

# Review of Electrical Accidents in Indian Industries

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## ABSTRACT

Electricity is a vital part of our modern world. Human cannot even think about a single day without electricity in life. The number of occupational electrical accidents in Indian industries declined over the last decade, but technician, worker injuries and fatalities still occurs among the country. Contemporary measures to increase electrical safety are not effective enough. In order to condense the number of electrical accidents, there is a necessity for more information about electrical accident risks at the operative level. This review presents statistical studies about electrical fatalities in India, various classifications of electrical accidents among country, statutory provisions for ensuring electrical safety to reduce the electrical accidents in India.

**Keywords:** Electrical Hazards, Electrocution, Step potential, Touch potential, Electrical shock, CEA.

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## 1. INTRODUCTION

Electricity is one of nature's phenomena. Electricity is undetectable by human senses other than touch. An electrocution is an event resulting from either personnel action or equipment failure involving electrical installations. It has the potential to result in an injury due to Electrical flash or burn. [2] Electric shock from a source more than 50 V, and Impulse action to an electric shock. Real electric shock may cause anything from a slight tingle to a prolonged illness, to sudden death. The aim of this review is to provide awareness to the technician about how electrical accident rate increasing in India.

## 2. STATISTICS OF ELECTROCUTION DEATH IN INDIA

In India each year about 12,000 electrical accidents to human being or animal lives are reported among the country. As shown in Table 1. The situation is crucial as a significant number of accidents are not reported. [6] According to data from the National Crime Records Bureau (NCRB), in 2019 total number of accidental death was about 42, 1104. In which 13,432 persons died due to Electrical accidents in India as shown in Fig. 1.

**Table 1: Statistics of death due to Electrical Accidents in India**

Year	Total no of accidental death	Death due to Electrocution	Contribution
2015	413457	9986	2.42%
2016	418221	11126	2.66%
2017	396584	12004	3.03%
2018	411824	12154	2.95%
2019	421104	13432	3.19%

There is 10.5% rise from the last year electrocution death rate. It shows that electrical fatalities in India keep on increasing more attention required.

**A. State / UT – Wise Deaths Due To Electrocution During 2019 in India**



**Fig. 1: State & Union territory wise death due to Electrical Accidents in India**

Workplace Electrical accidents report nearly 13 electrocution fatalities on an average day in India. This is the highest in the world. The yearly average of electric-related deaths in workplaces in the United Kingdom and the United States is 8 and 82 respectively. The Central Electricity Authority (CEA) data shows nearly 40% of deaths at the workplace due to electrical issues.

**B. Major causes of accidents**

- Non-adherence to specified procedure/work practice of construction and maintenance of distribution system.[7]
- Lack of adequate supervision for a particular job.
- Non following of the regulations in respect of use and maintenance of proper safety equipment's
- Lack of adequate training about safety precautions for technicians
- Illiteracy of the users/common man about the hazards of electricity

[7]Accident rates compiled by the International Brotherhood of Electrical workers show that the causes for purely electrical accidents in industries to workers can be grouped as shown in Table 2.

**Table 2: Contribution causes for Electrical Accident**

Accident rate in percentage	Cause
34%	Technician did not use proper personal protective equipment.
30%	Technician did not obtain adequately safety Clearance / insulation / guarding to energized equipment/line.
8%	Technician did not follow the work procedure as per the norms.
7%	Technician worked on de-energized lines without adequate temporary protective grounds and device.
7%	Faulty safety apparatus/tools
14%	Miscellaneous causes, such as tool contacting live conductor, Technician having poor work concentration due to some personal, mental worries / depressions, etc.

### 3. CLASSIFICATION OF ELECTRICAL HAZARDS

Electrical hazards have always been acknowledged, yet serious injuries, deaths, and property damage occurs daily. It is also define as such accidental condition which leads to arc flash and arc blast with fire. Basically electrical hazards categorized as three main hazardous conditions [1, 2].

1. Electrical Shock
2. Burn and Fire
3. Electrical Arc-Flash and Arc Blasts

#### C. Electrical shock

When persons come in contact with energized part of conductors they receive a shock. And current flowing to the body through their skin, muscles and vital organs. [1, 2, 10]. The severity of the shock depends on the time duration of current flow through the body, the current strength, and the duration of the contact. Persons may only experience a mild tingling sensation or it could result in serious injury or death.

As voltage levels increase, the effects of electric shock worsen. Current flow may also cause an unpredictable heartbeat known as ventricular fibrillation. If fibrillation occurs even momentarily and goes untreated, the effects are usually fatal death. Understanding of electric current travel path through the human body will support to minimize electrical injury if such kind of contact occurs.

There are three main basic pathways electric current travels through the human body

- Touch Potential (hand to hand path)
- Step Potential (foot to foot path)
- Touch/Step Potential (hand to foot path).

#### Touch Potential

In a touch potential contact, current travels from one hand through the heart and out through the other hand. During this this kind of incident heart and lungs are comes under the current flow so it may cause ventricular fibrillation, and difficulty in breathing, unconsciousness, or death may occur.

#### Step Potential

In a step potential contact shock, current flow travels from one foot through the legs, and out to the another foot. The heart is not in the direct path of current flow but the leg muscles may contract, causing the victim to folding or be momentarily paralyzed [10, 11].

#### Touch/Step Potential

In a combined incident of both touch/step potential contact, current travels from one hand, through the heart, down the leg, and out of the another foot. In this scenario The heart and lungs are in the direct path of current so ventricular fibrillation, difficulty in breathing, folding, coma, or death may occur [10, 11]. Even though there may be no external marks from the electrical shock, but internal tissue or organ damage may have affected. Signs of internal damage may not appear immediately, and when it does, it may be too late.

#### D. Burn and Fire

The Burns occurred in electrical accidents are of three basic types: electrical burns, arc burns and thermal contact burns. In electrical burn tissue damage (whether skin deep or deeper) will be occurs because the body is unable to dissipate the

heat from the current flow. Typically electrical burns are deliberate to heal. [1] Arc burns are caused by electrical arc due to short circuits and are similar to heat burn from high temperature. Temperature produced by the arc, will melt nearby materials, vaporizing nearby materials and burn them. It also ignites nearby flammable materials, clothing depending on the energy produced on the arc. Thermal contact burns are occurred when skin come into the interaction or physical contact with hot conductor which is overheated.

Electrically produced burns and fire can come from the following sources:

- Physical contact with conductors, tools, or other equipment that have been heated by the passageway of electrical current flow. These kinds of burns are different than burns received from any hot object.
- Current flow through the skin can cause burns in the amount of  $I^2 R$  energy. Since such burns are occur from the inside the body and comes out, they are frequently third degree burns.

Generally the fire and explosion due to short circuit happened in the electrical system, the arc or spark produced by short circuit may lead the fire caught to nearby flammable material. Fire is most frequent hazardous condition. It may be turn entire system into ashes, so safety against electrical fire and burns must be required always.

#### E. Electrical Arc-Flash and Arc Blasts

An Arc-Flash is an unpredicted abrupt release of heat and light energy produced by electricity traveling through air, usually it caused by unintentional contact between live conductors [1, 4]. Temperatures produced at the arc terminals can reach up to 35,000 degree Fahrenheit, or hundred times the temperature of the workplace temperature. The air and gases surrounding the arc are rapidly heated and the conductors are got vaporized. And causing arc blast with high a pressure wave. Electrical blast is bulk in nature, electrical blast involves three main possible effects [11].

1. Arc flashes result in powerful heat, strong light (can cause loss of sight), or ignition of other materials.
2. Arc blasts results the same conditions as an arc flash, but are more powerful and can also include a solid pressure wave. These pressure waves can damage machinery, person by collapsing a lung or break ear drums.
3. Freeing of toxic gases and pollutants

#### 4. MEDICAL ASPECTS OF ELECTRICAL EVENT

Fig. 2 illustrates the kinds of medical problems that may follow the exposure to an electrical event. The body's reaction to the transferred energy from the event in part depends on the form of energy, amount, and the duration of the exposure [1]. A simple electric shock can turns the individual into fatal condition.

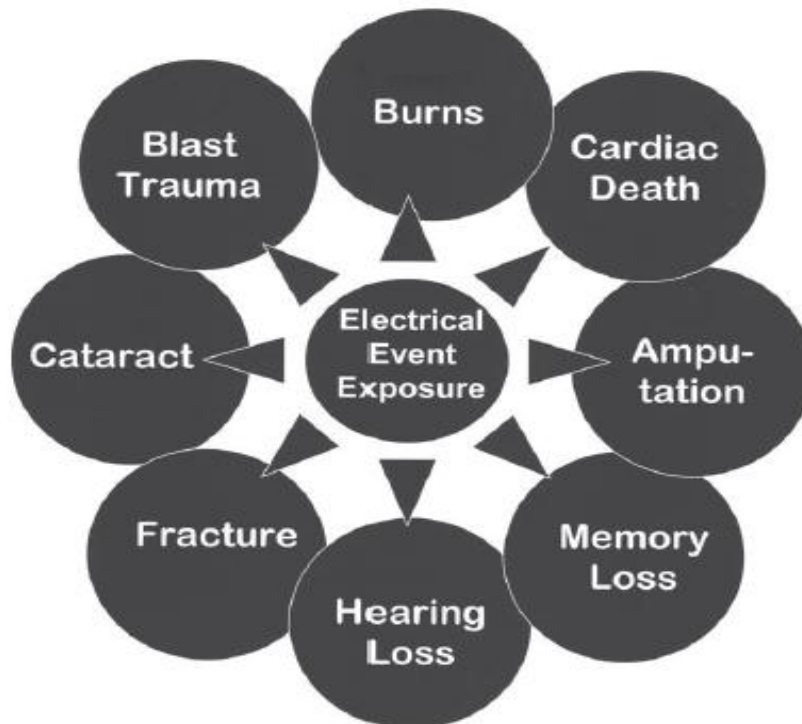


Fig. 2: Effects on human body during Electric shock

Necessary for understanding the flow of electric current travels through the body will provide basic awareness among the electrical professionals. The Table 3 below represents the effects of current flow on the human body [11].

**Table 3: Electrical current flow vs. physical effect**

Current flow through human body	Physical Effect on human body
1-3 mA of current	Mild sensation effect
10 mA of current	Muscles contract, releasing grip may be difficult during the electrocution
30 mA of current	Breathing difficulty, possible loss of consciousness and control
30 - 75 mA of current	Collapsing respiratory system and paralysis
100 – 200 mA of current	Severe Ventricular fibrillation
50 – 300 mA of current	Strong Electric Shock (potentially fatal)
Over 1500mA of current	Tissues and organ burns
150 ° F	Blood Cell destruction
200 ° F	Skin burns in higher rate (third degree burns)

### 5. INDIAN ELECTRICAL REGULATORY BODIES

**CEA** - The Central Electricity Authority of India is a statutory organization. It was constituted under section 3(1) of Indian Electricity Supply Act 1948. This has been outdated by section 70(1) of the Indian Electricity Act 2003. The CEA instructs the country on policy matters and frames plans for the development of electricity systems among the country.

**CERC** - Central Electricity Regulatory Commission a important regulatory body in India. It is formed under sec – 76 of the Electricity Act 2003. CERC is responsible for regulating the power consumption tariff of generating stations which were owned by the central government of India or power sectors generating or supplying the electricity for more than one state. Regulating the electricity transmission policy with in the state.

**BIS** - ISI was renamed as the Bureau of Indian Standards to promote melodious development of standardization and quality certification of goods. It is has the statutory power to ensure the quality and safety of the product. The previous BIS acts are now revised as BIS Act, 2016. This act had been established the BIS as the National Standards Body.

**NABL** - National Accreditation Board for Testing and Calibration Laboratories is a crucial regulatory body in quality Council of India. NABL is provides the quality and technical competence of testing and calibration laboratories of Government, Industry Associations located in India.

**ERDA** - Electrical Research and Development Association is a leading Electrical and Power sector Research & Development Organization. It providing services to the Power Sector in the nation. It concentrates following three major technical areas Testing & Evaluation, Field Services, R&D and Expert Services in power sector.

**ELCA** - Electrical Consultants' Association was founded and registered in 1990 at Bangalore. Its main objective is to create awareness among the Electricity Company and consumers towards a safe and quality of electrical installation. It also provides a platform between the manufacturers and the end users. By conducting, arranging technical seminars, workshops, exhibitions etc.

### 6. WORLDWIDE REGULATORY AGENCIES

**IEEE** - The Institute of Electrical and Electronics Engineers is the international level leading technically specialized organization. It is dedicated to advancing technology for the advantage of humanity. IEEE and members of IEEE will stimulate a global platform through its publications, conferences, improving technology standards, enhancing professional knowledge and educational activities [11].

**OSHA** - Occupational Safety and Health Administration is a most famous regulatory agency of the United States. The mission statement of OSHA is to ensure safe and healthful working conditions for workers. Which is obtained by setting the safety standards, enforcing safety standards and providing training, formulating audit procedure, safety education and assistance [1, 4, 11].

**NEC** - National Electrical Code is a regulatory body of United States of America. It provides set of updated standards for the electrical installations. Especially for the electrical wiring in the United States. First it was published in the year

of 1897. The NEC is updated once every three years. The NEC affords guiding principle for electrical installations in order to prevent electrical fire accident and other electrical accidents [1, 4].

**NFPA** - The National Fire Protection Association is an international self-funded nonprofit organization. It is dedicated to eliminating the human or other creature's death, injury, property and loss due to fire accident, and Electrical accidents [1, 4, 11].

**ANSI** - The American National Standards Institute is also a non-profit non-government organization [1, 11]. It was formed 102 years before (1918). It doesn't create the standards, instead of creating it empathizes the development standards from various countries for manufacturing products, services, processes and various systems to enhance the safety. ANSI is the key member of ISO.

**NIOSH** - The National Institute for Occupational Safety and Health is the non-profitable federal agency in United States. It was founded in 1970. The main objective and role of NIOSH is conducting research about safety hazards in work place and building a endorsements for the prevention of work-related injury and illness for the workers.

**NSC** - National Safety Council was established in 1913. NSC's main objective is principally to educate and influence the peoples to adhere safety policies and safe work practices. It is a nonprofit and non-governmental organization which gives the extent support to improve the safety culture.

### 7. MAJOR ELECTRICAL ACCIDENTS IN INDIA

By referring to the Statistics, the reasons it can be inferred that majority of the accidents are occurred in connection with 11 KV & LT distribution network of supplier [2]

- Major accidents were reported due to breaking of LT conductor, earthing of electric poles, guard wires, spiral earthing etc. due to leakage of current [2]
- Electrocutions reported due to repairing of live electric equipments like motor, household equipment's Iron box, mixer grinder, etc., [2]
- Next, other major accidents resulted by unauthorized energization of fencing. [2]
- Many farmers to safe guard their crops from wild animals, unauthorized energizing the fencing provided to their field, by this, people and animals unknowingly have come in contact with the unauthorized energized fencing and got electrocuted. [2]

And also it is noticed that majority of the electrical accidents have occurred due to clear violation of particular rules of IE Rules, 1956 such as [3] as mention in Table 4.

**Table 4: Major Violation of Electricity rules in India**

S. No	Violation of Rule	Description
1	29	Construction of electrical installation, protection, operation and maintenance of Electric supply lines, structures and electrical apparatus
2	35	Danger notices
3	36	Handling of electric supply lines and apparatus
4	45	Precautions to be adopted by every consumers, owners of installation, occupiers, electrical contractors, electrical workmen and suppliers
5	77	Clearance above ground of the lowest conductor
6	80	Clearances from buildings of high and extra-high voltage lines
7	82A	Transporting and Storing of material near overhead power lines

### CONCLUSIONS

The amount of fatal and non-fatal accident in India is around 1 No to 3 No's, which is very high as compared to developed countries like U.S.A., U.K., Australia, and Canada. Fatal and non-fatal accident rate in these countries where about 1 No to 6 No's [7]. This indicates first-aid for the accident person/victim is deficient in the country. This is mostly due to insufficient proper training for the technical staff. In general there is large chance of survival of victim if the first aid given to the victim in the first half an hour after accident happened.

Technician's behavior is habitually controlled by the local culture in terms of attitudes, procedures, and the use of PPE. Electrical safety regulatory bodies and state electrical inspectorate authorities have been tried past 20 years to change wrong-headed thinking and inaccurate and dangerous assumptions about electricity.

Even though there is necessity to take more contribution, hard work and long way to create awareness and training to ensure the electrical safety among the country. Lot of works has to do to changing the electrical safety culture and improving the safety awareness programs.

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