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ELECTRICAL HAZARD IN CONSTRUCTION SITE AND ITSPREVENTION

A.MAHENDRAN[1], R.HARI HARAN[2]

[1]*Assistant professor, Dept of Mechanical Engineering, Sona College of Technology, Tamilnadu,India*
[2]*PG student, Dept of Industrial Safety Engineering, Sona College of Technology, Tamilnadu, India*

Abstract-*Electricity is one of the serious hazard in the workplace. Working with electricity in any environment can be highly dangerous but particularly so on a construction site where the hazards have the potential to be on a much biggerscale. Its often a lack of awareness that causes the most damage so it's essential that anyone required to work on a construction site understands the risks and knows how to act to avoid themselves, or anyone else, coming to harm as a result of electricity. This paper describes the basic fundamental of OH transmission lines and UG cables that cause electric shocks, electrocutions etc and their prevention with safety precautions in construction sites.*

KEY WORDS :-OH transmission, UG cables, Electrical safety, Prevention.

1. INTRODUCTION

There are several hazards in the construction site while working the employee may undergo manyrisks, injury or accident. The focus on protection of the electrical worker was developing the safe work practices on the transmission lines. In transmission generally two types of transmission lines are there Overhead lines (OH lines) and Underground Cables (UG cables). In construction site these two transmission lines cause several hazards, before working on these transmission lines we have to plan the work and some guidance are provide in this paper to understand before gone to the work. Every year people at work are killed or seriously injured when they come into contact with live overhead electricity power lines. If a machine, scaffold tube, ladder, or even a jet of water touches or gets too close to an overhead wire, then electricity will be conducted to earth. This can cause a fire or explosion and electric shock and burn injuries to anyone touching the machine or equipment. An overhead wire does not need to be touched to cause serious injury or death as electricity can jump, or arc, across small gaps. One of the biggest problems is that people simply do not notice overhead lines when they are tired, rushing or cutting corners. They can be difficult to spot, e.g. in foggy or dull conditions, when they blend into the surroundings at the edge of woodland, or when they are running parallel to, or under, other lines. Always assume that a power line is live unless and until the owner of the line has confirmed that it is dead. This guidance is for people who may be planning to work near overhead lines where there is a risk of contact with the wires, and describes the steps you should take to prevent contact with them. The UG transmission have the potential dangers of working near underground services and gives advice on how to reduce the risks. It deals principally with risks to health and safety rather than damage to services. However, precautions taken which reduce risks to people's health and safety will generally also reduce the risk of damage to services, which can directly or indirectly pose a risk to people's health and safety.

Table -1: Number and Share of Accidental Deaths due to Electrocution

S.No.	Cause	2019		2020		% Variation
		No.	%	No.	%	
1	Electrocution	13432	3.3	13446	3.7	0.1

The tabulated figures delineated in Table 1

[2] divulge the incidence of inadvertent fatalities brought on by electrocution in the years 2019 and 2020. The aforementioned data explicitly indicates a rise of 0.1% in the number of unintended deaths due to electrocution in the preceding year.

Table -2: Number of Persons Injured and Died due to Electrocution during 2020

S.No.	Cause	No.	Persons injured			Persons Died		
			Male	Female	Total	Male	Female	Total
1	Electrocution	13432	210	35	245	11402	2043	13446

In Table 2 [2], we can discern the grievous impact of electricity by examining the number of persons injured versus the number of persons who perished due to electrocution in India during the year 2020. However, itis important to note that minor injuries resulting from electrocution are not included in the report as they are not reported anywhere. Furthermore, the number of male fatalities due to electrocution is significantly higher than that of their female counterparts. This is a result of the male- dominated workforce that exists in industrial and other sectors.

When evaluating electrical safety, it is imperative to refer to various standards such as the National Building

Code 2006 – Electrical Part, the Electricity Rules, and the appropriate sections of the NFPA 70 (an American standard) Edition 2011, particularly in areas that are deemed high-risk, including grounding, main and sub distribution boards, circuit protections, receptacles, hand-tools, and the like. Employing an electrical assessment for safety is crucial in Occupational Health & Safety Management System Standards, and for demonstrating due diligence to Occupational Health & Safety Regulations. By utilizing such a system, potential electrical hazards can be identified and subsequently prevented to minimize theloss of life and property.

2. LITERATURE REVIEW

i. Haumaru (2016) touching a live low voltage overhead electric line with any part of the body, a tool or equipment can cause death or serious injury. If work needs to be done near a live low voltage overhead electric line, the safest option is to eliminate the risk of electric shock by having the electricity supply to the property isolated before work starts. If isolating the electricity supply is not possible, workers must maintain a minimum approach distance (MAD) so that they keep their body, tools and equipment a safe distance from the overhead line. And also it describes the legal requirement of the legislation and the safety working procedures to the workers.

ii. R.LEE (2005) the molecular architecture of biological systems is heavily influenced by the highly polar interactions of water. Thus, macromolecules such as proteins that are highly water soluble must be electrically polar. One consequence of these biological design constraints is vulnerability to injury by electrical forces. Physiological electric forces cause damage to cells and tissues by disrupting cell membranes and altering the conformation of biomolecules. In addition, prolonged passage of electrical current leads to damage by thermal mechanisms. This review will focus on the non-thermal effects.

iii. McGraw (2017) thoroughly updated to reflect the 2017 National Electrical Safety Code (NESC), this authoritative resource explains the principles and practices of electric transmission and distribution line construction, operation, and maintenance. We will get comprehensive coverage of the newest equipment, techniques, and procedures along with current OSHA, ANSI, and ASTM regulations. Throughout, detailed illustrations and photos make it easy to understand the material, and self-test questions and exercises.

iv. Christian and spies (2006) the authors included relevant retrospective studies, case reports, and review articles published between 1966 and 2005. The authors also searched the Internet for information related to electrocution and life-threatening electrical injuries. They found that familiarity with basic principles of physics elucidates the typical injuries sustained by patients who experience electrical shock. Death due to electrocution occurs frequently. However, patients successfully resuscitated after cardiopulmonary arrest often have a favourable prognosis.

v. Doughty and Lee (2003) this review describes the destructive changes to cellular structure resulting from exposure to commercial electrical power sources and the resulting manifestations at the organ system level. Finally, several important new therapeutic approaches to treat and possibly reverse the molecular alterations of electrical shock are discussed. Human contact with strong electrical power sources often results in complex injury patterns whichhave been difficult to explain and even more difficult for survivors to overcome. Fundamentally, there are two basic modes of tissue injury: direct effects of strong electric fields on proteins and cellular structures and indirect effectsrelated to joule heating.

vi. Dalziel(2011) Electrical safety is a system of organizational measures and technical means to prevent harmful and dangerous effects on workers from electric current, arcing, electromagnetic fields and static electricity. Although thepotential engineer often gets his first practical knowledge of electricity in a school laboratory, few safety precautions are taught in these laboratories. Suggestions are given here for increasing safety awareness and decreasing hazards in experimental electrical laboratories of schools and industrial plants. These and all electrical devices used in the lab setting present a potential danger of injury due to electric shock, fires due to poorly installed ormaintained systems and fires due to sparks serving as an ignition source for flammable or combustible materials. And we learn about the general safety measures about working in the laboratory.

vii. Ralph (2014) it generally shows the construction for the electrical substation, transmission and the distribution lines. And showing the framework for the electrical current transmission from the generating side to the distribution side. It clearly shows how the electricity generated and transmitted over a long distance from the source to its destination.

3. PROBLEM IDENTIFICATION:

Each year workers in many places die or are seriously burned as a result of unsafe work practices around energized conductors. The following information is a reminder to operators of construction equipment and to construction and maintenance workers who must work near power lines:

- Most power lines are found overhead; however, some are buried just a short distance below the surface of the
- The normal operating range of your machine or equipment can often reach either the overhead or the undergroundpower lines above or below
- Supervisors and operators of equipment can prevent electrical accidents through knowledge of electrical systems and safework.

ELECTRICAL SAFETY IN THE WORKPLACE

The workplace is one significant area where many electrical incidents take place. Thereis always the potential for electrical injury,

Generally electrical hazard cannot be negotiated. However proper control measures which can reduce the risk of causing electrical accidents or injuries to the worker. These are the some common electrical hazard faced by the worker in the construction sites

- ❖ Inadequate wiring.
- ❖ Exposed electrical parts.
- ❖ Wires with bad insulation.
- ❖ Ungrounded electrical systemsand tools.
- ❖ Overloaded circuits.
- ❖ Damaged power tools and equipment.
- ❖ Using the wrong PPE and tools.
- ❖ Overhead power lines.
- ❖ All hazards are made worse inwet condition.

About 400 people are electrocuted at home each year, resulting in about 200 deaths.On average, **4 people die** from an at-home electrocution every week. About **10%** of all at- home electrocutions are caused by large appliances. About **4,000 people** are electrocutedin the workplace each year. Broken electrical equipment causes around **140,000 home and workplace fires** every year. These fires cause another 4,000 injuries, and claim an additional 400 lives on average. In 2019, out of every 100,000 electricians, **166 died from electrical accidents**. It is estimated that there are between **500-1,000** deaths from electrical injuries every year in the United States. There are approximately **30,000** nonfatal electrical injuries every year. Costs for treating non-fatal electrical injuries incurred while on the job cost between **1-4 million**. The Bureau of Labor Statistics has reported that a **majority of electrical accidents are preventable.** Workplace Electrical Fatalities, OSHA and BLS, 2011 – 2021

- ➢ 31% of occupations were electrically related occupations.
- ➢ 69% were non-electrical occupations.
- ➢ 1.2% average decrease in non- electrical occupation electricalfatalities.
- ➢ 0.89% average decrease in electrical occupation electricalfatalities.
- ➢ 118 occupations were involved in electrical fatalities.

whether it's in a high-risk or low-risk workplace. Since these areas often house large groups of people, it is crucial that business owners take actionable steps to ensure employee health and well-being. These are the important statistics that underline the importance of electrical safety guidelines in the workplace.

- Not all work industries experience high numbers of electrical injuries; however, some industries are more vulnerable to these risks. Electric fatalities often occurin the construction industry affecting workers between the ages of 36 and 45 (ElecSafety, 2022). These statistics show key areas where action must be taken to ensure worker safety. High-risk spaces such as construction work need safety guidelines to ensure the well-being of the workers. This will benefit the business in multiple ways besides improving safety measures. Employees will have better work satisfaction, and you will be able to finish projects on
- Despite the higher number of
- construction work fatalities in 2022, thisnumber has decreased from the injuries recorded in 2018/2017. In 2022, there were 30 recorded fatal injuries to construction workers, while in 2018/2017, there were 36 fatal injuries reported by workers (HSE, 2022). This figure is an indication that safety measures are successful are preventing fatal injuries from happening. Even though there was not a large reduction in workplace deaths, significant progress was made toward ensuring construction workers' health and safety.
- The type of work also affects the risk associated with electrical products. 7%
- of electrocutions affect workers undertaking electrical installations. On the other hand, 37% of electrocutions affect construction workers. 15% of workers in agriculture and horticulture

are also affected by electrocution (ESFI, 2022). This statistic highlight the key areas where workers are vulnerable to electrocution. Efforts should be made toensure worker safety in their industries. Business owners should provide safety training and ensure preventative measures to avoid accidents from happening.

- A great way to ensure electrical safety in the workplace is by involving your employees. 95% of workers believe that more can be done to improve safety in the workplace. (Fluke, 2022). Business owners should work alongside their time. Due to these reasons, it is important to implement electrical safety guidelines in construction worksites.
- Regarding workplace accidents, in 2022/2021,6% of fatal injuries sustained by construction workers originated from electrical components. (HSE, 2022). While 6% might not seem like a large number, it is still important to prevent these injuries from happening as they lead to devastating consequences. It is crucial for business owners to ensure the health and safety of their employees therefore, actionable steps should be implemented to avoid such incidents. Construction equipment offer carries high levels of risk, which is why workers should undergo rigorous safety training to ensure employee well-being in the workplace

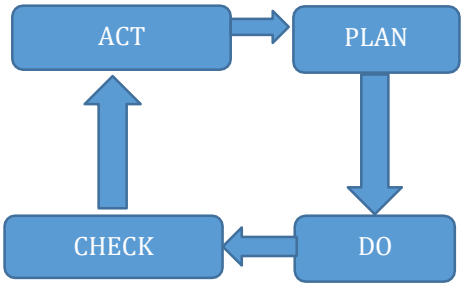
ASSESS THE RISK OF BEFORE WORK STARTS

Before starting the work, the safety precaution must be considered before it leads toa major accidents or fatality in order to promote the safety we must do Plan_Do_Check_Act approach to assess, monitor, manage and reviewwork risks.

MANAGING THE RISK OF ELECTRIC SHOCK

Thorough planning is essential. Before work starts PCBUs should

- identify all low voltage overhead electric lines in the area where work will be carriedout
- assess the risk of harm
- eliminate the risk of electric shock by isolating the electricity supply to the overhead lines
- If elimination is not reasonably practicable then minimise the risk.



METHODOLOGYHIRA

There are five basic steps to perform Hazard Identification, Risk Assessment and Control:

HAZARD IDENTIFICATION

Hazard identification is the first activity to be performed by a competent team by thoroughly analyzing all the tasks and considering previous accident record, first aid cases, enforcement actions and occupational diseases data. The team identifying the hazard must include engineers, safety supervisors, workers and operation specialist. In this stage, worksite analysis of work activities is carried out, this includes making a list of people to be involved, responsibility to be assigned, detailed work procedures in chronological order, materials required, loading and unloading location, equipment's to be used etc. For this various information's are required such as organizational charts, interviews, records and a 'walk-through' survey of the work site. A walk-through survey is considered to be the most effective way of listing out all the activities and possible failures at site. After analyzing and listing out everything necessary for completion of the activity, hazard identification is carried out. The goal of hazard identification is to find out potential risks associated with the hazard. The hazards identified during this stage is to be categorized on the basis of their nature, likelihood, severity and risk level. The list of identified hazards needs to be updated and reviewed in regular intervals.

Risk Assessment

Risk assessment is the second step in HIRAC in which the level of risk associated with the identified tasks are examined. In this step, a competent risk assessment team having expertise in hazards considers each and every tasks individually and determines the likelihood of the occurrence of hazards and its potential consequences on workers, property, business and environment. Previous accident data is also referred to draft the best possible assessment which is recorded and reviewed regularly. This assessment of risk helps us to determine the seriousness of the risk and its consequences link to the corresponding task.

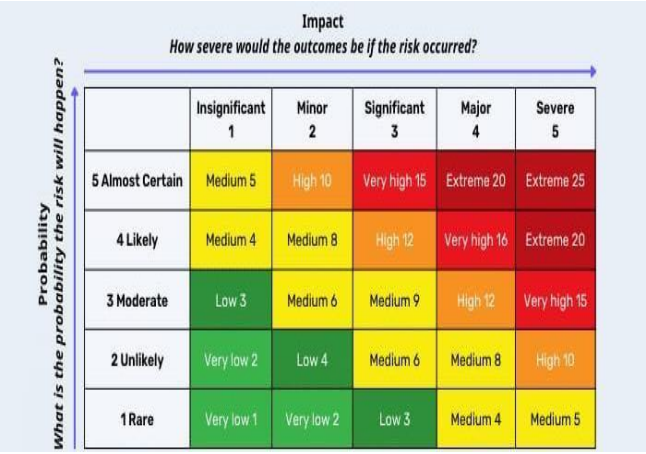
After identifying the hazards, risk associated with the hazard is estimated by considering number of people exposed to each hazard and exposure time. Thus the probability and severity of harm that can be caused by a hazard is estimated. Meanwhile in order to find out the probability and severity of harm, knowledge of the regulations and safety standards under which the facility operates is also important, as some of the regulations provide guidelines about risk assessment procedure.

S.NO	PROABILITY	DESCRIPTION
1	Rare	Some exceptional circumstance
2	Unlikely	Remotely possible
3	Possible	May not occur at some time
4	Likely	Probably occur
5	Almostcertain	Repeatedly occur in construction industry

RISK analysis

In this step again risk assessment sheet is considered and risk ranking is provided to every activity. Prioritization of risk aids in highlightingthe hazards that should be undertaken as a priority for emergency management program. The risk ranking is based on occurrence probability of hazard and its potential consequence arranged to form a risk matrix system. Risk matrix is a quantitative tool that is used to evaluate and analyses the risk level and to rank the risk according to their severity & probability. According to ISO 45001:2018,preparation of risk matrix is an integral part of the risk assessment process. The rows and columns in the risk matrix are the likelihood and consequences of the hazardous activity undertaken respectively.

Risk (R) = Likelihood (L) × consequences (C)



Control Measures

Control measure involves any system, procedure, device or process that is intended to eliminate the hazards or to reduce the severity of consequences of any accident that does occur. Based on the risk rating attained in the risk matrix, the risk level is determined as shown in Table 4 and on the basis of risk level corresponding control measures are selected to reduce the risk to an acceptance level. This reduction is to be achieved by reducing the likelihood and/ or severity by the implementation of control measures.

Rating	Level
1-3	Low risk
4-8	Medium risk
9-16	High risk
16-25	Very high risk

(i) Elimination – In the elimination part, we will try to eliminate the hazard which can remove the cause of danger completely. However, it is difficult to eliminate all hazards and unsafe conditions, and therefore elimination is notalways possible

(ii) Substitution – In the substitution part, we will try to find a substitute, if we can't eliminate the hazard completely, by finding a substitute it will be less risky to achieve the same outcome.

(iii) Isolation – In Isolation control measure, some form of barrier is placed between the employee and the hazard in order to provideprotection. The risk is always there but by providing the barrier, workers are shielded by the hazard.

(iv) Engineering Control – In engineering control,we can implement the engineering techniques toreduce the risk of the hazards such as doing any physical changes, adding safe guards etc.

(v) Administrative Control - In administrative control, the administrative works should be followed up properly such as proper training to the employees & workers, risk assessments, issue of permits etc.

(vi) PPE (Personal Protective Equipment) – This is the final stage, here proper PPE to be provided to the employees and workers to save themselves from the hazards. e) Monitor and Review All the updated Hazard Identification, Risk Assessment and Control have to be monitored and reviewed by management and competent staff at regular interval.

ELIMINATION
SUBSTITUTION
SEPERATION
ENGINEERING CONTROL
ADMINISTRATIVE CONTROL
PPE

PICTORIAL OBSERVATION

CATEGORY: Highly Hazardous

Location:xxx

Observation: The downed power lines. Which may cause electric shock lead to fatal death

Required action: need to address the employee and pole erection has to be done perfectly.

CATEGORY: Potential shock

Observation: possibility of electric shock due to the contact of wire

Required action: watch above before start of the work.

CATEGORY: Step potential

Observation: The electric current would flow from one leg to other leg.

Location : xxx

Required action: the pole or the machine should well insulated grounded to avoid electrocution.

CATEGORY: Open insulation

Observation: the UG cables has been visible over the ground and insulation are wide open.

Location:YYYY

Required action: Once aging the cables should be buried perfectly onto the ground.

CATEGORY:Dangerous

Observation: Exposed electrical parts

LOCATION: xxx

Required action: electrical parts should be raised or it should be covered carefully to avoid shock.

CATEGORY: Highly dangerous

Observation: the bucket from the excavator touches the overhead power lines.

Location:xxx

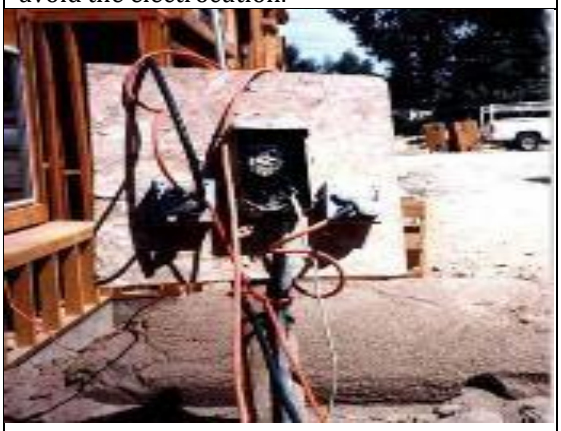
Required action: always have someone to look up at the work it will reduce the electrocution.

CATEGORY:DANGEROUS

Observation: Defective cord

Location: xxxx

Required action:The cord should be replaced or it should be double insulated in order to avoid the electrocution.



CATEGORY: Highly Dangerous.

Observation: Overloaded circuits

Location : xxxx

Required action: in order to avoid the overload circuits the proper PPE must be used. And ensure for proper grounding.

CATEGORY: Dangerous

Observation: Wet condition, will increase your risk of receiving an electric shock.

Location : xxx

Required action: So be extra careful and try to avoid working in these type of areas. Avoid or remove the power cable away from the water.

CATEGORY:HIGHLY DANGEROUS

Observation: Vehicle under the high transmission line

Location: onsite

Required action: vehicles should not be parked under the HVDC lines.

CATEGORY: Highly dangerous
Observation: Scaffolding near power lines which may cause death or fatal injury to the worker.
Location : Onsite
Required action: always keep a safe distance between the scaffold and power lines.

CATEGORY: HIGHLY DANGEROUS
Observation : due to the digging using the excavator the underground cables are damaged in the trench by digging.
Location: Onsite area.
Required actions: Isolate the cable and test core of the cable for earth fault. Use sign board in order to avoid unwanted contact.

By using these HIRAC methods the proper required action must be taken and it can reduce the risk and the injury for the workers in the workplace. These measures can increase the safe working environment for the workers in theconstruction site.

Tool box talk / PEP talk were delivered on the basis of observation during safety survey.The talk covered all the aspects of maintaining safer and healthy working environment. Few important talk included the training on electrical safety, training on work at height, training in fire, training on scaffolding, air & noise monitoring and mock drill at site.

CONCLUSION:

In the construction industry, electrical safety is non-negotiable. Workers and employers alike must recognize the importance of electrical safety measures and commit to their diligent implementation. By doing so we can ensure that construction sites are places of progress and innovation rather than danger, where electricity powers our project without compromising the safety of those who build them.

The true measure of success in construction is not just completing a project, butdoing so while keeping very worker safe and sound. Electrical safety is a fundamental part of that mission one that we must embrace every day on the construction site.

The research sets out the result of investigation performed to identify different electrical safety faults and their remedial measures in a power plant and the followingconclusions can be derived from the results.

- The methodology adopted in the research uses checklist method to identify the electrical safety hazards in the industry. Based on the experience of the author, checklist method can be highly useful if it is periodically implemented and most importantly updated based on new findings.

- It was also observed during the discussion with industrial workers that they were not given any separate electrical safety training apart from the general safety drill.

In the current research, only electrical related process was covered in-detail for identification of flaws during the working of sites. In the future research, all the tasks and process involved in the construction sites can be investigated with different analytical tools providing overall safety status.

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