




Electrical Safety Techniques for Industry presented by Steve Mackay

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EIT Micro-Course Series

- Every two weeks we present a 35 to 45 minute interactive course
- Practical, useful with Q & A throughout
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Principles of Safety Rules

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Safety is Critical

A number of serious accidents and fatalities occur every year in industry ranging from electrocution, shock, explosions and arc blast.

A short review of the key issues here ranging from electrical shock and methods of prevention to arc flash, earthing and bonding and safety in substations.

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Objectives

- Course overview
 - Hazards of general nature in industrial installations
 - Electrical hazards
 - Requirements for safe working on electrical installations
 - o Technical measures
 - o Preventive measures
 - o Organisational measures such as improving the knowledge at work place and certification of competency



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Overview

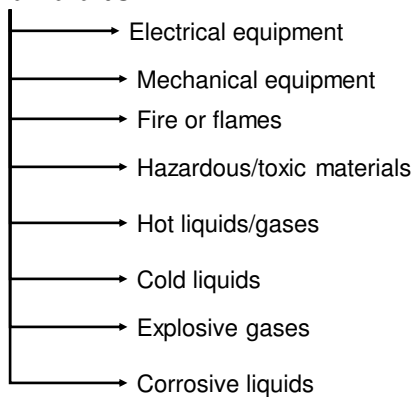
- Improper use of electricity or careless handling of electrical equipment leads to a number of avoidable accidents every year, resulting in huge loss of productive man-hours, monetary compensation liability to the employer and sometimes instances of fatalities.
- **Safety**
 - Safety should be built into the design of electrical equipment.
 - Incorrect selection and application of even the most well designed piece of electrical machinery can give rise to hazardous conditions.
 - Care is required in operation and maintenance of any electrical equipment to avoid accidents.
 - Appropriate knowledge of equipment and systems is a must for each and every person who operates or maintains the equipment
 - All electrical equipment/installations must be monitored closely for their continued safe operation.

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Industrial hazards

- **Industrial hazards**

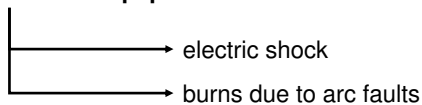


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Hazards due to electrical/ Mechanical equipments

- **Hazards due to electrical equipment**



- **Hazards due to mechanical equipment**

- Injuries from moving parts of static machinery
- Injuries from moving vehicles
- Injuries from falling objects (including head injuries)
- Injuries from flying objects following an explosion
- Injuries to eye from moving particles
- Injuries to eye from prolonged exposure to bright light
- Loss of hearing due to prolonged exposure to noise

- **To Avoid Hazards due to mechanical equipment**


- implement safety through proper equipment design
- adopt safe working practices in operation and maintenance

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Hazards due to Toxic materials/ Fire

- **Hazards due to Toxic materials**
 - External contact on skin and eyes
 - Ingestion
 - Inhalation
- **Fire hazard**
 - short circuit
 - excessive heat produced in conductors and sometimes the arc flash
 - Necessary to install alarm systems to warn of incipient fires and fire fighting measures appropriate to the materials
 - Install automatic extinguishing systems to limit the damaging effects of a fire.

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Hazards from hot surfaces, liquids or gases


A common cause of industrial accidents is burn injuries from contact with hot surfaces, liquids or gases.

Enclosures of electrical equipment can often attain high temperatures when they are in operation and contact with them can cause burn injuries.

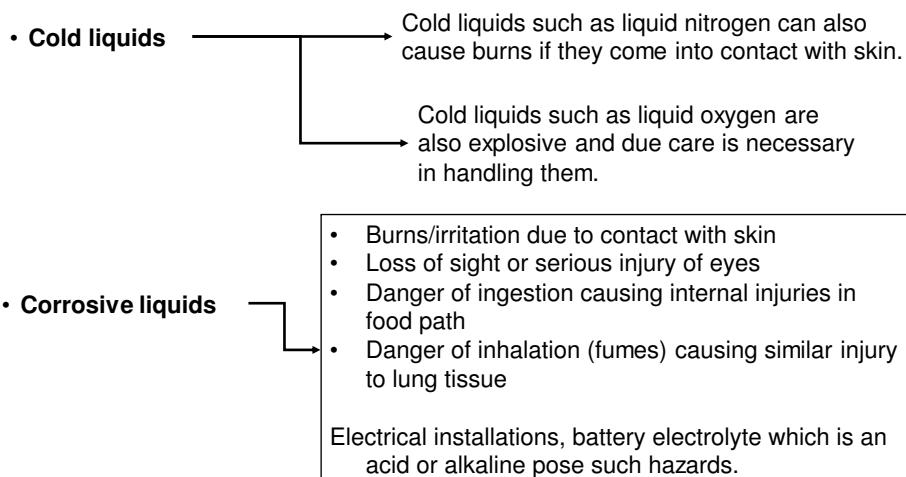
Similar precautions are also necessary in the case of other hot substances includes handling of molten metals and hot gases including steam.

Molten metals should also be prevented from coming into accidental contact with water since, the its sudden evaporation can result in explosions and splashing of liquid metal.

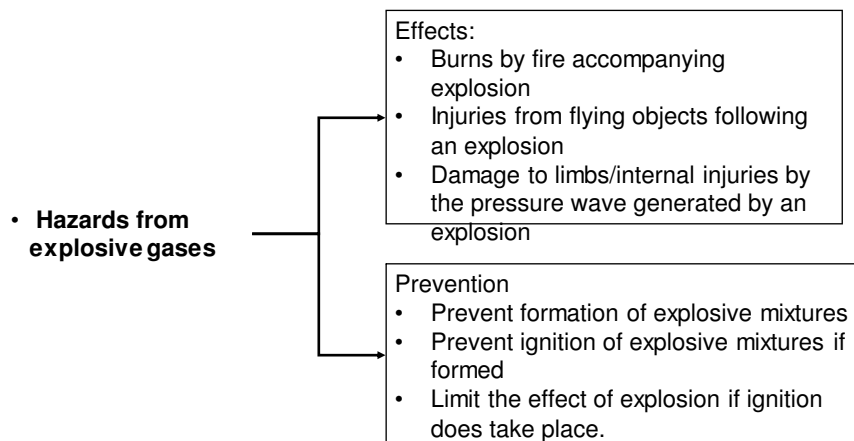


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Hazards from cold/ corrosive liquids




Hazards from explosive gases




Electrical hazards

- Electrical hazards
 - Electric shock and associated effects
 - Internal organ damage due to passage of electricity through body
 - Burns on skin at point of contact
 - Injuries by electric shock combined with fall
 - Temperature hazards due to high temperature during operation
 - Arc flash causing external burns and injuries by explosive expansion of air due to the arc.




- Electric shock
 - Electric shock is a result of the following conditions.
 - Exposure to live parts (Direct contact)
 - Exposure to parts that accidentally become live (Indirect contact)
 - Potential difference between different points in the earth under certain conditions

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Electrical hazards

- **Electric Shock**
 - ↓
 - Direct contact of equipment**
 - Current flow through body and results in muscular contraction
 - If the current flows through heart muscles it can cause stoppage of heart (fibrillation).
- **Other Hazards**
 - Accumulation of static electrical charge while processing/conveying materials also poses hazards of electric shock, ignition and explosion.
 - Burn injuries result from an arc flash. The seriousness of injury depends on:
 - Fault energy as given by the fault level of the system (VA)
 - Time of fault clearance

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Electrical equipment hazards

Type of equipment	Hazards
Generation equipment	Electric shock, arc flash, mechanical hazards
Transformers	Electric shock, arc flash, fire hazard
Overhead Transmission/distribution lines	Electric shock, arc flash, fall from heights
Cables	Electric shock, arc flash, fire hazard
Bus ducts	Electric shock, arc flash, thermal hazard
Distribution equipment	Electric shock, arc flash, thermal hazard, fire hazard
Motive equipment	Electric shock, arc flash, thermal hazard, mechanical hazards
Heating equipment	Electric shock, arc flash, thermal hazard
Lighting equipment	Electric shock, arc flash, thermal hazard, fall from heights
Uninterrupted power supplies with battery	Electric shock, arc flash, hazards from corrosive liquids and explosive gases

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Electrical accidents and safety measures

Electrical accidents happen mostly as a result of the following:

- Failure to isolate or inadequate or insecure isolation of live parts (60%)
- Poor maintenance and faulty equipment (30%)
- Insufficient information about the system being worked on
- Carelessness and lack of safety procedures

Safety Measures:

- Isolation measures and work on/near live equipment
- Eliminate faults to improve safety
- Improved knowledge level



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Safety measures

Technical measures

- Safe design/installation of plant and equipment as per applicable codes and regulations
- Posting clear warning signs at points of hazard
- Use of equipment/sensors to warn incipient problems with automated hazard containment measures

Accident prevention measures

- Safe operating and maintenance practices established through documented procedures and instructions
- Proper periodic inspection and prompt repairs
- Use of personal safety equipment mandated in safety procedures
- Avoiding live or hot work except as mandated in the relevant codes of practice and carried on using the stipulated procedures and precautionary measures.

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Safety measures

Organisational measures

- Creating an organizational safety structure to handle safety issues, lapses and accidents
- Documenting the procedures required to operate and maintain different electrical installations in a work place, reviewing them vis-à-vis the various applicable regulations and updating them to keep these procedures in step with regulatory changes
- Appropriate knowledge on the part of workers by proper structured training
- Establishing the requirements for levels of competence for operating electrical equipment, carrying out or supervising the issue of work-permits to work on equipment and for normalization of system after completion of work and carrying out or supervising maintenance work on equipment on which a permit-to-work has been issued.
- Creating and enforcing a system for certification of personnel in accordance with the competence levels demanded by their duties.
- Create and encourage safety awareness among the workforce

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Summary

- Improper use of electricity or careless handling of electrical equipment leads to a number of otherwise avoidable accidents. .
- Electrical safety is a well-legislated subject and the various acts and regulations enacted in each industrialized country
- Safety is not simply a matter of taking precautions in the workplace but has to start at the stage of equipment design.
- Electrical hazards are mainly from electric shock, fall as a result of an electric shock, burns due to arc flash and injuries by explosive expansion of air due to the arc.
- Failure to isolate or inadequate or insecure isolation of live parts is the reason for over 60% of accidents.

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Summary

- Poor maintenance and faulty equipment, insufficient information about the system being worked on and lack of safety procedures are the other major reasons for electrical accidents.
- The possibility of accidents can be reduced substantially by various steps starting with the design of equipment to include appropriate safety features, installation in accordance with relevant regulations, adopting proper documented procedures,
- Adequate training to working personnel and creating safety awareness among the workforce, are also the measures which can prevent accidents.

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