

REFOCUSING ELECTRICAL SAFETY ASPECTS & ITS REGULATORY REQUIREMENT IN POWER PLANT

Vikas Kumar Jha¹, Ranjeet Kumar²

¹M.tech Student, Industrial safety, SKSITS, Indore

²Dean, SKSITS, (Indore)

ABSTRACT- Electrical energy required special attention because of its hidden inherent hazard which can be fatal to the user as exposure to electrical hazard has very high severity or consequences. Evolution & control of risks from electrical hazards is mandatory requirement for safe operation & use of electrical equipment. It is therefore necessary that the user takes care of safety to a great extent by obeying electrical safety and its regulatory statutory requirements on highest priority bases & avoid the risk associated with the activity by adopting all hierarchy of control measures. Most of electrical accidents are avoidable and occur as a result of carelessness, lack of training, poor workmanship or due to faulty equipment. Electrical safety related work practices should be followed to protect workers from the hazards of electrocution through training, procedures such as lockout/ tag out and the use of personal protective equipment. The need for higher reliable power system demands makes serious consideration for electrical protection system which includes controlling & designing of equipment. Many of the features for electrical equipment safety are inherent in the original design. It is believed that adhering to the safety measures suggested for the different mechanical & electrical related works will greatly reduced the number of injuries to personnel at the work site. The aim of the paper is to promote awareness in the electrical safety by identifying and analyzing root causes of electrical accidents.

Keywords- Electric Hazards, Electrical safety, Electric flashover, Electric shock, safety by design, Operation & maintenance safety, Earthing, Electrical Act.

1. INTRODUCTION

Mechanical & electrical hazards are generally not recognized because of their hidden inherent character they increase the vulnerability or risk level of workers. Majority of electrical & mechanical accidents are due to unsafe action of workers because of their lack of awareness & education. The major share of these accidents is accounted by contractor labor due to their unsafe act, this contractor labor are unskilled belonging from unorganized sector having little or low awareness regarding these hazards.

Another reason is not adopting proactive safety management system. The well planned and organized safety management activities are the backbone to prevent and control work place hazards at electrical installation. Involvement of line management is very essential to ensure safe working conditions and practices at electrical work. If requirements of electricity act & rules are followed rigorously then it will help to reduce the number of injuries related to electrical hazards. Safety- related work practices should be used to prevent electric shock or other injuries that may result from accidental contact with energized equipment and circuits, especially overhead power lines and energized electrical panels. Incidents occur due to electrical hazards having serious consequences. Before working with electricity, implementation of recommended safety measures & practices is must. Some of the basic safety measures which should be followed are classification of area, selection & use of electrical appliances as per area classified, use of protective devices (overload relay & MCB), follow approved procedures, use of flame proof, lighting arresters, ELCB, & work permit system (LOTO).

Various Safety measures are implemented as per the rule & codes to prevent any incidents to occur. The acts & rules together ensure that if not violated the consumer and the supplier both can enjoy the benefits of electric energy without any harmful effects of electricity. The purpose of all these regulations is to avoid human injury and loss of property due to unsafe acts in use of electricity. It is believed that by adhering to safety rules & regulation in all the electrical related works, they hazards associated with electricity will greatly reduce. One needs to be careful towards the applications & use of electrical energy.

In this paper an attempted is done to touch upon this safety mandatory requirement & identify the reasons for probable unsafe conditions and regulatory requirement on various applications. Paying attention religiously & obeying all rules, regulation & recommendation not just ones that are convenient. Post-job reviews help in keeping us safe from repeating errors; they provide the edge we need to be safe with electrical energy. Special care to be taken to ensure shutdown and system energization before and after execution of any maintenance & modification work.

2. Scope

In this paper all conditions which lead down unsafe action resulting an accident while handling electrical & mechanical equipment & provoking the need of proactive safety management system implementation. An attempt has been made to bring out the possible hazards associated with these operations and safety measures for these hazards are suggested. It is believed that adhering to the safety measures suggested for the different mechanical & electrical related works will greatly reduced the number of injuries to personnel at the work site.

3. Electricity

Electricity is a form of power; it is the energy to do use full work. Electricity is a flow of electron in a particular direction due to influence of applied voltage. Primary hazards include electrical shock, burns, fire & explosion & secondary hazards include falling of person from height, dropping of tools & objects.

4. Definitions

- **Safety-** It is the freedom or protection from risk or danger or hazards which result in accident.
- **HAZARS:** - hazard is a source, condition or a situation with have a potential for harm or contribute to the severity of an accident.
- **Unsafe Act:** - Any Violation of the accepted standard procedure, process with result in any accident.
- **Unsafe Condition:** - Existence Of Any Physical / Chemical /Mechanical Or Environmental Condition Which May Create Condition For Accident.
- **Risk:** - Risk Is The Likelihood Or Chance Or Probability Of An Undesired Event Which Lead To An Accident
- **Risk Assessment:** - Risk Assessment is the overall process of estimating the magnitude of risk & deciding whether risk is acceptable or further modification in design change is required.
- **Risk Control:** - Risk control is the overall process of developing control measures, implementation of engineering control, safety procedures & other risk control measures to control the hazard.

5. Hazards of Electricity

a. Shock- whenever human body become path of a electrical circuit, Resulted effect is Shock, since electricity always flow short cut path or least resistive path or least resistive circuit. Effect of electricity on human body is either direct effect or indirect effect depending of condition.

b. Burns- whenever a person comes in contact with electrical circuit, current flow through human body its created heating effect & cause serious Burn injuries. Heat produced is depending on amount of current flow & its time period.

c. Arc-Blast / flash over – Arc-Blast occur when contact between two energized high amperage current circuit occurs which break down the dielectric insulation of air due to this arcing ,the temperature may rise as high as 35000 degree F, which caused serious accident, potential hazards of Arc blast are Thermal Radiation, Pressure wave, Projectiles, Explosions& Fires.

6. Effect Of Shock On Human Body

Effect of electric shock depends on various factors, when even human body the severity of electric shocks depends on following point-Rate of flow of current & voltage, Resistance, Path through body, Duration of shock.

- a) Rate of flow of current & voltage-** As the valve of voltage increase or resistance decrease current following through the body increase with increasing valve of current ,the sensations of tingling contractions of muscles increase which increase the damage too, at around 15 MA the contractions of muscles increase & the victim “freeze “at the conductive surface, means cannot let go.
- b) Resistance-**Resistance of human body depends on various factors-Amount of moisture on skin surface, Cut or other break in skin, Contact area. Resistance of human body decrease as the amount of moisture on skin increase, outer layer of skin having very high resistance when dry its valve around 10,000 ohms as skin become wet its resistance decrease to 1000 ohms. Any cut or break in skin decrease the skin resistance, as the contact area increase its lower the resistance of skin.
- c) Path through the body-**The degree of injury depends on the path of current takes through the body, any current that pass through the heart

resulting in causing severe injury, even small current approaches 100MA pass through heart causing ventricular fibrillation of heart capable of causing death within few minutes. The path of current involving heart or lungs capable of causing shock which can be fatal.

- d) Duration of shock**-More the duration of shock, more time the victim is in contact with the flowing current & more is the damage, deeper burn injury occurs as more heat is produced($H= I^2RT$).

7. Causes of Electrical accidents

In general electrical accident occurs due to unsafe act or due to unsafe condition. When not follow national electrical codes, safety instruction, BIS codes. Some common reasons are -Lack of proper insulation, Inadequate wiring, Overhead power line contact, Defective insulation (cause shock), Improper grounding, Earthing of equipment, Overloaded circuits (produce arcing), Damaged power equipment, Static electricity, Inadequate protection from lightning, Lack of training, awareness & unsafe work environment this condition aggravate the situation.

8. Electrocution related scenario

In industry electrocution hazards should be considered seriously, especially at places in close proximity to cables of different kind. All connections must be done under direct supervision of authorized electrical person which posses sound knowledge. Prior to commencement of any kind of maintenance on electrical machinery lockout & tag out procedure should be strictly followed. While maintenance activity carried out visible marking should be done. In the tags the same reference number as in the work permit must be mentioned conspicuously. The work permit should contain all the necessary safety precautions which should followed at each step & enforcement of all local statutory safety requirements as well as industry specific safety requirements shall be religiously followed. By this way a foolproof methodology of executing the work safely can be ensured.

9. Prevention from electrical accidents-

Accidents are preventable by adopting various electrical hazards prevention measures. The most effective control measure which eliminates or reduces the hazard is at source. Effective engineering features have to be built to eliminate the probability of hazard to achieve total safety following approaches should be focused- safety by Design & Operation & maintenance safety.

8.1 Design safety (safety by design) -

Any electrical accident is a result of failure of many electrical barriers. Thus by Rubusting these electrical barriers it automatically prevents such electrical accidents. Failure of electrical barriers can be prevented by developing equipment initial robust design system. The safety by Design is a philosophy to isolate the hazard at design stage by considering all relevant failure modes of equipment. Incorporation of active & passive features at design stage rubusting the barriers resulting in isolating the hazards & Review of design of system by hazard identification techniques.

8.2 Operation & maintenance safety of electrical equipment-

- a) Personnel safety**- Before starting any work it is essential to follow safe work practice/ work procedure/ permit to work system. It is assumed that before engaging in any maintenance work proper isolation procedure (lockout & tag out system) should be followed, Proper procedure for awareness & training for maintenance worker who engaged in operation of equipment.
- b) Equipment isolation before maintenance work**- Lockout & tag out procedure before any work on equipment which is normally in live state to be followed.
- c) Working near live equipment**- It is some time necessary for condition monitoring of live equipment to open guards / covers. For all such type jobs only electrical authorized person is permitted which have sufficient skill & training with one prior check person.
- d) Earthing & bonding**- All non current carrying metal parts associated with high voltage & extra high voltage shall be effectively earthed to a grounding system.
- e) Earthing connection maintenance**- All earthing connection is of good mechanical strength & mechanically sound contact area. Earthing provision should be done as per Indian electricity rules 1956. There should be two separate earthing points for all medium & high voltage equipment. Provision of designing layout in earthing system for measuring individual earth resistance should be there. All material, fittings which are used in earthing system should confirm to ISI (Indian standard).

9. Preventive measure During electrical maintenance works

1. Prior to attempting repairs on the equipment switch off, isolate, discharge and earthing of terminal adherence to The Indian Electricity Rule (IER) should be strictly followed.
2. No person should carry out work on any live voltage (low or medium) unless such parts of equipment follow lockout & tag out procedure. All non current carrying part of equipment should be earthed. Adjacent nearby live current carry equipment should be screened & precautionary caution & danger notice board is provided.
3. Permit to work system should be followed for all electrical work & it is the duty of permit issuing person to comply with all safety instruction.
4. All electrical work should be commenced by trained electrical authorized person.
5. All electrical equipments are considered energized before taking permit to work.
6. Any electrical equipment do not energize unless person is authorized. All workers in the vicinity are specifically notified when ever power is about to turned on or off.
7. For healthiness of all electrical tools & equipment periodical examination to be done.
8. All portable hand tools incorporated use of double insulated cable of ISI mark. As these hand tools are not provided with earthing connection.
9. Use of safety related personal protective equipment as per safety section recommendation should be strictly followed. Some of the personal protective equipment which are used for electrical work are approved I.S.I marked electrical Rubber gloves, Approved I.S.I marked electrical Helmet, Rubber mats, and Rubber soled shoes, Use of safety glass or face shields when possibility of arc there, Use of safety belt while working at height more than 2.5meter, Use of insulated handles tools.

10. Regulatory Requirements related to electrical energy

From time to time various Regulatory requirements guide lines are imposed by government of India. The main objective of all these regulation & rules is to make transmission, distribution, generation & utilization of electricity as safe, trouble free & reliable operation of electrical installations. In addition to above B.I.S (bureau of Indian standards) has come with various codes & standards which are supporting above acts & rules. All these acts deal with generation, utilization, distribution & transmission of electrical energy. The basic objective is utilization of

electrical energy as safe as possible. As per guide lines given in IE rules/ regulations/ standards/ code of practices take measures to avoid unsafe act & unsafe condition at the time of erection/ installations/ commissioning/ breakdown maintenances. All statutory requirements related to electrical safety are stipulated in the following acts & rules as below-

• The Electricity Act-2003

The electricity act-2003 Consolidate the three existing legislations namely- Indian electricity act-1910, the Electricity (Supply) Act-1948 & the Electricity Regulatory Commissions Act-1998. The objective of the act is to consolidate the act & creating sub rule relating to transmission/ generation/ distribution & use of electricity. Ensuring transparent & environmentally benign policies. Constitution of Central electricity commission & state electricity commission for tariff determinations & establishment of Appellate tribunal.

• The Indian Electricity Rule (IER)-1956

The central Electricity Board framed the Indian Electricity Rule (IER)-1956 under section-37 of Indian Electricity Act-1910. It was amended in 1986 & 1987.the objective of these rules is to fulfill the purpose of Indian Electricity Act-1910. The main features of this Rules are-

- i. Without certificate of competency or permit to work. No person is authorized to perform any activity of operation, maintenance; construction & erection of equipment work which involving electricity & appointment of safety officer for proper observation of safety measures during the work (Rules-3).
- ii. Provision of Cutout in every conductor of service line at the point of junction other than earthed neutral conductor (Rule-31).
- iii. Permanent Identification of earthed & earthed neutral conductors. So that I can be distinguished from live conductor (Rule-32).
- iv. Provision of Earthed Terminal on consumer's premises by supplier & responsibility of consumer to take all reasonable precautions (Rule-33).
- v. Display on danger notice in local language & English which conforming to IS: 2551 shall be affixed on every medium, high & extra high voltage installation (Rule-35).
- vi. Only electrical authorized person approved by electrical inspector who is sufficiently trained should be allowed to work related to electricity (Rule-36).
- vii. Tested fire extinguishers shall be kept near the equipment for immediate electrical fire

- viii. extinguishment & availability of at least one trained first aid person in every shift (Rule-43).
- viii. Instruction on Rescue of persons suffering from Electric shock in Hindi, English & local language shall be installed at all prominent places & availability of at least one artificial respirator (Rule-44).
- ix. Before energization of electrical supply line or apparatus testing of earthing resistance systems to ensue efficient earthing (Rule-61).
- x. Installation of Earth leakage protective device (ELCB) if supply energy is above 5 KW shall be provided for instantly disconnection of supply on occurrence of fault (Rule-61A).
- xi. The minimum clearance which should be maintain between ground & the lowest level conductor is 5.8(19 ft)meters & for high voltage line is 6.1(20 ft) meters(Rule-77).
- xii. The minimum clearance from Building for low & medium voltage overhead lines a vertical clearance of 2.4 meters(8 ft) from highest point of building & a horizontal clearance of 1.2 meters(4 ft) from nearest point(Rule-79).

11. Conclusion-

This paper discusses the relevant Indian electricity rules & execution in addition to the various standards followed while procuring & installing the equipment. Various Safety measures are implemented as per the rule & codes to prevent any incidents to occur. Accidents occur due to electrical reasons are very frequent in industry and the type of accidents occurred due to electrical faults often found fatal. As per the statutory factory act 1948 it is the responsibility of employer to provide safe working environment by assessing the risk associated with the activity & adopting all hierarchy of control measures to control the risk. Training of employees for their awareness regarding the electrical hazards through cooperative efforts & employees can learn to identified, control & eliminate electrical hazards. Further to achieve total safety a holistic approach has to be adopted through building safety by design engineering safety concept, adopting necessary precaution & recommendations as per applicable codes, manufacturers instruction during operation & maintenance of electrical equipment.

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