FIRE – ELECTRICITY & FIRE

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Background :

Safety in any workplace is important for those who install and service electrical systems. Nothing can replace a human being loved one that has died or suffered the irreparable consequences of an electrical accident. No matter how much one tries to safeguard people or how much safety training is provided; the ultimate responsibility lies with the people at the work place. Unfortunately, it is always a human factor in most of the accident or injury. Data collected in many studies show that more than 60% fires are of electric origin on account of electric short circuit, overheating, overloading, use or nonstandard appliances, illegal tapping of electrical wires, improper electrical wiring, carelessness and ignorance etc. (Fig 1) In India the data of NCRB since 1998 has been showing a continuous rise in number of deaths due to electrical fires. (Fig 2)

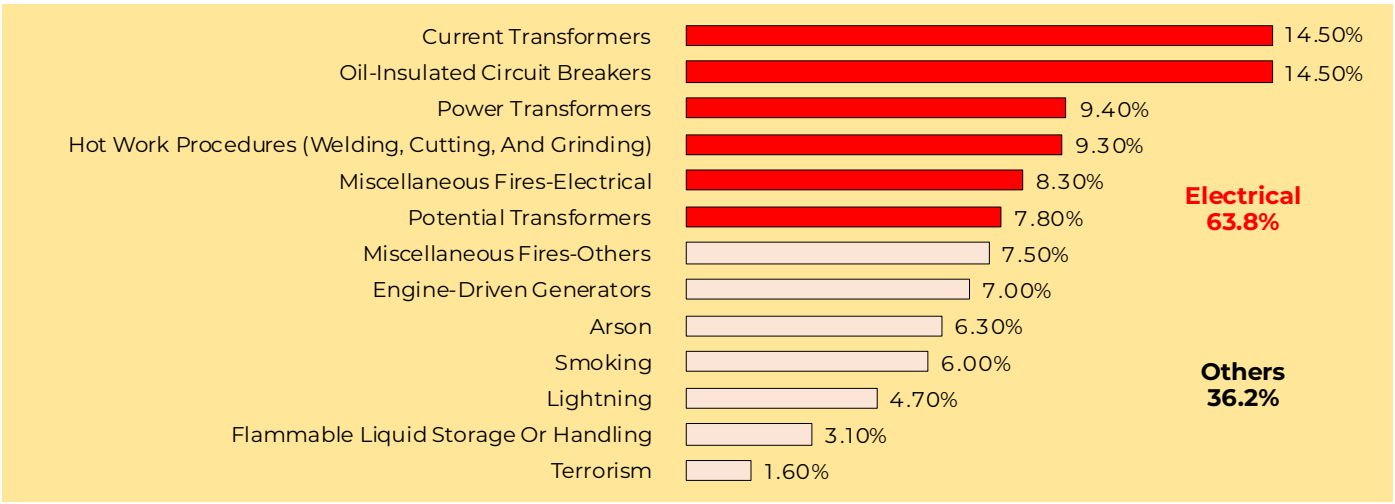


Fig. 1

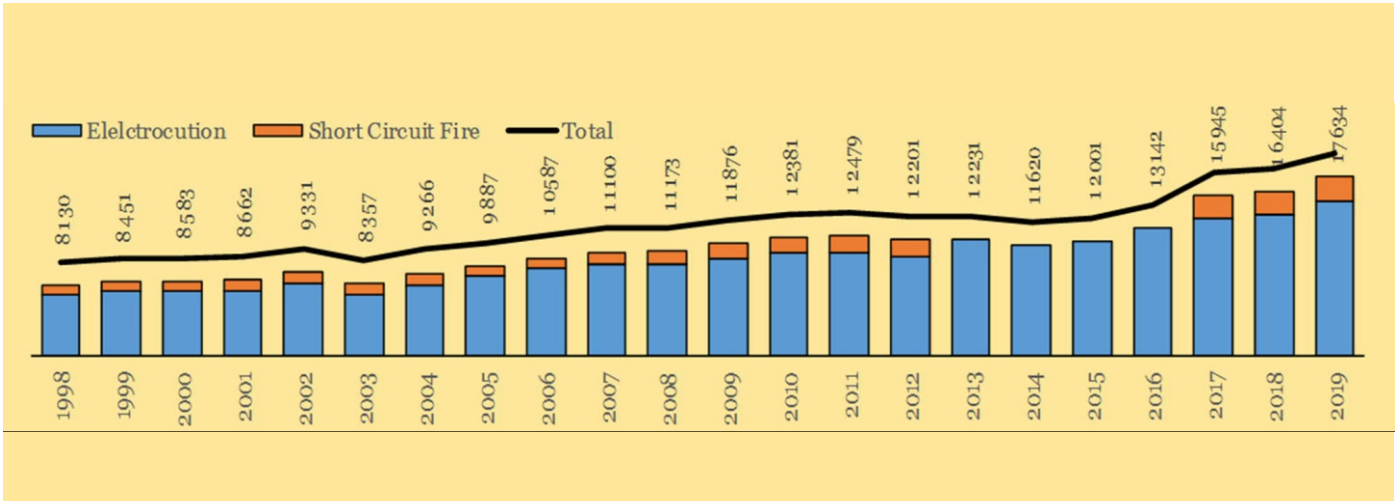
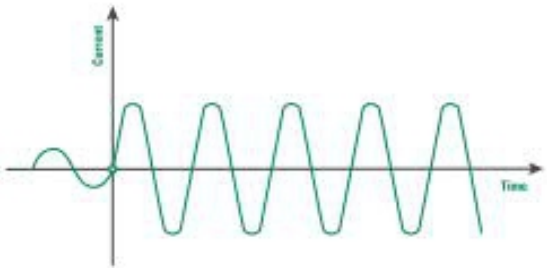
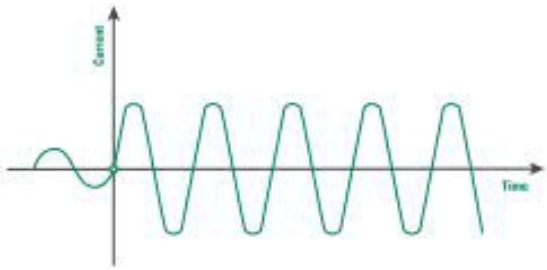


Fig. 2

Electrical fires spread rapidly causing loss of lives and property. It is, therefore, necessary to act fast, raise an alarm for help, and switch off power supply to de-energise the equipment. Use dry sand, CO2, dry powder or Halon extinguishers and these incidents / accidents can be minimized to a great extent if adequate fire precautions are observed. Even the simplest electrical system can become dangerous. Unless proper procedures are put in place & personnel are trained about the hazards of shock, arc flash and arc blast. Eliminating and/or reducing these hazards require a basic knowledge of electric circuits. The following is brief overview.

Understanding Nature of Electrical Currents Under Faults :

The system protection and circuit breakers must be able to differentiate between normal current variations that pose no threat to equipment, and dangerous overloads or short circuits that can cause extensive damage to equipment and compromise safety. Not all devices are designed to protect against both overloads and short circuits. These protective devices should be selected carefully to make sure they will open the circuit safely under any abnormal overcurrent condition. Fault Breaking ratings and opening times, especially under short-circuit conditions, must also be carefully chosen. Failure to select the properly rated overcurrent protective device can result in fires, explosions, and death.

Overload Fault	***Shot Circuit Fault***
	
An Overload is a flow of an abnormal current in the circuit when the load draws the excess currents due to any reason. However as the most conductors can carry a moderate overload for a short duration without damage to accommodate the transient conditions, if the overload persists for too long, excessive heat will be generated ultimately causing insulation failure. This may result in fires or lead to a short circuit.	A Short Circuit is any current not confined to the normal path. Short Circuits are usually caused by accidental contact or worn insulation and are more serious than overloads. Damage occurs almost instantly.

Interrupting Rating :

Also known as Interrupting Capacity or Breaking Capacity, is the highest symmetrical RMS alternating current which the equipment can handle / interrupt safely under standardized test conditions. Different set of equipment have different interrupting ratings and depending upon application, system voltage, fault level and configuration, suitable interrupting capacities from 10 KA to 75KA (even some makes also have started offering equipment with 300 KA breaking capacity in specific voltage ranges) re also available.

Historical Development of Electrical Safeties :

Historical time lines of evolution on electrical safety

1860	First Fuse Developed	1976	NFPA Formed
1880	AC/DC System Expanded	1979	NFPA 70E Released
1882	First Commercial Power Distribution Started By Edison	1982	Ralph H Lee Published A Research Paper On Electrical Arc Blast Burns
1889	Electric Chair Developed	1995	NFPA 70E Acknowledges Arc Flash Electrical Hazard
1890	Circuit Breaker Developed	2000	NFPA 70E Expanded On Arc Flash
1895	Five Different Electrical Safety Codes Were Developed	2002	NEC Introduces Warning Labels/IEEE Guidelines For Performing Arc Flash Calculation Released
1897	First NEC Codes Were Published	2004	NFPA 70E Expanded & Revised
1911	NEC Perfected Safety Protocols	2005	NEC Is Updated With New Safety Definition
1940	Current Limiting Fuses Developed	2007	The National Electrical Safety Code (Nesc) Made It Mandatory To Perform Arc Flash Assessment
1956	Charles Daiziel Started Research O Electrical Shock	2009	PPE Addressed In NFPA 70E
1969	Alice Still & Maria Chianta Initiated Study of Heat Related BurnInjuries Inventing Stoll Curve	2015	OSHA Updated Its Labelling Standards For NFPA 70E For Arc Flash
1970	USA Congress Cleared Occupational Safety & Health Act (OSHA)	2018	NFPA 70E Added Risk Assessment For Electrical Safety

Causes of Electrical Accidents & Electrical Fire :

The electrical fires can happen because of many reasons but most of them are due to lack of understanding of electrical system and taking this unseen energy for granted. Below give are some of the common causes of electrical accidents / fire:

- Assuming low voltages to be safe.
- Use of wrong / undersized wires and cables & switches.
- Using any metallic structure as earth / neutral.
- Improper protection devices (relays / high rupturing Capacity (hrc) fuses/ fuse wires etc.)
- Use of old & damaged tools / cables / appliances with Poor insulation
- Improper physical protection of electrical panels (entry of moisture & vermin)
- Excavating buried cable route without proper Identification.
- Dropping tools to live bus bars accidentally while Working.
- Repairing electrical equipment / hand tools with Power on.
- Insulation damage / failure due to dragging of Metallic objects above cables
- Improper positioning of scaffolding / crane boom Touching live overhead lines.
- Haphazard way of taking power from dbs / panels
- Mismatched plug sockets and with multiple twisted Joints.

Prevention of Electrical Fire :

- Always allow only authorized person to work on Electrical system
- Always treat electricity with caution.
- Never treat any electrical voltage safe.
- Always use standard equipment.
- Ensure any electrical modifications are done properly as per standards / norm.
- Regularly do health checks of electrical system & Attend the abnormalities.
- Always use system matched electrical equipment & Protection.
- In india, where aluminium is used extensively in Cabling & wiring, their joints need.
- To be checked periodically to access the condition of oxidation.
- Keep checking for any minor pin holes in cables / wires which can cause arc fault Leading to fire.

Electric Current Flow & its Effect on Human Body (1 Sec Exposure) :

When an electrical current passes through the body, the nervous system experience an electric shock. The intensity of the shock depends mainly on the strength of the current and the path taken by the current through the body and the duration of contact. In extreme cases the shock causes the failure of the normal action of the heart and lungs, resulting in unconsciousness or death. Researches have shown that the current below 5mA are not dangerous. The current above 5mA is dangerous because it can cause damages to human body depending upon level of current and for the duration it has been allowed to pass though the body (as shown below).

Effects of Electrical Current in The Human Body		
Current	Reaction	1000
10 Amp 1.0 to 4.3 Amp	Cardiac arrest, Severe Bums, Death is probable. Rhythmic pumping action of the heart ceases. Muscular contraction and nerve damage occur; Death is likely.	500 300
50 to 150 mA 9 to 30 mA (men)	Extreme Pain, Respiratory arrest, Severe muscle Reactions, Death is possible The freezing current or “Let Go” range. If extensor muscles are excited by shock, The person may be thrown away from the por source. Individuals cannot let go strong involuntary reactions can lead to other injuries	200 100 90 60 30
6 to 25 mA (women)	Painful shocks, Loss of muscle control	20
5mA	Slight shock felt. Not painful but disturbing, Average individual can let go, Strong involuntary reactions can lead to other injuries	10 5
1 mA	Faint tingle	2
Below 1mA	Generally not pereceptible	1

The resistance of human body taken between two hands or between and legs ranges 500mA to 50k Ω If the resistance of the human body has assumed as 20k Ω, then a contact with 230 volt supply can be potentially fatal, 230/20,000 = 11.5 mA.

Types of Electrical Accidents :

Falls

Fall happens due to muscle contractions, or a locked reaction, when the electrical current flows through human body. This can cause serious injuries

Burns

As much as 80% of all electrical injuries are burns and occurs when anyone touches electrical wiring or equipment without proper protection and / or the equipment is improperly insulted, used or maintained

Electrical Shock

An electrical shock is an electrical harm that does not result in death. Still the effect can be very serious form physical damage to internal damage to human body

Electrocution

In contrast to electrocution, An electrocution means that a person has died as a result of an exposure to electricity

Safe Work Practices :

First & foremost thing to ensure electrical safety is that the person who is expect to work on electrical system is properly trained and qualified for the job and that he also thoroughly understand the job as with any minor lapse even a properly qualified workers may be exposed to accidents. That's why it's important to make safety an integral part of the planning process for every job.

Other Important Safety Tips to Help Avoid Electrical Injuries / Accidents Include :

- Regularly conduct electrical system hazard and operability (ehazop / safop) study which is a structured and systematic examination of electrical system in order to identify and evaluate hazards that may represent risks to personnel or equipment, or prevent efficient operation.
- Identify the electric shock and arc flash hazards, as well as others that may be present.
- Use the right tools for the job.
- Isolate equipment from energy sources.
- Frequently test all the components / equipment of electrical system at planned time gaps, keep records and watch for any abnormalities to take corrective action.
- Follow lock out / tag out and ground before working on equipment & start the work only when the system is de-energized.
- Treat de-energized electrical equipment and conductors as energized until lockout / tag out, test, and ground procedures are implemented.
- Use recommended PPEs as recommended depending upon the type of electrical system

Epilogue :

Being most convenient form of energy electricity has become an integral part of our daily lives but it is also one of the largest life taking factor if not handled properly. Anyone can be exposed to electrical hazards at home or work. Trainings, precaution, awareness, rules and regulations can only guide people to use electricity safely yet they cannot guarantee of 100% safety if people do not use electricity judiciously. Below given are some general statistics related electrical hazards to highlight the dangers involved when due respect is not given to the electrical energy while utilising the tremendous benefits it offers to human race.

Some Statistics of Electrical Hazards and Electrical Safety Organization :

1) According to osha 10% of job fatalities due to the electrocution.
2) 97% of all electricians have been shocked or injured on the job.
3) Approximately 30,000 workers receive electrical shocks yearly.
4) Over 3600 disabling electrical contact injuries occur annually.
5) Electrocutions are the 4th leading cause of traumatic occupational fatalities.
6) Over 2000 workers suffer each year with severe arc flash burns.
7) Estimates show that 10 arc flash incidents occur every day in the us.
8) 10% of workplace accident deaths are caused by burn injuries.
9) Over 1000 electrical workers die each year from workplace accidents.
10) Medical costs per person can exceed $4 million for severe electrical burns.
11) Total costs per electrical incident can exceed $15 million.
12) In the year 2002, work injuries cost americans $14.6 billion
13) According to nfpa 25% of all fires occurs due to electricity
14) About 12 people dead in india daily due to electrocution according to ncrb.

References :

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ii) Electrical Fire Prevention A Publication by Schneider Electric

iii) Electrical Fire Safety-Handbook - सचेत by BIS & IEEMA

iv) International Journal of Engineering Innovation & Research, Volume 5, Issue 3, ISSN: 2277 – 5668

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