Bangladesh Power Development Board

INTEGRATED MANAGEMENT SYSTEM
(BASED ON ISO 9001:2015, ISO 14001:2015 & ISO 45001:2018 STANDARDS)

ELECTRICAL SAFETY PROCEDURE

1 Purpose

The purpose of this electrical safety procedure is to promote an electrically safe workplace free from the exposure to electrical hazards for all employees and contractors of BPDB.

Also, this procedure documents the electrical safety for working in hazardous areas of the BPDB plant, and establish requirements and controls for implementation.

2 Scope

This document applies to all personnel who are all involved in the operation, supervision and maintenance of electrical equipment and in hazardous areas of BPDB plant.

The electrical safety procedure shall also apply to all subcontractors and any individual performing electrical work or using electrical equipment in BPDB.

3 Terms and Definition

There is a danger of an explosion or fire occurring wherever combustible material is handled. This aspect of safety has become more important at work as BPDB has become an installation using Natural Gas for firing of the gas turbine. To prevent any electrical equipment from becoming a source of ignition for an explosion, safety measures need to be in place to prevent explosions during maintenance work.

a. **Authorized PTW issuer -** Person who is competent and is authorized for lockout or tag out a specific machine or equipment shall perform isolation of Electrical equipment for service or maintenance. A Person must be certified as an Authorized PTW issuer in order to apply a lock or tag to control hazardous energy.
b. **De-energized electrical work** - Electrical work that is performed on equipment that has been previously energized and is now free from any electrical connection to a source of potential difference and from electrical charges.
c. **Disconnecting (or isolating) switch -** A device designed to isolate an electric circuit or Equipment.
d. **Energy source -** Any source of electrical, mechanical, hydraulic, pneumatic, chemical, thermal or other energy.
e. **Exposed Electrical parts -** Energized parts that can be inadvertently touched or approached nearer than a safe distance by a person. Parts not suitably guarded, isolated, or insulated. Examples include terminal contacts or lugs, and bare wiring.

f. **Current –** (measured in amps/amperage) - Term used to describe electric flow. It is current that can cause electric shock. However, the flow of current depends on the circuit voltage and resistance.

g. **ELCB -** Earth Leakage Circuit Breaker provides additional protection from shocks by shutting off supply to equipment when a change in electricity is sensed.

h. **Grounding -** Provides a safe path for the leakage current to the earth. It prevents leakage current to cause damage to other component or prevents shock in case of insulation failure. The creation of conductivity path for electricity between a circuit and the equipment to ground.

i. **High Voltage -** Electrical system or equipment operating at or intended to operate at a sustained voltage of more than 1000 volts (IEEE standard).

   I. **Low Voltage**– Electrical system or equipment operating at or intended to operate at a sustained voltage of 1000 volts or less.

   II. **Resistance –** The ease with which electricity flows through the material (conductor). Materials (conductors) with higher resistance properties can become hot (Measured in ohms)

Abbreviations

BPDB – Bangladesh Power Development Bboard

4 Roles and Responsibility

Plant Manager / Managing Director - Provides for all the arrangements required to the implementation of this procedure.

Manager - Electrical Maintenance - responsible for updating this procedure according to regulatory and other requirements

Maintenance Manager and Operation Manager: responsible for ensuring that this procedure is adhered to by the relevant Maintenance and Operation personnel respectively

MR shall ensure this procedure is implemented and complied with PROCEDURE

5 Procedure

5.1 **Common electrical hazards in a power plant:**

5.2 **Electrocution**

6 Falls

1. Confined Spaces (engulfment)
2. Fires and Explosions

Implement the Hierarchy of Controls to reduce risk. The controls are:

a) Elimination - moving a power control station from a raised platform to ground level,

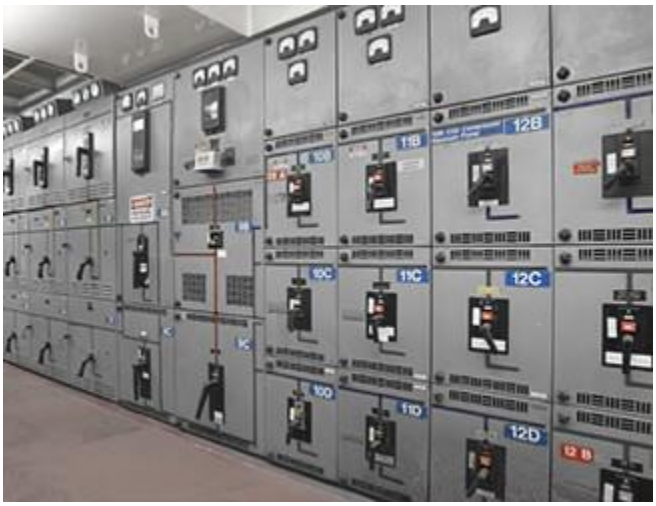
ensuring that the fall hazard no longer exists.

Substitution - replacing a severe hazard with a less severe one. For example, using textured floor tape instead of floor paint to reduce risk of a slip and fall.

b) Engineering Controls - employing a physical barrier that protects workers from a hazard. Examples include machine guards, railings, or locked-out machines.

c) **Awareness** - providing information to allow employees to make safe decisions through *clear and obvious signage, specific machine training, and other education.*

d) ***Administrative Controls*** *- using specific policies (like powering down a machine before* maintenance) to limit employee exposure to a hazard.



e) Personal Protective Equipment - using protective clothing and equipment to limit employee injuries from a harmful event, like arc rated clothing or a fall harness. It is important to note that PPE is the last solution in the hierarchy.
It is the final line of defense between a worker and common power plant hazards. The first five steps are about preventing the hazard from ever occurring, while the sixth is assuming the worst-case scenario (the hazard still exists and may harm the worker) and tries to mitigate risk.

6.1 CLASSIFICATION OF HAZARDOUS AREAS

According to National Electrical Code (NEC), America, hazardous areas may be classified into Class and Division. The class defines the types of hazardous material in the vicinity of the ignition source.

Class I Location - An area where flammable gas or vapor are or may be present in the air in quantities sufficient to produce explosive or ignitable mixture.

Class II Location - An area where presence of combustible dust presents a fire or explosion hazard.

Class III Location - An area made hazardous because of the presence of easily ignitable fibers or flying but in which such fibers or flying are not likely to be in suspension in the air in quantities sufficient to produce ignitable mixtures.

The Division defines the probability of the explosive material coming into contact with the ignition source.

Division 1 - Area where the hazard exists under normal operating conditions or due to frequent maintenance work.

Division 2 - Area where ignitable gases or vapors are handled, processed or used, but which are normally in closed containers or closed systems from which they can only escape through accidental rupture or breakdown of such containers or systems.

Except for very few areas, the majority of the areas in the power stations are classified as Class I Div. 2.

Abbreviations

BPDB – Bangladesh Power Development Board

6.2 CLASSIFICATION OF THE GASES BY GROUPS

Combustible and flammable gases and vapors are divided into four groups.

Groups A to D, according to American, NEC code. Group A being the most difficult to control as they create the most pressure during explosion. Group D is the least explosive. Hydrogen gas is classified as a Group B gas. Ammonia and Natural Gas is in Group D.

The European, IEC standard, groups gases into three. Group IIB and IIC. The most explosive being Group IIC and Group IIA the least. Hydrogen gas is classified as being in Group IIC. Ammonia and Natural Gas as Group IIA.

The Japanese, Ministry of Labor standard, classify explosive gases by combustion characteristics into three degrees: 1, 2 and 3. The larger the number the more easily the gas is ignited. Hydrogen gas comes under degree 3. Ammonia and Natural Gas degree 1.

6.3 TEMPERATURE RATINGS

The classification is based on the maximum internal or external temperature attainable by the equipment. T1 has the highest temperature of 450^{o}C and T6 has the lowest of 85^{o}C. The temperature attainable by the equipment used must be lower than the ignition temperature of the gas for safety.

The Japanese, Ministry of Labor standard, classify explosive gases into five ignition degrees by ignition temperature; G1 to G5. The larger the number, the lower the ignition temperature, i.e. more hazardous. The ignition degree for Ammonia, Hydrogen and Natural gas is G1.

The classifications may be compared for the three commonly used gases in BPDB in tabular form as follows:

Material	American (NEC)	European (IEC)	Japanese
Natural gas	Gp D	Gp IIA/T1	1G1
Ammonia gas	Gp D	Gp IIA/T1	1G1
Hydrogen gas	Gp B	Gp IIC/T1	3G1

6.4 METHODS OF PROTECTION USED FOR EQUIPMENT

In the power station, three methods of protection are employed for safety purposes. The salient points associated with each of them are presented below.

6.5 **Flame Proof/Explosion Proof Equipment (Ex-d)**

The enclosure of the electrical equipment can withstand an internal explosion and prevent the ignition of external gases. Cables must enter the enclosure via flame-proof glands or if conduit entries are used, properly filled “stopper” fittings must be used.

6.6 **Intrinsically Safe Equipment (Ex-i)**

The energy of the electrical circuitry is too low to ignite the most readily ignitable mixture of gas (or vapor) with air. Since the energy is incapable of causing an explosion, it is possible to carry out maintenance of the equipment without isolation of supply.

6.7 **Increased Safety Equipment (Ex-e)**

The electrical equipment does not produce arcs or sparks in normal service. Additionally, measures to reduce the possibility of excessive temperatures on the enclosures are employed. Equipment will be imprinted with the gas grouping and the temperature classification for which it is safe for use.

CHECKLIST AND IMPORTANT POINTS FOR CONSIDERATION DURING MAINTENANCE WORK

5.6.1 Electrical 24 V System Safety Procedure

- Only 24v hand lamp sets should be used while work inside Confined Space. To take 24V supply, use portable 240/24v transformer with Industrial socket fixed box.
- Ensure that transformer incoming supply to be taken through 30 milliamp rated ELCB.
- 240/24v transformer both primary and secondary sides earth wire should be connected properly and checked before usage.
- Portable transformer should be fixed in non-conductive material box.
- Use correct (Violet) color Plug and socket for 24v supply.
- Use 3-core fixable cable. Do not use bare wires.
- Use 240V socket supply for the portable transformer, which is nearest from the working place.
- Do not use damaged or PVC insulation taped cable
- Use only ECLB mounted Extension cables.

5.6.2 Electrical 110/ 230 V system

- All electrical portable hand tools to be tested as per Portable and Powered Hand Tools program.
- Three core extension cable to be used.
- Earth wire to be connected properly and checked regularly.
- Ensure suitable color Plug and socket to be used. (110 V - Yellow, 220 V - Blue)
- ELCB mounted extension to be used.
- 110V socket supply not available in plant. If 110v supply is required, Use portable 240/110v transformer.
- Use of 110/230V Hand lamp sets is not allowed in Confined Spaces and wet places.

5.6.3 Electrical 415V system

- 15 V breaker rack in and rack out to be done as per procedure
- Three phase portable extension cable to be used with ELCB
- Temporary cable joint is not allowed
- To do any maintenance on 415 V systems, it is advisable that two persons carry out the job.
- While working on 415V MCC panel's individual MCC:
  - Check breaker KKS code
  - Do not open other module door
  - Do not operate other MCC breakers.
  - After disconnecting the power cable from the system like Motor and panels cable core end should be taped and secured properly.
  - After reconnection at the motor or panel end always check power cable's IR value (Insulation value) to by 1000 V Megger. Energize the system only if IR value is OK.
  - During operation of breakers do not touch the panel/breakers.
  - Do not open MCC door when breaker is 'ON'.
- All panels Earth resistance value to be checked& maintained periodically.
- For all electrical works, use only 1000V certified insulated tools.
- Hand tools should not be kept inside panels.

- After completion of job, check inside the panel thoroughly and only then close the panel doors.
- All MCC panel's bus bar IR value to be checked periodically and same to be attended if IR value is less than the standard acceptable value.

5.6.4 Electrical 11kv system

- 11 kV breaker rack in rack out training is given to Operation staff and Electrical Team. Procedures are posted in all 11 kV switchgear rooms. This procedure is to be strictly followed.
- Arc Flash suit, headgear and rubber gloves of proper rating must be used while racking in or racking out the 11 kV breakers.
- Any job on 11 kV systems should be carried out by at least 2 persons.
- It is highly recommended that a second person (witness) is positioned preferably close to an exit while witnessing the rack in, rack out operation and communicates the steps to the control room.
- Verify KKS tag before opening the isolated breaker's backside door.
- After taking out the Breakers from cubicle Bus bar shutter should be closed and locked, if Bus bar shutter is not closed and locked then nobody is allowed to do any jobs inside the cubicle.
- Before disconnecting any 11kv cable, earth switch must be applied on power cable.
- Check breaker earth switch operation during annual shutdown or during breaker PM.
- Test breaker earth switch and breaker interlock annually.
- Apply temporary earth before starting any job on 11KV bus bar.
- While racking in and racking out the Breakers, standard PPE must be used.
  - Wear Helmet, Electrical rated Safety Shoes and work clothes when working on the Electrical equipment.
  - Wear the Arc flash suit & proper rated insulating HV rubber gloves on both hands.
- Before starting any job in 11kV motor terminals temporary earth should be applied to discharge.
- After connecting the 11kV cable in motor terminals and panels earth connection and tightness to be checked.

- Complete plant earth resistance should be checked & maintained periodically.

6.8 General Electrical Safety

- Up to date electrical drawings should be available in respective switchgear rooms.
- If any electrical or instrumentation devices, tools, parts, machinery, etc. shows evidence of defect or damage that might expose an employee to injury, the defective or damaged item must be tagged “DO NOT USE” and removed from service. Do not remove the tags until the equipment is repaired and tested by a qualified person. It is not to be used until repairs and a qualified person has made tests necessary to render the equipment safe. If the defective piece cannot be repaired and returned to a safe working condition, then it is to be removed from the workplace
- Do not wear exposed jewelry such as watches, rings, necklaces, earrings, etc. when working around exposed electrical equipment.
- Do not wear loose fitting clothing such as ties, un-tucked shirts, etc. when working near equipment where it would be likely to become entangled.
- Do not perform housekeeping duties near exposed energized parts unless a barrier or insulating device is used.
- Maintain sufficient access and working space around all electrical equipment to permit safe operation and maintenance of such equipment.
- Maintain proper lighting for all switchgear areas.
- Flash suits, rubber gloves and headgear should be placed in proper position and should be inspected before use.
- Tools required for racking in and racking out of breakers should be kept at the designated place.

6.9 Training

Operation representatives conducting rack-in/rack-out: CCR Engineer, BOP & Power Block Engineers, Shift Charge Engineer and Electrical Maintenance team members will be trained to operate electrical system. Electrical breakers operation course will be conducted for necessary Technical staff of Operation and Maintenance.

People who have suitable qualification and requisite experience will do maintenance of electrical system. People will be trained on all aspects of electrical system.

6.10 FIRST AID AND EMERGENCY PROCEDURES

6.10.1 BURNS

Burns are caused by dry heat such as fire, **electricity**, strong acids and alkalis.

Burns Covering Small Area	Burns Covering Extensive Area
i. Allow cold tap water to run gently over the area or immerse in cold water. ii. It may be necessary to cover with gauze or a clean handkerchief, and bandage.	i. Allow person to lie down. ii. Cover burned areas with sterile dressing or clean cloth and lightly bandage. iii. If clothing is adhering, do not disturb; leave the clothing alone. iv. Keep person warm. If person is not nauseated, he may have sips of water. v. Arrange for immediate medical care. (Call 997 for ambulance.)

NOTE :	Do not use ointments, greases, pastes or powder on burned area. Do not prick the blisters caused by burns.

Tetanus Immunization

Protection against tetanus should be considered whenever the skin is broken by injuries.

6.11 ELECTRIC SHOCK

i. If possible switch off current.

ii. If not, remove casualty from contact with electric source using non-conductive articles like a dry broom handle or dry rope. Insulated Rod is available in all the switchgear for this purpose

iii. Do not touch patient directly, or with object that will conduct electricity.
(Examples of objects that are electricity conductors: iron, metal, wet clothing, etc.)

iv. Give Rescue Breathing if breathing has stopped.
(See "Artificial Respiration" Instructions ii, iii, iv, v and vi.)

v. Call Emergency Hotline…….

6.12 **ARTIFICIAL RESPIRATION, RESCUE BREATHING TECHNIQUE**

To be used for a person who has CEASED BREATHING due to drowning, choking, electric shock or other causes.

vi. Wipe out any fluid vomits, mucus or other objects from the mouth with fingers.
Be certain to reach into the throat with finger in case there is an object blocking the throat.
Remove clothing to expose chest.

vii. Place person on his back, place hand or soft object under neck,
and keep the head tilted back as far as possible.

viii. Grasp the angles of the jaw below the ears and lift the jaw so that it juts forward.
This will keep the tongue away from the back of the throat, so that air can get in.

ix. Pinch nose with your fingers and blow breath into mouth with smooth,
steady action until the chest is felt of seen to rise.

x. Remove your mouth.
Allow lungs to empty.
This action should be repeated at the normal breathing rate, i.e. 12-15 times a minute.

xi. The purpose is to make the chest move as it would normally.

xii. Have someone contact a doctor.

THE EFFECT OF CURRENT ON HUMAN BODY	
CURRENT	**EFFECT**
1 mA or less	No sensation, not felt
More than 3 mA	Painful shock

More than 10 mA	Local muscle contractions, sufficient to cause “freezing” to the circuit for 2.5 percent of the population
More than 15 mA	Local muscle contractions, sufficient to cause “freezing” to the circuit for 50 percent of the population
More than 30 mA	Breathing is difficult, can cause unconsciousness
50 mA to 100 mA	Possible ventricular fibrillation
100 mA to 200 mA	Certain ventricular fibrillation
More than 200 mA	Severe burns and muscular contractions; heart more apt to stop than to go into fibrillation
More than a few amperes	Irreparable damage to body tissue

7 Reference

Electrical Safety

8 Appendices

Electrical First Aid and Emergency Procedures

9 Revision History

Sl No.	Revision Number	Section	Change Made	Date of Revision
