.0 Temporary Protective Grounding Equipment



---

Grounding equipment shall be utilised subsequent to the development of an electrical safe working condition. The purpose of the grounding equipment shall serve to ensure that personnel drain any stored electrical energy prior to making contact with the equipment as well as to protect personnel working on equipment in the event of any unintentional re-energisation of equipment while works are being performed.

General guidelines for the utilisation of grounding equipment

1. Grounding equipment shall be properly labelled and stored when not in use.
2. Grounding equipment shall be inspected prior to every use. Equipment shall be repaired or discarded in the event of any frayed insulation or faulty mechanical clamps.
3. PPE shall only be removed after all grounds have been successfully installed and shall be worn while removing grounds.
4. For equipment such as transformers, both the primary and secondary side of the equipment shall be grounded.
5. In cases where testing is to be performed, grounds may be temporarily removed, however, it shall be reinstalled prior to making contact with the equipment.
6. The ground cables and clamps to be installed must be rated to be higher than the maximum fault current available for the equipment or system on which it is installed and able to withstand the fault for a period longer than the breaker clearing time.
7. It is recommended that a grounding diagram as per Appendix C be utilised for the application and removal of grounds to ensure that proper grounding is completed and all grounds are removed prior to re-energisation of the system.

# 13.0 Portable Equipment Guidelines

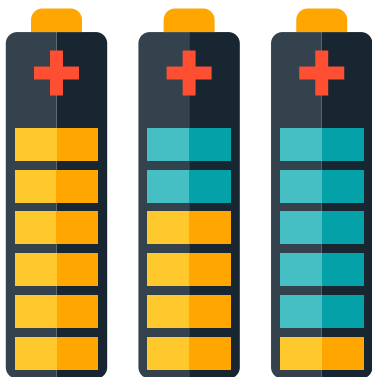


This section outlines the guidelines for use of portable equipment, including but not limited to:

1. Portable electrical cables (extension cords)
2. Portable generators
3. Welding sets
4. Lighting towers
5. Electrical equipment/tools

The following guidelines shall be followed when utilising portable equipment:

1. Shall be installed in accordance with NFPA 70 article 590.
2. All extension leads shall be equipped with a GFCI and a ground lead (except for welding leads).
3. The use of damaged cables is strictly prohibited.
4. Cables with improperly prepared and exposed joints are strictly prohibited.
5. All welding ground leads shall be suitably installed in near proximity (less than 10 feet) from the welding electrode.
6. All portable equipment shall be grounded directly via a ground rod, ground lead or manufactured with a plastic housing.
7. Shall be inspected and tagged as suitable for use.



# 14.0 Electrical PPE, Tools and Equipment



In accordance with the NFPA 70E, PPE, tools and equipment shall be defined as the following:

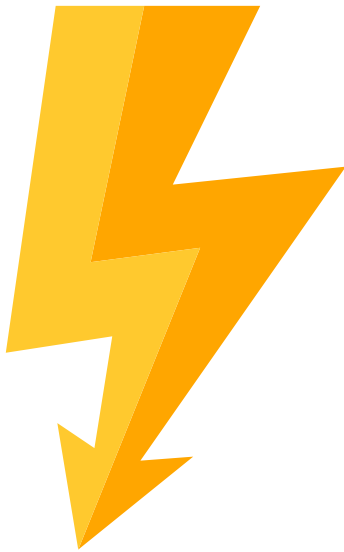
1. Grounding equipment
2. Hot sticks
3. Rubber gloves, sleeves, and leather protectors
4. Test instruments
5. Blankets and similar insulating equipment
6. Insulating mats and similar insulating equipment
7. Protective barriers
8. External circuit breaker rack-out devices
9. Portable lighting units
10. Temporary protective grounding equipment
11. Dielectric footwear
12. Protective clothing
13. Bypass jumpers
14. Insulated and insulating hand tools



**Figure 4:** Various Electrical PPE and Tools

The following rules shall apply to PPE, tools and equipment:

1. All PPE shall be maintained and stored as per manufacturers' recommendations in a manner that does not compromise its functionality nor does it pose additional risk to the personnel utilising the equipment.
2. All PPE shall be selected and tested as guided by the relevant standards listed in Table 130.7(C)(14) Informational Note: Standards For Personal Protective Equipment (NFPA 70E). At a minimum, contractors shall ensure that hot sticks are tested every three (3) years and gloves are tested every six (6) months.
3. All PPE shall be tested in accordance with these guidelines at an approved testing facility or by approved methods and the test certificates shall be available upon request.
4. All PPE shall be inspected visually prior to use to ensure that it is physically suitable for use.
5. Arc flash PPE that is worn in layers must be tested and certified to illustrate the ATPV rating of the layered material. Companies shall ensure that this is performed whenever there is a change in the materials being utilised.
6. Electrical tools shall be routinely visually inspected and tested in accordance with manufacturers' recommendations.



# 15.0 Labels and Alerting Techniques



This section defines the rules for labels and alerts applicable to electrical equipment.

1. All areas designated for the permanent storage and containment of electrical equipment shall be properly labelled to alert of electrical hazards.
2. All electrical equipment inclusive of cabinets containing electrical power (control or otherwise), greater than 50V shall be affixed with a label identifying an electrical hazard.
3. All electrical distribution and control equipment shall be labelled to identify the following:
  - a. Nominal system voltage
  - b. Arc flash boundary
  - c. Maximum incident energy and PPE required
4. Energised overhead lines shall be properly labelled and identified with barriers identifying the limited approach boundary.
5. Energised underground cable trenches shall be properly labelled with appropriate signage.
6. Temporary installed electrical cables energised with a voltage >120V shall be properly labelled and cordoned off.
7. All energised electrical work, inclusive of switching, shall be properly secured with barriers and warning signs to mitigate against the entrance of personnel not related to the task.

<b>⚠ WARNING</b>	
<b>ARC FLASH &amp; SHOCK HAZARD</b>	
480V	Nominal System Voltage
4 Ft 8 In	Arc Flash Boundary
3 Ft 0 In	Limited Approach Boundary
1 Ft 0 In	Restricted Approach Boundary
25.7	Incident Energy (cal/cm <sup>2</sup> )
<b>PPE Required:</b> Arc-Rated Long-sleeved Shirt, Pants or Coverall Hard Hat, Blast-Resistant Face Shield (rated equal to or greater than listed Incident Energy) Safety Glasses or Goggles Hearing Protection (ear canal) Leather Footwear Shock Protection: Gloves Class 00, Voltage-rated Tools	
Equipment ID: Panel #123      Location: Main Building Date of Arc Flash Risk Analysis: 1-1-15	

Figure 5: Typical Arc Flash and Shock Hazard Label

# 16.0 Special Equipment Considerations



This section relates to equipment that is not defined as electrical equipment and may be operated on or by persons who are neither qualified nor competent, however, the equipment and interaction with the same may pose a significant electrical hazard that must be reviewed. Such equipment includes but is not limited to:

1. HVAC systems
2. Elevator/lift systems
3. Welding machines
4. Portable lighting machines
5. Fire and gas systems
6. Communication equipment

The following guidelines are recommended to be followed by personnel maintaining such equipment:

1. Personnel shall undergo specific electrical safety training to aid them in the identification of electrical hazards.
2. Personnel shall be equipped with the necessary PPE rated to mitigate against the hazards associated with the repair procedures and shall be able to identify the necessary hazards associated with the tasks being performed.
3. All such equipment shall be clearly marked as containing hazardous electrical energy and cordoned off when works are being performed.
4. Personnel in such positions shall ensure that they reasonably isolate and LTT power sources when performing troubleshooting and maintenance functions. Where applicable, panels, doors and covers shall be closed at all times during these procedures.
5. It is recommended that a detailed work plan is developed where energised works are to be performed and reviewed and approved by site personnel.
6. Where live work is to be performed, the site shall ensure that all permitting procedures are followed.

# 17.0 Contractors/Service Providers



All contractors and service providers working within the Point Lisas Industrial Estate shall adopt this document and the training specified. As a contractor working on the facilities, the training specified within this document shall be adhered to and records shall be kept.

The following shall be the procedure for electrical contractors to commence work at a facility:

1. Presentation of certificate of completion of Electrical Safety Awareness as a prerequisite for employees to complete PLEA Electrical Safety CBT at the training institution.
2. Completion of PLEA Electrical Safety CBT and examination. Module completion will be uploaded to the PLEA Passport.
3. Verification by facility personnel of completion of the training module prior to the engagement of a contract.
4. Provision of PPE and tools as required for the completion of work on the facility as dictated by the tasks to be performed.
5. Test certificates for PPE and tools shall be made available for review and verification by the facility personnel.



# 18.0 General Notes and Guidelines



The following is a listing of best practices that all companies operating within the Point Lisas Industrial Estate should utilise within their facilities:

1. All electrical relays that trip under ground fault conditions should NOT be reinstated until Competent Persons review the system and deem the equipment healthy. The exceptions are GFCIs, for which only one (1) reset is allowed.
2. Infrared inspection windows should be considered for installation to reduce exposure to live conductors.
3. All electrical works shall be completed within line of sight and the area must be properly illuminated. The job shall be reassessed where there is not proper access to the equipment or obscured visibility.
4. Energised electrical work shall NOT be completed in a Confined Space.
5. All energised electrical work, inclusive of de-energisation to complete works, shall be completed with no less than two (2) persons.
6. All electrical equipment shall be installed and designed in a manner that conforms to an approved standard to ensure that personnel are protected under normal operating conditions and that protection is available for abnormal operation.
7. All facilities should ensure that a maintenance programme is established and implemented to improve the reliability and safety of the equipment, thereby protecting personnel who come into contact with the equipment.
8. All equipment shall be routinely inspected to ensure the proper function of the equipment and to detect any hazards or anomalies.
9. All facility operators should routinely perform power system studies to validate the levels of protection of the electrical equipment, electrical hazards presented by the equipment on the facility and to ensure proper coordination is available. It is recommended that a period of five (5) years between studies should be the minimum.
10. All facility operators should review existing electrical equipment operation and hazards and implement strategies to reduce electrical hazards as applicable, specifically where the incident energy exceeds 40 cal/cm<sup>2</sup>. Examples of such strategies include but are not limited to Quick-Trip devices, 'Chicken Switches', remote operating consoles and SCADAs.



11. All facility operators should perform audits on installed equipment to ensure that protective covers and guards are properly installed, and shall repair equipment where there is open equipment with exposed energised conductors.
12. All facility operators shall properly label ALL electrical areas with signage that is permanently installed and visible.
13. All facility operators shall implement programmes to review and audit all electrical equipment entering into the facility to ensure that they are in proper working condition and are free from defects.
14. During the preparation of a safe work plan, the hazard with the largest risk, even if not electrical in nature, shall be reviewed and mitigating factors implemented.
15. Electrical incidents shall be investigated and considerations should be given to share the outcomes of the review for improved safety across the industry.
16. All electrical facilities and programmes shall be routinely audited to ensure the adequacy of the programmes and determine gaps to be addressed in the execution of the programme.
17. All electrical equipment shall be properly bonded to ensure the protection of personnel from electrical touch hazards associated with loose energised conductors.
18. Electrical work should not be performed where energised equipment or cables can come into contact with water.
19. Electrical cables that are disconnected for maintenance or repair works should be properly secured and sealed from water ingress as well as grounded where permissible.



# 19.0 Audit



The PLEA ESSC shall be responsible for auditing and validation of the implementation of this document which shall include but not be limited to:

1. Development and execution of audit procedures for facilities
2. Review of certification of contractor employees for the general electrical safety awareness programmes
3. Review of PLEA Electrical Safety CBT results and statistics
4. Review of testing and certification for electrical tools and equipment

# 20.0 References



1. 1910.269 Electrical Safety – OSHA Requirements for Electric Power Generation, Transmission and Distribution
2. ANSI/AIHA Z10 Occupational Health and Safety Management Systems
3. IEC 60038 – IEC Standard Voltages
4. NFPA 70 – National Electrical Code
5. NFPA 70B – Recommended Practice for Electrical Equipment Maintenance
6. NFPA 70E – Standard for Electrical Safety in the Workplace 2018
7. Nucor Tier 1 and Tier 2 Electrical Safety Standard
8. Point Lisas Nitrogen Limited Electrical Safe Work Policy
9. Point Lisas Nitrogen Limited Electrical Safe Work Procedure
10. PotashCorp Workplace Electrical Safework Guidance Document
11. TTS 171:Part 1: 2015 – Trinidad and Tobago Electrical Wiring Code Part 1: Low Voltage Installations
12. TTS 171:Part 2: 2002 – Trinidad and Tobago Electrical Wiring Code Part 1: High Voltage Installations
13. Yara – Tops-1-19 – Electrical Safe Work Compliance Document

# 21.0 Main Contributors



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## 21.1 Independent Review

This document was independently reviewed by Randy Barnett. Randy Barnett is an NFPA-certified electrical safety compliance professional with more than 35 years of industrial electrical construction, maintenance and training experience. He has worked as a journeyman electrician in nuclear and coal-fired power plants, on railroad locomotives and in various manufacturing environments. He is the author of “Commercial and Industrial Wiring” from ATP Publishers, the EC&M Book, “Introduction to Industrial Electrical Maintenance” as well as numerous articles. Randy conducts electrical code and safety classes and consulting worldwide and holds the NCPCCI General Electrical Inspector Certificate. He is the Programme Manager for Electrical Codes and Safety for NTT Training.

# Appendix A:

## NFPA 70E – Annex J: Energised Work Permit

ENERGIZED ELECTRICAL WORK PERMIT	
<b>PART I: TO BE COMPLETED BY THE REQUESTER:</b>	
Job/Work Order Number _____	
(1) Description of circuit/equipment/job location: _____ _____	
(2) Description of work to be done: _____ _____	
(3) Justification of why the circuit/equipment cannot be de-energized or the work deferred until the next scheduled outage: _____ _____	
Requester/Title _____	Date _____
<b>PART II: TO BE COMPLETED BY THE ELECTRICALLY QUALIFIED PERSONS <i>DOING</i> THE WORK:</b>	
	<b>Check when complete</b>
(1) Detailed description of the job procedures to be used in performing the above detailed work: _____ _____	<input type="checkbox"/>
(2) Description of the safe work practices to be employed: _____ _____	<input type="checkbox"/>
(3) Results of the shock risk assessment: _____	
(a) Voltage to which personnel will be exposed	<input type="checkbox"/>
(b) Limited approach boundary	<input type="checkbox"/>
(c) Restricted approach boundary	<input type="checkbox"/>
(d) Necessary shock, personal, and other protective equipment to safely perform assigned task	<input type="checkbox"/>
(4) Results of the arc flash risk assessment: _____	
(a) Available incident energy at the working distance or arc flash PPE category	<input type="checkbox"/>
(b) Necessary arc flash personal and other protective equipment to safely perform the assigned task	<input type="checkbox"/>
(c) Arc flash boundary	<input type="checkbox"/>
(5) Means employed to restrict the access of unqualified persons from the work area: _____ _____	<input type="checkbox"/>
(6) Evidence of completion of a job briefing, including discussion of any job-related hazards: _____ _____	<input type="checkbox"/>
(7) Do you agree the above-described work can be done safely? <input type="checkbox"/> Yes <input type="checkbox"/> No    (If no, return to requester.)	
Electrically Qualified Person(s) _____	Date _____
Electrically Qualified Person(s) _____	Date _____
<b>PART III: APPROVAL(S) TO PERFORM THE WORK WHILE ELECTRICALLY ENERGIZED:</b>	
Manufacturing Manager _____	Maintenance/Engineering Manager _____
Safety Manager _____	Electrically Knowledgeable Person _____
General Manager _____	Date _____
Note: Once the work is complete, forward this form to the site Safety Department for review and retention.	
© 2017 National Fire Protection Association	NFPA 70E

Figure 6: Sample Electrical Safe Work Permit (Source NFPA 70E)

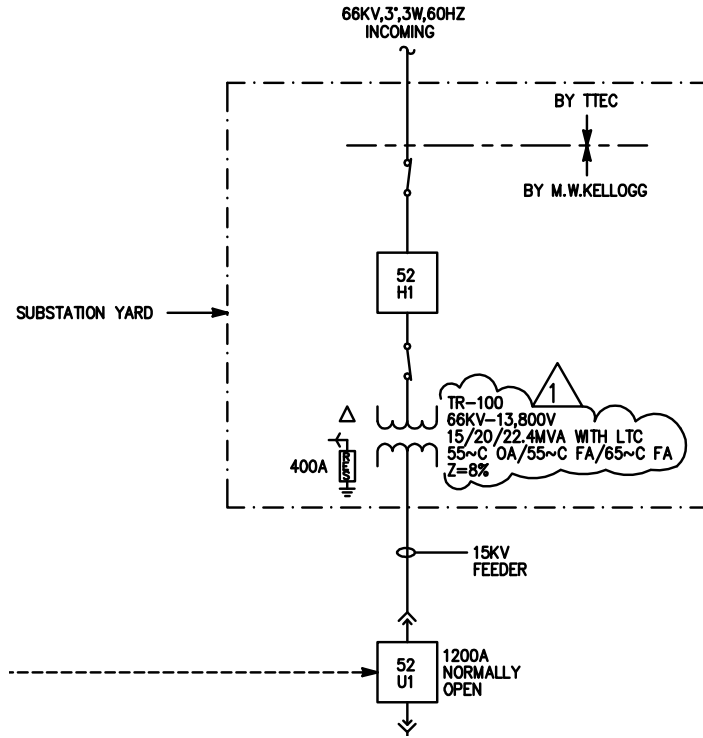
# Appendix B:

## One Line Verification Legend

Asset No: <i>TR1234</i>	Equipment Location: <i>Main Substation</i>	Date: <i>1/1/2019</i>	
Task: <i>To perform Preventative Maintenance on TR1234</i>			
Permit No: <i>123456</i>	Work Order No: <i>54321</i>	Crew: <i>E&amp;I</i>	Supervisor: <i>J Doe</i>

Isolation Location and description	LTT Applied	Isolation completed by (Signature)	Verified by (Operations - Signature)	Isolation Removed by (Signature)	Verified by (Signature)	Date

Sketch or attach a single line diagram indicating the area of work and the isolation points.



Notes:

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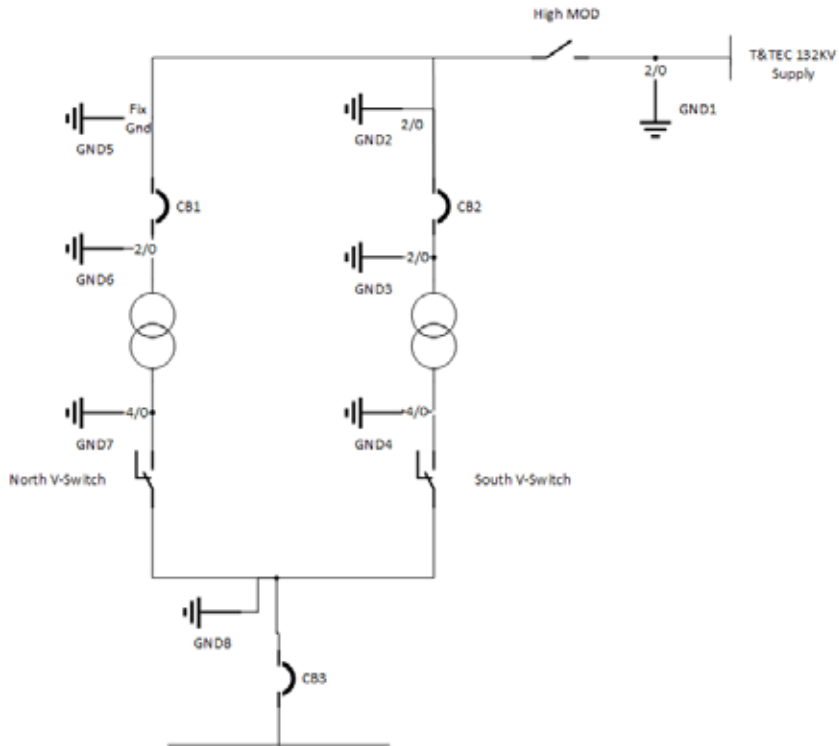
Isolation Plan Completed by:		Reviewed by:	
Job Completed:		Accepted by: (Operations)	

# Appendix C:

## Electrical Grounding Legend

(Source: NUCOR Electrical Safe Work Practices)

Type and Location of Applied Ground	Labelling on Grounding Diagram	Ground Applied by (Signature)	Verified by (Signature)	Ground Removed by (Signature)	Verified by (Signature)	Date
	G1					
	G2					
	G3					
	G4					
	G5					
	G6					
	G7					
	G8					



### 132KV Switchyard Grounding

Grounding point G1-G7 indicates location and size of grounding cable.

**Note: If the size of grounding cable required is not available, use the next larger available size.**